ORIGINAL RESEARCH

SECONDHAND AND THIRDHAND TOBACCO SMOKE EXPOSURE IN CHILDREN LIVING IN STATES CONTAINING APPALACHIAN COUNTIES: A SURVEILLANCE

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ABSTRACT
Objectives: Exposure to second-hand smoke (SHS) is a known child health hazard, but surveillance information concerning its prevalence in rural children living in the 13 U.S. states containing Appalachian counties is lacking. The purpose of this study was to determine the exposure to SHS, and exposure to a smoker's clothing, hair, and breath (third-hand smoke; THS) of rural children living in states containing Appalachian counties as compared with urban children living in the same states. **Methods:** The 2007 U.S. National Survey of Children's Health database was used to evaluate 22,196 participants aged 18 years or older who responded for a randomly selected child in the household. Participants addressed queries about the tobacco smoke exposure of the child. The households were dichotomized into rural or urban households based upon definitions utilized by the Rural Health Research Center. **Results:** The states containing Appalachian counties had an overall SHS exposure of 11.7% (95% confidence interval = 95%CI: 11.1, 12.3). Urban children in those states had a SHS exposure of 10.2% (95%CI: 9.6, 10.8); and rural children had a SHS exposure of 16.1% (95%CI: 14.6, 17.6). These states also had an overall THS exposure of 19.6% (95%CI: 18.4, 20.8). There were no significant difference between the urban children (19.0; 95%CI: 17.7, 20.3) and rural children (21.4; 95%CI: 19.2, 23.6) in THS exposure. **Conclusion:** In a large survey of the states containing Appalachian counties, more rural children were exposed to second-hand smoke than urban children living in the same states.

Key Words: Second-hand tobacco smoke; Third-hand tobacco smoke; National Survey of Children's Health; Appalachia; United States of America.

INTRODUCTION

Second-hand smoke (SHS) exposure, passive smoke, or involuntary exposure to tobacco smoke (previously referred to as environmental tobacco smoke) are defined by the U.S. National Cancer Institute as being exposed to (1) "sidestream" smoke, which is the smoke from burning tobacco, and (2) "mainstream" smoke, which is the exhaled smoke of the smoker (HHH, 2004; NCI, 2003; Moritsugu, 2006).   The World Health Organization reported that 40% of children, worldwide, are regularly exposed to SHS in their homes (WHO, n.d.). Childhood SHS exposure is not equally distributed. The highest prevalence was in Europe, particularly in Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine, where the proportion of children exposed to SHS was 61% (Oberg et al, 2011). Other regions with high proportions of children exposed to SHS were: the western Pacific, Indonesia, Sri Lanka, and Thailand, with more than 50% of some population groups exposed (Oberg et al, 2011). The proportion of children exposed to SHS was lower in the Americas and eastern Mediterranean regions (Oberg et al, 2011).   In Australia, 28% of Indigenous children and 9% of non-Indigenous children are exposed to SHS (Australian Institute of Health and Welfare, 2009). In Africa, the exposure was assessed to be at 12 to 13% (Oberg et al, 2011).

SHS exposure is associated with sudden unexplained infant death (HHH, 2004), respiratory infections, middle ear disease, asthma, and increased blood levels of lead in children (Mannino et al, 2003).   Increased blood levels of lead are associated with decreased intelligence, impaired growth, anaemia, and attention and behavioural problems (Mannino et al, 2003). There is a greater than expected effect of SHS exposure upon the genetic propensity to asthma, resulting in a greater than expected amount of asthma developing in children than on the basis of independent genetic and SHS exposure effects alone (Jaakkola et al, 2001a). SHS exposure is also associated with adverse effects on foetal growth (Perera et al, 1999; Hofhuis et al, 2003), and preterm birth in pregnant women who do not smoke (Windham et al, 2000; Jaakkola et al 2001b).

SHS has over 7000 components (HHH, 2004). Some contaminates are more concentrated in SHS than in first hand smoke (Wong et al, 2004; Yuan et al, 2007). SHS has twice as much nicotine, tar, nitric oxide, and carbon monoxide levels as first hand smoke (Wong et al, 2004). SHS generates the aromatic amines, o-toluidine, 2-naphthylamine, and 4-aminobiphenyl posing carcinogenic risks to those exposed to SHS (Wong et al, 2004).

Third-hand smoke (THS), has been defined as the tobacco smoke contaminants and by-products that remain in the clothing, hair, carpet, furniture, etc., after extinguishing a tobacco product (Ballantyne, 2009; Winickoff et al, 2009; Hurt, n.d.). Studies indicate that THS results in rapid, persistent absorption of nicotine, which reacts with ambient nitrous acid, to form carcinogenic tobacco-specific nitrosamines onto indoor surfaces, clothing and skin with the potential of dermal, inhalation, and ingestion exposures to children (Sleiman et al, 2010; Petrick et al, 2011). The amount of THS exposure and exposure to nicotine by-

products is related to the substrate (nature of the indoor surface, clothing, carpeting, drapes, furniture, etc.) and relative humidity (Petrick et al, 2011, Ueta et al, 2010). In a study of the change in occupancy of homes and THS, homes previously occupied by smokers and vacant for up to two months still had THS, even after the homes were cleaned and prepared (some were painted and recarpeted) for new residents (Matt et al, 2011).

Studies often use serum cotinine, a biomarker for nicotine, to establish prior exposure to nicotine. Cotinine is present and detectable in serum and urine for several days after a person has been exposed to nicotine. Based on cotinine measurements, approximately 22 million U.S. children aged 3 to 11 years, and 18 million non-smoking U. S. adolescents aged 12 to 19 years were exposed to SHS in 2000 (Moritsugu, 2007). An analysis of National Health and Nutrition Examination Survey data from 1999–2002 indicated 24.9% of children aged 3 to 11 years lived with one or more smokers in the household, but the serum cotinine biomarker indicated a 59.6% exposure to nicotine (0.05ng/ml or higher serum cotinine) (Moritsugu, 2007). Geographic areas in the U.S. varied in reported exposure prevalence from a low of 11.7% in Utah to a high of 34.2% in Kentucky (Moritsugu, 2007). Throughout the world, attempts have been made to protect children from SHS in response to Article 8 of the WHO Framework Convention on Tobacco control which requires appropriate smoke-free measures by the countries ratifying the global health treaty (Mittal and Das, 2011). Although globalization of tobacco began with Columbus's introduction of it to Europe 500 years ago, public health initiatives to deter its use are barely 50 years old, and the response to SHS and THS is in its infancy and faces many challenges (Glynn et al, 2010). In India, 21.9% of children aged 13 to 15 years are exposed to SHS in their own homes and a community based cross-sectional study there indicated a 73.3% failure of their initiatives to have smoke-free homes (Mittal and Das, 2011). A United Kingdom qualitative study of parents/guardians who smoked indicated that, despite the growing epidemiological evidence, they did not recognize child SHS exposure as a clear-cut health issue (Holdsworth and Robinson, 2008).

One U.S. geographic region that is associated with similar need for health education, and is also known for health disparities, is Appalachia, consisting of specific counties in the 13 states that include the Appalachian Mountain chain. Current data concerning SHS and THS exposure to children in this geographic region is lacking. The purpose of this research was to compare the rural and urban exposure of children to SHS and THS in the 13 states that include Appalachian counties. The research hypotheses are: 1) rural children living in states with Appalachian counties have a higher exposure to SHS than urban children living in the same states; and 2) rural children living in states with Appalachian counties have a higher exposure to THS than urban children living in the same states.

METHODS
The data source for this study was the 2007 U.S. National Survey of Children's Health (NSCH), a de-identified, open-access database which did not require institutional review board approval to conduct a secondary data analysis. Ethical consideration of disclosure of personal information was precluded by the de-identification of participants in the study data by the NSCH which provided the data. The Centers for Disease Control and Prevention's National Center for Health Statistics supervised the State and Local Area Integrated Telephone Survey Program (SLAITS) for the Maternal and Child Health Bureau and the Department of Health and Human Services in the collection of the data (HRSA, 2007). The study design and study methodology are available in detail elsewhere (HRSA, 2007). In summary, the 2007 NSCH survey involved computer assisted telephone interviews contacting 1 million households in the U.S. to screen for childhood immunization and collect health-related, age-eligible information. The SLAITS collected the land-line numbers, used a 50% rule for directory listings in identification of the estimation areas and determined banks of 100 consecutive numbers with prefixes assigned (HRSA, 2007). Adjustments were made for those not having land-lines; homes that had interrupted telephone service were weighted to represent those with no land-line (HRSA, 2007). The sample was divided into sub-samples which were updated every 3 months with software which removed known businesses, phones on the "no call" list, and duplications (HRSA, 2007). The system sent advance letters by reverse matching of addresses. There were at least 6 repeat calls for an improved response rate. If the SLAITS samples were too small, there were additional samples created independently. The samples were adjusted with weighting to be representative of the population (HRSA, 2007). The Appalachian population of children under age 18 is 22.7% non-Hispanic White, 30.0% non-Hispanic Black, and 33.0% Hispanic as of the 2000 census (Pollard, 2004). The NSCH response rate was 46.7% and the alternate resolution rate was 89.9%, which reflected the repeated calling (HRSA, 2007).

Parents or guardians of children aged 0 to 18 years living in the home selected by SLAITS were eligible for participation. After obtaining consent, one of the children in the home was randomly assigned to be the object of the interview. The interviews occurred between April 2007 and July 2008 and involved 91,642 participants nationally with at least 1,700 participants per state.

Geographic location and SES in Appalachia
Appalachia is the area surrounding the 2,400 km Appalachian chain (Pollard, 2004). By a federal-state partnership created by Congress in 1965, the Appalachian Regional Commission (ARC) was created. The ARC defined Appalachia in 1965 as 410 counties in eastern North America (Pollard, 2004). In 2008, 10 additional counties were added to the region by the Appalachian Regional Commission (ARC, n.d.). Appalachia is 42% rural, includes 24.8 million people, and had a poverty rate in 2008 of 18% (ARC, n.d.).

This analysis used the 13 states which contain Appalachian counties: Alabama, Georgia, Kentucky, Maryland, Mississippi, Ohio, Pennsylvania, New York, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. Many rural areas in these states are isolated due to the hills and rapidly rising mountain peaks to over 1,200 meters (Huttlinger et al, 2009) and many lack basic infrastructure such as roads, community water, and sewage (ARC, 2010). The study population, in addition to the NSCH study's overall inclusion description, had a residential inclusion in that respondents had to be living in one of the 13 states which contain Appalachian counties at the time of the interview.

Definitions for rural and urban that were used were Version 2 definitions developed at the University of Washington in collaboration with the U.S. Health Resources and Service Administration's Office on Rural Health Policy, the U.S. Department of Agriculture's Economic Research Service, and the Washington, Wyoming, Alaska, Montana, Idaho (WWAMI) Rural Health Research Center (RHRC, 2010). They officially classified rural and urban distinctions based on the U.S. Bureau of 2000 Census data, and a Rural Health Research algorithm which used commuting information, census-tract, and/or zip codes to identify and discriminate urban and rural areas (HRSA, 2007; RHRC, 2010).

SES was based on U.S. federal poverty levels (FPL) in effect in 2007. For the 48 contiguous states and Washington, DC, they were based upon the number of people in the family. A one-person family was at the FPL if his or her annual income was $10,210 or less; for 2 people in the family the limit was $13,690; for 3 people the limit was $17,170; for 4 people the limit was $20650; for 5 people the limit was $24,130; for 6 people the limit was $27,610; for 7 people the limit was $31,090; for 8 people the limit was $34,570; and for families above 8 people $3,480 was added for each person (Poverty guidelines, 2007). The indicator categories, 0-199% FPL, 200-299% FPL, 300-399% FPL and 400% and above, were developed by the Maternal and Child Health Bureau, National Center for Health Statistics and an expert panel of technical advisers as cut-points which provide critical distinctions in SES (HRSA, 2007).

Exposure: SHS and THS

SHS exposure was defined as a selection of the answer choice, "Yes, someone [in the household] uses tobacco, smokes inside child's home," to the question "Does anyone smoke inside the child's home?" The question relates to the U.S. Healthy Person 2010 Objective, 27-10, which concerns the exposure of children to tobacco smoke at home. THS exposure was defined as a selection of the answer choice, "Yes, someone [in the household] uses tobacco, not inside child's home," to the question "Does anyone smoke inside the child's home?". The response limited THS exposure to smoker's clothing and hair and excluded the children represented as having SHS exposure. There was less than 1% unknown (refused/don't know/missing) values which were excluded, and their exclusion did not change prevalence estimates (HRSA, 2007).

Statistical analysis

The Child and Adolescent Health Measurement Initiative (CAHMI) of the Data Resources Center for Child and Adolescent Health provides the NSCH as an open access database to encourage public data use to advance the health of children, youth and families (HRSA, 2007). An online, user-friendly data query tool based in SAS (Cary, NC, http://www.sas.com) and in SPSS (http://www.spss.com) Complex Samples permits analysis for prevalence data with confidence intervals and limited multivariate data analysis. The Child and Adolescent Health Measurement Initiative (CAHMI) is responsible for the analysis, interpretations, presentations and conclusions presented on the site providing Taylor linearization methods to calculate variance estimated for proportions which are in turn used to construct 95% confidence intervals (95%CI) using standard statistical formulae. The site was queried for tobacco use or non-use within the home and outside of the home with rural and urban status for the states in

the Appalachian region; and for tobacco use or non-use within and outside of the home with 4 levels of income utilizing the FPL. Site-generated weights were used to determine the regional prevalences. Due to sample size limitations of the NSCH data, state and Appalachian regional race/ethnicity specific analyses did not meet the standard for reliability or precision (HRSA, 2007).

RESULTS

Of the 91,642 national interviews, 22,196 respondents were residents of the 13 states which had Appalachian counties and who provided information to determine rural/urban status. Nationwide, the sample included 51.95% males and 48.54% females with 23.85% who identified as Hispanic, 40.59% as non-Hispanic White, 18.35% as non-Hispanic Black, 8.9% as non-Hispanic multi-racial, and 8.26% as non-Hispanic other.

The present study population, 22,196 participants, included 52.41% males, 7.46% who identified as Hispanic, 68.56% non-Hispanic White, 17.54% non-Hispanic Black, 3.81% non-Hispanic multi-racial, and 2.63% non-Hispanic other. They responded for children in the household who were aged 0 to 18 years. The nature of the population of rural Appalachia is different from the U.S. national population in that it is characterized as being influenced by geography and is primarily of European-descendent inhabitants (Goins et al, 2010).

Nationally, the overall SHS exposure of children was 7.6% (95%CI: 7.2, 8.0). The 13-state SHS exposure of children was 11.7% (95%CI: 11.1, 12.3) which was significantly higher than the national exposure. The national overall SHS exposure of children in terms of their race/ethnicity was: Hispanic: 2.6% (95%CI: 2.1,3.1); non-Hispanic White: 8.0% (95%CI: 7.5,8.5); non-Hispanic Black: 13.6% (95%CI: 12.2,15.0); non-Hispanic Asian: 1.6 (95%CI: 0.7,2.4); and non-Hispanic other: 10.3% (95%CI: 8.4,12.12).

The national urban SHS exposure of children was 6.5% (95%CI: 6.1, 6.9) and the national rural SHS exposure of children was 12.5% (95%CI: 11.4, 13.5). The national rural SHS exposure of children was statistically greater than the national urban prevalence. The 13-states' urban exposure to SHS of children was 10.2% (95%CI: 9.6, 10.8) and the rural exposure to SHS of children was 16.1% (95%CI: 14.6, 17.6). The 13-state overall, urban, and rural exposures were significantly higher than the corresponding national SHS exposures of children. The 13-state rural exposure to SHS of children was significantly greater than the corresponding SHS exposure of the region's urban children. Specific state data are presented in Table 1.

The national THS exposure, as defined as exposure to someone who uses tobacco, but not inside the child's home (excluding SHS exposure), was 18.6% (95%CI: 17.9, 19.2). The national urban THS exposure of children was 17.9% (95%CI: 17.2, 18.7). The national overall SHS exposure of children in terms of their race/ethnicity was: Hispanic: 20.0% (95%CI: 18.4, 21.5); non-Hispanic White: 19.38.0% (95%CI: 19.0, 19.6); non-Hispanic Black: 13.5% (95%CI: 13.4, 13.9); non-Hispanic Asian: 11.6 (95%CI: 9.1, 14.2); and non-Hispanic other: 24.4% (95%CI: 22.8, 26.1). The national rural THS exposure of children was 21.6% (20.2, 23.0). The national rural THS exposure was statistically greater than the national urban THS exposure.

In the 13 states with Appalachian counties, the overall exposure of children to THS was 19.6% (95%CI: 18.4, 20.8). The 13-state regional urban THS exposure of children was 19.0% (95%CI: 17.7, 20.3) and the 13-state regional rural THS exposure of children was 21.4% (95%CI: 19.2, 23.6). The values were not significantly different from the corresponding national values, or among the three (overall, urban, and rural) 13-state regional exposures of children. Specific state data are presented in Table 2.

Table 1: Percent exposure of children to second-hand smoke (SHS) in states with Appalachian Counties (95% CI)(NSCH, 2007).

Region	Overall	Urban	Rural
National total	7.6 (7.2,8.0)	6.5 (6.1,6.9)	12.5 (11.4,13.5)
13-State region	11.7 (11.1,12.3)*	10.2 (9.6,10.8)**	16.1 (14.6,17.6)***
Alabama	11.3 (9.0,13.7)*	8.9 (6.4,11.3)	17.5 (12.0,23.1)
Georgia	7.4 (5.1,9.7)	6.6 (4.1,9.1)	10.4 (4.8,16.1)[1]
Kentucky	17.6 (15.3,19.9)*	14.6 (11.5,17.7)**	19.8 (16.5,23.1)***
Maryland	7.2 (5.5,9.0)	6.7 (5.0,8.5)	16.5 (6.7,26.3)[1]
Mississippi	13.8 (11.5,16.0)*	10.8 (7.6,14.0)**	15.5 (12.5,18.6)
New York	7.9 (6.1,9.8)	7.1 (5.3,8.9)	15.3 (6.8,23.8)[1]
North Carolina	11.3 (8.9,13.7)*	10.5 (7.7,13.4)**	12.8 (8.4,17.3)
Ohio	16.3 (13.5,19.2)*	16.6 (13.3,19.8)**	15.6 (9.2,22.1)[1]
Pennsylvania	13.6 (11.0,16.2)*	11.3 (8.8,13.8)**	22.4 (14.7,30.1)[1]***
South Carolina	9.5 (7.7,11.4)	9.4 (7.3,11.5)**	9.7 (6.4,13.1)[1]
Tennessee	13.2 (10.8,15.6)*	10.4 (7.8,13.1)**	20.0 (15.0,24.9)***
Virginia	8.6 (6.6,10.5)	7.2 (5.2,9.2)	15.3 (9.5,21.1)[1]
West Virginia	17.9 (15.5,20.3)*	14.6 (11.3,18.0)**	20.8 (17.3,24.3)***

[1]sample size under 50, use caution in interpreting results; *significantly higher than national; **significantly higher than the national urban;***significantly higher than the national rural.

Table 2: Percent exposure of children to third-hand smoke (THS) in states with Appalachian Counties (95% CI)(NSCH, 2007).

Region	Overall	Urban	Rural
National total	18.6 (17.9,19.2)	17.9 (17.2,18.7)	21.6 (20.2,23.0)
13-State region	19.6 (18.4,20.8)	19.0 (17.7,20.3)	21.4 (19.2,23.6)
Alabama	21.5 (18.6,24.4)	20.9 (17.6,24.3)	22.9 (17.0,28.8)
Georgia	19.3 (16.4,22.2)	18.9 (15.8,22.1)	20.6 (13.9,27.3)
Kentucky	21.9 (19.4,24.4)*	17.9 (15.0,20.7)	24.9 (21.2,28.6)
Maryland	15.9 (13.5,18.3)	14.9 (12.6,17.3)	33.6 (19.5,47.7)[1]
Mississippi	21.3 (18.8,23.9)	23.6 (19.5,27.7)**	20.0 (16.7,23.2)
New York	16.9 (14.5,19.4)	16.7 (14.1,19.2)	19.2 (11.2,27.2)[1]
North Carolina	17.6 (14.9,20.3)	17.3 (14.0,20.5)	18.3 (13.5,23.1)
Ohio	20.2 (17.4,23.0)	19.7 (16.6,22.8)	22.0 (15.5,23.4)
Pennsylvania	19.0 (16.0,22.1)	18.3 (15.1,21.5)	21.8 (13.5,30.1)[1]
South Carolina	17.8 (15.4,20.1)	17.7 (15.1,20.2)	18.0 (13.5,22.4)
Tennessee	20.3 (17.7,22.8)	18.6 (15.7,21.6)	24.2 (19.2,29.2)
Virginia	17.2 (14.8,19.6)	15.9 (13.3,18.4)	23.6 (16.8,30.5)
West Virginia	20.3 (18.0,22.6)	19.2 (16.0,22.5)	21.2 (18.0,24.4)

[1]sample size under 50, use caution in interpreting results; *significantly greater than national; **significantly greater than the national urban.

Nationally and for the 13-state region with Appalachian counties, the highest exposure to SHS and THS of children had significant inverse dose-response relationships with the percent federal poverty level. Nationally, the children whose parents or guardian had household incomes in the 0-199%FPL category had a SHS exposure of 12.3% (95%CI: 11.5, 13.0), whereas the children whose parents or guardians had a household income in the 400% and higher FPL category had a SHS exposure of 2.3% (95%CI: 2.0, 2.6). Similarly, in the 13-state region which included Appalachian counties, children whose parents or guardians had household incomes in the 0-199%FPL category had a SHS exposure 18.8% (95%CI: 15.2, 22.3), whereas the children whose parents or guardians had a household income in the 400%FPL and above category had a significantly lower SHS exposure of 3.0%(95%CI: 2.6, 3.5). The 13-state regional children whose parents or guardians had household incomes in the 0-199%FPL and 300-399%FPL categories had significantly higher SHS exposure than the corresponding national categories, whereas the 200-299%FPL and 400%FPL and above categories had similar values to the national levels. Specific state values stratified by FPL are presented in Table 3.

Nationally, the children whose parents or guardians had a household income of 0-199%FPL category had a THS exposure of 23.1% (95%CI: 21.9, 24.3), whereas the children whose parents or guardians had a household income in the 400%FPL and higher category had a THS exposure of 12.6% (95%CI: 11.7, 13.6). Similarly, in the 13-state region with Appalachian counties,

the children whose parents or guardians had a household income in the 0-199%FPL category had a THS exposure of 22.6% (95%CI: 20.6, 24.4) and the children whose parents or guardians who had a household income in the 400%FPL and higher category had a THS exposure of 12.9% (95%CI: 11.2, 12.7).

Both national and regional trends were significant in demonstrating lower THS exposure with higher income, but there was no significant difference between the national and corresponding regional categories (Table 4).

Table 3: Percent exposure of children to second-hand smoke (SHS) stratified by percent Federal Poverty Level (FPL) in states with Appalachian Counties (95% CI)(NSCH, 2007).

Region	0-199% FPL	200-299% FPL	300-399% FPL	400%+ FPL
National total	12.3 (11.5,13.0)	8.0 (7.0,8.9)	4.8 (4.0,5.6)	2.3 (2.0,2.6)
13-State region	18.8 (15.2,22.3)*	10.0 (8.4,11.5)	7.1 (5.9,8.2)*	3.0 (2.6,3.5)
Alabama	14.9 (10.7,19.0)	4.6 (8.4,20.9)	5.4 (2.5,8.3)[1]	4.9 (1.9,7.8)[1]
Georgia	11.9 (7.3,16.6)[1]	5.8 (1.2,10.4)[1]	4.0 (0.5,7.6)[1]	3.0 (1.0,5.0)[1]
Kentucky	26.8 (22.5,31.1)*	14.0 (9.3,18.7)*[1]	13.5 (9.0,18.0)*[1]	4.6 (2.8,6.4)*[1]
Maryland	16.1 (10.6,21.6)[1]	7.7 (3.7,11.7)[1]	5.6 (2.6,8.5)[1]	2.5 (1.1,3.8)[1]
Mississippi	17.4 (13.8,20.9)*	14.3 (9.0,19.6)*[1]	6.8 (3.4,10.1)[1]	5.5 (3.2,7.8)*[1]
New York	12.2 (8.5,15.9)	8.9 (4.2,13.6)[1]	7.4 (4.2,13.6)[1]	2.5 (1.4,3.6)[1]
North Carolina	19.2 (14.2,24.2)*	7.3 (3.8,10.7)	6.3 (2.6,10.0)[1]	3.8 (2.2,5.4)[1]
Ohio	30.7 (24.7,36.7)*	10.8 (6.2,15.4)[1]	6.4 (2.9,10.0)[1]	2.8 (1.4,9.2)[1]
Pennsylvania	23.7 (17.9,29.4)*	11.9 (7.2,16.6)	12.1 (6.4,17.8)*[1]	2.9 (0.9,4.8)[1]
South Carolina	13.8 (10.3,17.3)	10.1 (6.4,13.7)[1]	7.8 (3.7,11.9)[1]	1.7 (0.5,2.8)[1]
Tennessee	21.0 (16.5,25.6)*	10.1 (6.2,14.0)[1]	5.7 (2.5,8.8)[1]	3.7 (2.2,5.3)[1]
Virginia	17.2 (12.1,22.4)	9.8 (5.7,14.0)[1]	3.2 (0.8,5.5)[1]	2.5 (1.2,3.8)[1]
West Virginia	27.0 (22.6,31.3)*	15.1 (10.8,19.4)*	6.4 (3.2,9.5)[1]	6.0 (3.6,8.3)*[1]

[1]sample size under 50, use caution in interpreting results; *significantly greater than the national prevalence in same column.

Table 4: Percent exposure of children to third-hand smoke (THS) stratified by percent Federal Poverty Level (FPL) in states with Appalachian Counties (95% CI)(NSCH, 2007).

Region	0-199% FPL	200-299% FPL	300-399% FPL	400%+ FPL
National total	23.1(21.9,24.3)	20.7(19.0,22.4)	15.6(14.1,17.1)	12.6(11.7,13.6)
13-State region	22.6(20.6,24.4)	20.9(17.9,23.8)	16.3(149,17.7)	12.9(11.2,14.7)
Alabama	23.8(18.8,28.8)	22.0(14.8,29.1)	19.5(12.8,26.2)[1]	17.5(13.7,21.3)**
Georgia	24.3(18.7,29.9)	19.5(13.3,25.8)	20.0(13.3,26.6)[1]	11.2(8.2,14.2)
Kentucky	25.1(20.9,29.4)	27.8(21.6,33.9)	14.3(9.7,18.9)[1]	15.4(11.9,18.8)
Maryland	20.3(13.7,26.9)	22.3(15.7,28.9)	14.6(94,19.7)[1]	11.5(9.1,13.9)
Mississippi	24.5(20.5,28.5)	21.5(16.1,27.0)	18.3(12.9,23.6)[1]	12.5(9.5,15.5)
New York	16.8(12.5,21.2)*	24.4(17.3,31.5)	17.6(11.3,23.9)[1]	13.0(9.6,16.3)
North Carolina	20.4(15.6,25.3)	21.0(14.0,27.9)	15.9(9.9,21.9)[1]	11.5(8.4,14.6)
Ohio	26.0(20.6,31.5)	20.4(14.6,26.2)	12.5(7.8,17.1)	15.3(11.3,19.4)
Pennsylvania	24.9(18.6,31.2)	16.5(10.5,22.4)	14.2(7.6,20.9)[1]	15.8(11.5,20.1)
South Carolina	23.8(19.4,28.3)	13.0(09.3,16.8)*	17.7(12.7,22.6)	10.1(7.6,12.5)
Tennessee	24.5(20.0,29.0)	20.3(14.8,25.8)	17.8(12.7,22.9)	12.9(9.8,16.1)
Virginia	22.1(16.3,27.9)	23.4(17.4,29.5)	16.4(11.0,21.9)[1]	10.1(7.9,12.3)
West Virginia	24.0(20.1,27.8)	20.1(15.4,24.8)	18.4(13.0,23.8)[1]	13.0(9.7,16.3)

[1]sample size under 50, use caution in interpreting results; *significantly less than the national prevalence in the same column; **significantly greater than the national urban prevalence in the same column.

DISCUSSION

Childhood exposure to SHS and THS is a public health concern due to the many and severe potential deleterious health consequences of tobacco smoke to children. This study indicates that, in the U.S., about 8% of children are exposed to SHS, while the children living in the 13 states which contain Appalachia had nearly 12% of its children exposed to SHS. Georgia and Maryland had lower SHS exposures than nationally, though within national confidence intervals. Rural areas on both the national and regional levels had more children exposed to SHS and the trend was stronger in the 13-state region. Low family income was associated with more SHS exposure in both groups and the trend was stronger in the 13-state region. THS, as defined as exposure to someone (in the household) who uses tobacco, but not inside the child's home (excluding SHS exposure) was approximately 19% both nationally and in the 13 states which contain Appalachian counties, with an increasing trend for rural over urban areas. Maryland, New York, and North Carolina had lower THS exposure than nationally, though within national confidence intervals. Though there is a lack of literature about passive smoke exposure in general, these results are similar to previously published studies showing that the prevalence of smoking in U.S. adults having rural residency is higher than U.S. adults with urban/suburban residencies, independent of other factors (Doescher, Jackson and Jerant, 2006; Vander Weg et al, 2010). Rurality has been independently associated with youth tobacco

use in America (Lutfiyya et al, 2008; Rhew et al, 2011) as well as rural youth in Washington state and Victoria, Australia (Coomber et al, 2011).

Nevertheless, these results are well below the 40% WHO estimation of child exposure to SHS (WHO, n.d.). There are few current U. S. studies which examine SHS exposures in a child's home. From the 1988-1994 NHANES parent/guardian reports of children aged 0 to 5 years approximately 38% of children were identified as having SHS exposure (Gergen, 1998). A study of urban caregivers (n=174) indicated that 56.3% of children aged 0 to 7 years lived with a smoker, and smoking was allowed in the home of 75% of the homes of the smokers, resulting in a SHS exposure of 20.7% (Hopper and Craig, 2000). The discrepancies between findings may exist as the result of the variation in the exposure questions posed and the ages considered in the studies.

One possible explanation of the strong effect that rurality, and counties in Appalachian states in particular, had on SHS and THS exposure is that these areas are important tobacco producing areas (Meyer et al, 2008) and that marketing strategies specifically focus on these areas (Ling et al, 2010; Meyer et al, 2008). Nevertheless, focus group analyses indicated that residents in Appalachian mountain rural areas recognize health warnings about tobacco (Meyer et al, 2008), therefore more research into the factors explaining SHS and THS exposure of children in rural regions is needed.

It is interesting to note the use of court adjudicated Tobacco Master Settlement (TMS) monies of 1998 (a 25 year distribution in most cases) and U.S. Centers for Disease Control (CDC) spending recommendations. Nationwide, 2% of the tobacco monies are being spent upon tobacco prevention and cessation programs (Elliot, 2008; Campaign for tobacco free kids, 2011). Of the four states in Appalachia with the highest rural SHS child exposure, Pennsylvania allocated 12% of the TMS for tobacco prevention and cessation, which is 11.4% of what the CDC recommended in 2010 (Campaign for tobacco free kids, 2011). West Virginia received a lump sum of settlement money, which was used to pay the state debt in 2008, but West Virginia is funding tobacco prevention and cessation at 20.5% of the CDC recommendation; Tennessee, before 2008 had no state fund directed to tobacco prevention, but has since funded a quit-line with 0.3% of CDC recommended spending; and Kentucky is using 10% of the TMS for tobacco and substance abuse programs, amounting to 4.9% of CDC recommended spending (Campaign for tobacco free kids, 2011). The programs are drastically underfunded to impact successfully on health promotion.

The strengths of this study include its large, representational, national nature and the rigorous character of the data collection. Also, the SHS exposure was well developed and provided options that reflected the Healthy People 2010 objectives. The Maternal and Child Health Bureau and the National Center for Health Statistics with a national expert panel of from other federal agencies, state Title V representatives, family groups, and child health researchers, developed, pretested, revised, and validated the questions.

The study also has limitations. The assessment of SHS exposure from parent/guardian reports might have inaccuracies due to social desirability bias. Availability of the biomarker, cotinine, a stable nicotine metabolite, to verify the veracity of the reported SHS exposure would have been advantageous, and as a result, SHS exposure is being used as a proxy measure of the child's exposure. Social desirability was not addressed in this study. Any self-reporting is potentially subject to under-reporting of behaviour which is considered socially unacceptable, such as exposing children to SHS or THS. This information bias would be expected to be non-differential in both rural and urban participants and would lead to a bias towards the null. Therefore, there is a potential for under-estimation of the prevalence of SHS and THS exposure of children both in rural and urban areas of states which have Appalachian counties.

Due to sample size limitations of the NSCH data in which state data had fewer than 50 participants, race/ethnicity analyses did not meet the standard for reliability or precision on a state basis (HRSA, 2007). Also, percent exposure to SHS in each of the 13-states' data and %FPL were under 50 participants in some circumstances, which limited the analysis possibilities and limits interpretation as to the effect of %FPL upon SHS exposure.

The study used data for the states which had Appalachian counties. The number of counties in Appalachia from 1965 to 2008 was 410, whereas Appalachia, as redefined by the Appalachian Regional Commission in 2008, now contains 420 counties (Pollard, 2004; ARC, n.d.). The number of counties in Appalachia may change over time. The 13 states have a total of 1047 counties. All West Virginia counties and most counties in Pennsylvania (except those in the Southeast) are in Appalachia.

In conclusion, in this nationally representative sample of U.S. adults reporting SHS and THS exposure of their children, it was found that there was a significantly higher amount of SHS exposure in rural respondents, and respondents with lower SES. The pattern was even stronger in states which had Appalachian counties. Understanding the surveillance data and the epidemiology of passive smoking is important for developing needed targeted strategies to help reduce child SHS and THS exposure. Education to restrict SHS and THS at home is needed to protect children from the adverse health consequences associated with SHS and THS (Mittal and Das, 2011). Community smoke-free policies have been helpful in preventing overall SHS and THS exposure, but home exposure remains problematic and dependent upon the decisions of parents/guardians to provide no smoking rules in their homes. Additionally, some research indicates that, in rural areas, making non-smoking normalized through policy change may be difficult (Hahn et al, 2010). Rural areas have fewer resources for mass media messages about smoking prevention and treatment which will require policies to fund education campaigns (Doescher et al, 2006).

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