Title

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ABSTRACT

Objective. We examined the levels and change in prevalence of self-reported secondhand smoke (SHS) exposure at home, and analyzed sociodemographic differences in exposure among children (aged 0–17 years) and nonsmoking adults (aged ≥18 years) in the United States in 2000 and 2010.

Methods. We included 18,731 children and 44,049 adults from the 2000 and 2010 National Health Interview Survey Cancer Control Supplements. We used multivariate logistic regression to determine the factors associated with exposure.

Results. The prevalence of self-reported SHS exposure declined from 2,627 of 10,636 (24.7%) to 663 of 8,095 (8.2%) for children and from 2,863 of 23,665 (12.1%) to 897 of 20,384 (4.4%) for adults from 2000 to 2010. SHS exposure declined for all population subgroups between the two years, but differences were found. Compared with 2000, children aged 12–17 years in 2010 were no longer more likely than children aged 0–5 years to be exposed to SHS. Non-Hispanic black children and adults were more likely than non-Hispanic white children and adults to be exposed to SHS in 2010. In 2010, no differences were found for children whose parents had a higher level of education, and no differences were observed for children or adults with high family income vs. other levels of family income. Children living in the Midwest and South had higher levels of SHS exposure than children in other regions in 2010.

Conclusions. Self-reported SHS exposure at home declined for all population subgroups from 2000 to 2010, but socioeconomic differences existed for some subgroups in both years. Current tobacco control policies need to be improved to reach all population subgroups so that SHS exposure can be further reduced, especially among vulnerable populations.

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Secondhand smoke (SHS) exposure has been linked to numerous health conditions, including respiratory illness, cancer, and heart disease for adults;[1,2] and middle ear disease, asthma, respiratory symptoms, abnormal pulmonary function, and attention deficit hyperactivity disorder (ADHD) for children.[3,4] The health effects of SHS exposure also result in excess economic costs. One study estimated the total annual SHS-attributable medical cost in the United States at $6.9 billion in 2005.[5] Another study reported that SHS exposure resulted in more than 42,000 deaths, nearly 600,000 years of potential life lost, and $6.6 billion of lost productivity in 2006 in the United States.[6]

SHS exposure occurs in three main settings: at home, in the workplace, and in public places. The home setting is the primary source of SHS exposure for children and a major source of exposure for non-smoking adults.[3] The prevalence of SHS exposure in the United States has been declining in recent years.[3,7] Using data from the National Health and Nutrition Examination Surveys (NHANES), a recent Centers for Disease Control and Prevention (CDC) report found that the percentage of the U.S. nonsmoking population (aged ≥3 years) with cotinine-measured SHS exposure declined from 52.5% in 1999–2000 to 25.3% in 2011–2012.[7] Previous studies have also reported socioeconomic differences in SHS exposure for both adults and children. A study using 1999–2010 NHANES data found that never-smoking adults (aged ≥20 years) in the lowest socioeconomic quintile were two to three times more likely than those in the highest quintile to be exposed to SHS at home.[8] Another study that used the 2007 National Survey of Children's Health in the United States found that, compared with children from higher socioeconomic backgrounds, children from lower socioeconomic backgrounds had higher odds of self-reported SHS exposure at home; and that non-Hispanic white, non-Hispanic black, American Indian, and mixed-race children had higher odds of SHS exposure at home than Hispanic children.[9] CDC's most recent report also found that cotinine-measured SHS exposure was highest among children aged 3–11 years, non-Hispanic black people, those living below the federal poverty threshold, and people living in rental housing during 2011–2012.[7]

Many smoke-free policies were implemented from 2000 to 2010,[10] which contributed to a decline in SHS exposure in the United States.[7] To examine whether or not all population groups benefited from these policies, we examined the change in prevalence of self-reported SHS exposure at home for children and nonsmoking adults in the United States from 2000 to 2010, assessed the sociodemographic factors associated with SHS exposure, and compared the significant factors in the two years.

METHODS

Data sources
We analyzed data from the 2000 and 2010 National Health Interview Survey (NHIS) Cancer Control Supplements.[11] NHIS is an annual, nationally representative, in-person survey of households in the civilian, noninstitutionalized population in the United States. In each sampled household, one adult and one child are randomly selected to provide detailed health information. For children, a knowledgeable adult in the household—usually a parent—answers questions about the child. Periodically, the same randomly selected core NHIS adult participants are also asked to participate in a Cancer Control Supplement, which contains detailed questions about tobacco use and exposure.

Measures

Nonsmoker. We defined nonsmokers as those who had not smoked 100 cigarettes in their lifetime (from the question, "Have you smoked at least 100 cigarettes in your entire life?"), or those who had smoked 100 cigarettes in their lifetime but currently do not smoke at all (from the question, "Do you now smoke cigarettes every day, some days, or not at all?").

Self-reported SHS exposure at home. Children and non-smoking adults were considered to be exposed to SHS at home if they lived in a household where residents smoked inside the home at least one day per week (from the questions, "In a usual week, does anyone who lives here, including yourself, smoke cigarettes anywhere inside this home?" and "Usually, about how many days per week do people who live here smoke anywhere inside this home?").

Covariates
Sociodemographic characteristics considered as covariates in our analyses included age, sex, marital status (for adults only), race/ethnicity, education level, poverty status, and region. We categorized marital status as married, single, widowed/divorced/separated, and living with a partner. We categorized race/ethnicity as non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic other, and Hispanic. We categorized education as <high school degree, general educational development (GED)/high school graduate, some college, and ≥college degree. For children, the education variable was based on their parents' highest education level. Based on the

ratio of self-reported family income to federal poverty thresholds that takes into account family size and number of children younger than 18 years of age,[12,13] we categorized poverty status into four groups: poor (0.00–0.99), low income (1.00–1.99), middle income (2.00–3.99), and high income (≥4.00). Because more than 15% of respondents had unknown income status, we categorized them as "unknown" in a separate group. We categorized region as Northwest, West, Midwest, and South.

Study sample
We examined self-reported SHS exposure at home for children (aged 0–17 years) and nonsmoking adults (aged ≥18 years) separately. NHIS did not ask smoking questions of children, so we considered all children to be nonsmokers. We limited the adult analysis to non-smokers, because it is difficult to separate the impact of active smoking and passive smoking for smokers. We included 18,731 children and 44,049 nonsmoking adults in the final study sample after excluding 1,084 respondents with missing information on marital status (for adults only) or education.

Statistical analysis
For both children and nonsmoking adults, we estimated the prevalence rate of SHS exposure among the entire study sample and the subgroups stratified by each covariate separately for 2000 and 2010. Using the χ^2 test from bivariate analysis, we determined the correlation between each covariate and SHS exposure. Changes in prevalence of SHS exposure were estimated and tested against the null hypothesis that the changes from 2000 to 2010 were zero using multiple independent z-tests on proportions. We estimated multivariate logistic regression models to determine the significant predictors of SHS exposure after controlling for other covariates. The dependent variable of the logistic regression model was 1 for respondents exposed to SHS and 0 for SHS-unexposed respondents. The models controlled for all the aforementioned covariates.

We estimated results by incorporating the appropriate sampling weights to adjust for selection probabilities from the sampling design and survey nonresponse, and by accounting for NHIS's multistage complex survey design. We conducted analyses using SAS® version 9.4 with PROC SURVEYLOGISTIC for logistic regression and PROC SURVEYFREQ for bivariate analysis.[14] We estimated adjusted odds ratios (AORs) and 95% confidence intervals (CIs) from the multivariate logistic regression models and set statistical significance at $p<0.05$.

RESULTS

Sociodemographic characteristics of the study sample
Among children in both years, more than half were male, were non-Hispanic White, had a parent with some college or higher education, and lived in a household with middle or high income; about one-third were in each age group; and more than one-third lived in the South (Table 1). Among adults in both years, more than half were female, were married, had some college or higher education, and had middle or high income; nearly half were aged 35–64 years; more than two-thirds were non-Hispanic white; and more than one-third lived in the South (Table 2).

Prevalence of SHS exposure
Among children, the prevalence of SHS exposure at home declined by 66.8%, from 24.7% (95% CI 23.6, 25.7) in 2000 to 8.2% (95% CI 7.5, 9.0) in 2010 (Table 1). In 2000, bivariate analysis results showed that SHS exposure rates differed significantly ($p<0.001$) by all sociodemographic characteristics except sex. SHS exposure was highest among children who were aged 12–17 years, were non-Hispanic black, had parents with a high school diploma/GED, were poor, and lived in the Midwest. SHS exposure was lowest among children who were aged 0–5 years, were non-Hispanic Asian, had parents with a college degree or higher education, had a high family income, and lived in the West. In 2010, bivariate analysis results showed that SHS exposure rates differed significantly only by age ($p=0.005$), race/ethnicity ($p<0.001$), and region ($p<0.001$). SHS exposure was highest among children who were aged 6–11 years, non-Hispanic black, and living in the Midwest; and lowest among children who were aged 0–5 years, non-Hispanic Asian, and living in the West. From 2000 to 2010, statistically significant declines in SHS exposure occurred for all subgroups except for children whose parents had at least a college degree. Substantial declines in prevalence of SHS exposure at home ranged from 39.7% for those in high-income households to 81.7% for those whose parents had a high school diploma or GED (Table 1).

Among nonsmoking adults, the prevalence of SHS exposure at home declined by 63.6%, from 12.1% in 2000 to 4.4% in 2010 (Table 2). In 2000, the prevalence of SHS exposure at home differed significantly by all sociodemographic characteristics except sex. SHS exposure was highest among adults who were aged 18–34 years, were non-Hispanic black, lived with a partner, had less than a high school education, were poor, and lived in the Midwest; and lowest among adults who were ≥65 years of age, were Hispanic, were married, had a

Table 1. Prevalence of secondhand smoke exposure[a] at home and adjusted odds ratios of exposure for U.S. children, by sociodemographic characteristics, National Health Interview Survey, 2000 and 2010[b]

Characteristics	2000					2010					Percent change in home SHS exposure from 2000 to 2010[c]
	Number of children	Prevalence of SHS exposure at home (95% CI)	P-value (χ²)	AOR (95% CI)	P-value (logistic regression)	Number of children	Prevalence of SHS exposure at home (95% CI)	P-value (χ²)	AOR (95% CI)	P-value (logistic regression)	
Total	10,636	24.7 (23.6, 25.7)				8,095	8.2 (7.5, 9.0)				−66.8
Sex											
Female	5,146	24.4 (23.0, 25.8)	0.590	Ref.		3,887	7.9 (6.9, 9.0)	0.472	Ref.		−67.6
Male	5,490	24.9 (23.5, 26.4)		1.04 (0.93, 1.16)	0.514	4,208	8.5 (7.4, 9.6)		1.08 (0.87, 1.32)	0.489	−65.9
Age, in years											
0–5	3,710	21.3 (19.7, 22.9)	<0.001	Ref.		2,857	6.8 (5.7, 7.9)	0.005	Ref.		−68.1
6–11	3,413	25.7 (23.9, 27.5)		1.30 (1.13, 1.49)	<0.001	2,406	9.9 (8.3, 11.6)		1.48 (1.15, 1.89)	0.002	−61.5
12–17	3,513	27.0 (25.2, 28.8)		1.43 (1.25, 1.65)	<0.001	2,832	8.0 (6.8, 9.2)		1.16 (0.91, 1.49)	0.227	−70.4
Race/ethnicity											
Non-Hispanic white	5,656	25.8 (24.4, 27.2)	<0.001	Ref.		3,402	9.7 (8.6, 10.8)	<0.001	Ref.		−62.4
Non-Hispanic black	1,568	31.2 (28.4, 34.1)		0.75 (0.64, 0.88)	<0.001	1,309	11.5 (9.5, 13.5)		1.12 (1.07, 1.43)	<0.001	−63.1
Non-Hispanic Asian	299	13.4 (8.8, 18.1)		0.56 (0.37, 0.85)	<0.001	468	3.0 (1.3, 4.6)		0.34 (0.19, 0.62)	<0.001	−77.6
Non-Hispanic other	310	25.9 (19.2, 32.5)		0.89 (0.62, 1.28)	0.524	370	11.3 (7.9, 14.8)		1.32 (0.91, 1.89)	0.345	−56.4
Hispanic	2,803	16.3 (14.6, 18.0)		0.33 (0.28, 0.40)	0.006	2,546	3.1 (2.3, 4.0)		0.38 (0.28, 0.53)	<0.001	−81.0
Parents' education level											
<High school	1,741	35.1 (31.8, 38.4)	<0.001	1.17 (0.97, 1.42)	0.102	1,205	9.4 (7.1, 11.6)	0.424	1.36 (0.95, 1.93)	0.453	−73.2
High school graduate/GED	2,661	39.3 (37.0, 41.7)		Ref.		1,764	7.2 (5.8, 8.6)		Ref.		−81.7
Some college	3,335	24.5 (22.7, 26.3)		0.53 (0.46, 0.61)	<0.001	2,525	8.4 (6.9, 9.8)		1.15 (0.86, 1.53)	0.350	−65.7
≥College degree	2,899	9.0 (7.8, 10.3)		0.18 (0.14, 0.22)	<0.001	2,601	8.3 (6.9, 9.6)		1.13 (0.82, 1.57)	0.091	−7.8
Poverty status[d]											
Poor (0.00–0.99)	1,450	38.3 (34.7, 41.9)	<0.001	Ref.		1,696	7.5 (5.9, 9.0)	0.439	Ref.		−80.4
Low income (1.00–1.99)	1,949	32.1 (29.5, 34.7)		0.84 (0.69, 1.02)	0.073	1,706	7.8 (6.4, 9.2)		1.07 (0.77, 1.48)	0.154	−75.7
Middle income (2.00–3.99)	2,897	23.8 (21.9, 25.7)		0.59 (0.48, 0.73)	<0.001	2,015	8.8 (7.2, 10.5)		1.28 (0.90, 1.84)	0.703	−63.0
High income (≥4.00)	2,443	13.1 (11.5, 14.8)		0.42 (0.34, 0.53)	<0.001	1,936	7.9 (6.4, 9.4)		1.14 (0.81, 1.59)	0.170	−39.7
Unknown	1,897	24.1 (21.6, 26.6)		0.56 (0.46, 0.69)	<0.001	742	10.0 (6.9, 13.0)		1.40 (0.88, 2.21)	0.448	−58.5

Table 1 (continued). Prevalence of secondhand smoke exposure[a] at home and adjusted odds ratios of exposure for U.S. children, by sociodemographic characteristics, National Health Interview Survey, 2000 and 2010[b]

Characteristics	2000					2010					Percent change in home SHS exposure from 2000 to 2010[c]
	Number of children	Prevalence of SHS exposure at home (95% CI)	P-value (χ²)	AOR (95% CI)	P-value (logistic regression)	Number of children	Prevalence of SHS exposure at home (95% CI)	P-value (χ²)	AOR (95% CI)	P-value (logistic regression)	
Region											
Northeast	1,902	25.9 (23.5, 28.2)	<0.001	Ref.		1,156	6.9 (5.0, 8.7)	<0.001	Ref.		−73.4
West	2,591	14.0 (12.3, 15.8)		0.46 (0.38, 0.56)	<0.001	2,288	3.0 (2.0, 3.9)		0.50 (0.32, 0.78)	0.002	−78.6
Midwest	2,365	29.3 (27.5, 31.1)		1.08 (0.92, 1.26)	0.351	1,732	12.6 (10.9, 14.4)		1.81 (1.31, 1.98)	<0.001	−57.0
South	3,778	26.9 (24.8, 29.0)		0.87 (0.73, 1.04)	0.122	2,919	9.5 (8.1, 10.8)		1.43 (1.03, 1.98)	0.033	−64.7

[a]SHS exposure at home: children living in a household where residents smoked inside the home at least one day per week

[b]2000 and 2010 National Health Interview Survey: Centers for Disease Control and Prevention (US), National Center for Health Statistics. National Health Interview Survey [cited 2015 Dec 9]. Available from: http://www.cdc.gov/nchs/nhis/methods.htm

[c]Except for children whose parents had ≥college degree, changes for groups were all statistically significant at p<0.05 based on chi-squared statistics from bivariate analyses.

[d]Ratio of self-reported family income to federal poverty thresholds

SHS = secondhand smoke exposure

CI = confidence interval

AOR = adjusted odds ratio

Ref. = reference group

GED = general educational development

college education, had a high family income, and lived in the West. In 2010, SHS exposure at home differed significantly by all sociodemographic characteristics except sex and poverty status. Prevalence of SHS exposure at home followed a similar pattern as in 2000, except that widowed, divorced, or separated adults had the lowest exposure. The percentage reduction in prevalence of SHS exposure at home between the two years ranged from 41.9% for adults with a college degree to 79.2% for non-Hispanic Asians (Table 2).

Factors associated with SHS exposure
Children aged 6–11 years were more likely than children aged 0–5 years to be exposed to SHS in both years. Children aged 12–17 years were more likely than children aged 0–5 years to be exposed to SHS in 2000, but this association did not exist in 2010. Compared with non-Hispanic white children, non-Hispanic Asian and Hispanic children were less likely to be exposed to SHS for both years, and non-Hispanic black children were less likely to be exposed to SHS in 2000 but more likely to be exposed to SHS in 2010. Children whose parents had at least some college education were less likely to be exposed to SHS in 2000 than children whose parents had a high school diploma or GED, while no significant differences were found in 2010 by educational attainment. Children who lived in a household with middle or high income had decreased odds of being exposed to SHS in 2000 than those in poor households, but no significant differences were found by poverty status in 2010. Compared with children living in the Northeast, those living in the West had lower SHS exposure for both years, while those who lived in the Midwest and South were more likely to be exposed to SHS in 2010 but had no significantly different exposure rate during 2000 (Table 1).

Adults aged ≥65 years were less likely than adults aged 18–34 years to be exposed to SHS in both years. Non-Hispanic black adults were more likely than non-Hispanic white adults to be exposed to SHS in 2010 but not in 2000. Hispanic adults were less likely than non-Hispanic white adults to be exposed to SHS in both years. Adults who were single or living with a partner were more likely than married adults to be exposed to SHS in both years. Those with less than a high school education were more likely than those with a high school diploma or GED to be exposed to SHS in 2000 but not in 2010. Adults with at least some college education were less likely than adults with a high school diploma or GED to be exposed to SHS in both years. The high-income group and those with unknown income were less likely than the poor group to be exposed to SHS in 2000, while no significant dif-

ferences in SHS exposure by poverty level were found in 2010. Adults living in the West were less likely to be exposed to SHS than adults living in the Northeast in both years (Table 2).

DISCUSSION

Our finding that self-reported home SHS exposure decreased by 66.8% for children from 2000 to 2010 is consistent with a study that found that self-reported home exposure to SHS decreased by almost two-thirds for children aged 3–11 years and adolescents aged 12–19 years from 1999–2000 to 2005–2006.[15] Our estimates of adults' self-reported home exposure rate (12.1% for 2000 and 4.4% for 2010) are consistent with two CDC reports showing that the rates of self-reported home exposure to SHS for adults was 10.2% in 1999–2004[16] and 5.4% in 2007–2008.[17]

We found that exposure was much lower for all groups in 2010 but dropped at different rates for different groups. For example, non-Hispanic black children and adults were more likely to be exposed to SHS than were their non-Hispanic white counterparts in 2010 vs. 2000, reflecting the greater reductions in exposure among other racial/ethnic groups. This finding is consistent with CDC's latest Vital Signs report, which used serum cotinine-measured SHS exposure data from the 1999–2012 NHANES and found that SHS exposure was highest among non-Hispanic black people during 2011–2012.[7] Fewer non-Hispanic black households than non-Hispanic white households had complete home smoking restrictions.[18] Continued health education and efforts are needed to reduce SHS exposure among the non-Hispanic black population.

Also, children aged 0–5 years were less likely than children aged 6–11 years to be exposed to SHS during both years. This decreased likelihood of SHS exposure may have been because a number of community-based child health promotion programs (e.g., the Special Supplemental Nutrition Program for Women, Infants and Children [WIC] and Head Start) were developed to provide health counseling for low-income children aged 0–5 years and prevent them from SHS exposure after 2000.[19,20] A previous study showed that these programs significantly decreased the amount of reported SHS exposure at home among children.[21]

Non-Hispanic Asian and Hispanic children were less likely than non-Hispanic white children to be exposed to SHS in 2000 and 2010. This finding is consistent with the finding from King et al. that non-Hispanic Asian and Hispanic people had the highest prevalence of smoke-free home rules (91% and 88%, respectively).[22]

Children whose parents had ≥college education

Table 2. Prevalence of secondhand smoke exposure[a] at home and adjusted odds ratios of exposure for U.S. nonsmoking adults, by sociodemographic characteristics, National Health Interview Survey, 2000 and 2010[b]

Characteristics	2000					2010					Percent change in home SHS exposure from 2000 to 2010[c]
	Number of nonsmoking adults	Prevalence of SHS exposure at home (95% CI)	P-value (χ^2)	AOR (95% CI)	P-value (logistic regression)	Number of nonsmoking adults	Prevalence of SHS exposure at home (95% CI)	P-value (χ^2)	AOR (95% CI)	P-value (logistic regression)	
Total	23,665	12.1 (11.6, 12.7)				20,384	4.4 (4.0, 4.8)				−63.6
Sex											
Female	13,856	12.0 (11.3, 12.8)	0.682	Ref.		11,701	4.1 (3.6, 4.6)	0.180	Ref.		−65.8
Male	9,809	12.3 (11.5, 13.1)		1.04 (0.93, 1.15)	0.860	8,683	4.7 (4.0, 5.4)		1.11 (0.91, 1.36)	0.207	−61.8
Age											
18–34	6,937	14.9 (13.8, 16.1)	<0.001	Ref.		5,723	5.8 (5.0, 6.7)	<0.001	Ref.		−61.1
35–64	11,492	11.4 (10.7, 12.1)		0.95 (0.85, 1.06)	0.198	10,114	3.8 (3.3, 4.4)		0.81 (0.66, 1.10)	0.280	−66.7
≥65	5,236	9.5 (8.5, 10.4)		0.58 (0.49, 0.68)	<0.001	4,547	3.6 (2.9, 4.4)		0.83 (0.63, 0.99)	<0.001	−62.1
Race/ethnicity											
Non-Hispanic white	15,357	11.7 (11.1, 12.3)	<0.001	Ref.		11,340	4.4 (3.9, 5.0)	<0.001	Ref.		−62.4
Non-Hispanic black	3,192	17.7 (15.8, 19.5)		1.12 (0.96, 1.30)	0.244	3,152	7.4 (6.0, 8.8)		1.49 (1.18, 1.90)	<0.001	−58.2
Non-Hispanic Asian	672	12.0 (9.0, 14.9)		1.24 (0.93, 1.66)	0.152	1,393	2.5 (1.4, 3.7)		0.62 (0.39, 1.01)	0.452	−79.2
Non-Hispanic other	273	14.2 (10.0, 18.5)		1.11 (0.78, 1.57)	0.209	343	5.8 (2.0, 9.6)		1.33 (0.67, 2.64)	0.227	−59.2
Hispanic	4,171	9.3 (8.2, 10.4)		0.55 (0.46, 0.65)	<0.001	4,156	2.5 (1.9, 3.1)		0.57 (0.43, 0.76)	0.039	−73.1
Marital status											
Married	12,068	10.2 (9.5, 10.8)	<0.001	Ref.		9,665	3.6 (3.1, 4.1)	<0.001	Ref.		−64.7
Living with partner	870	19.1 (16.2, 21.9)		1.93 (1.56, 2.39)	<0.001	958	7.2 (5.3, 9.1)		1.99 (1.48, 2.67)	<0.001	−62.3
Single	4,738	17.4 (15.9, 18.9)		1.58 (1.40, 1.80)	<0.001	4,634	6.7 (5.6, 7.9)		1.62 (1.32, 1.99)	<0.001	−61.5
Widowed, divorced, or separated	5,989	11.8 (10.7, 12.9)		1.12 (0.98, 1.28)	0.104	5,127	3.2 (2.5, 3.9)		0.87 (0.66, 1.14)	0.378	−72.9
Education level											
<High school	4,747	16.7 (15.3, 18.2)	<0.001	1.22 (1.07, 1.41)	0.042	3,334	5.1 (4.3, 5.9)	0.019	1.36 (1.00, 1.85)	0.619	−69.5
High school diploma/GED	6,458	15.6 (14.5, 16.7)		Ref.		5,024	4.9 (3.8, 5.9)		Ref.		−68.6
Some college	6,577	11.6 (10.6, 12.6)		0.67 (0.59, 0.76)	<0.001	5,927	4.1 (3.4, 4.7)		0.51 (0.44, 0.65)	<0.001	−64.7
≥College degree	5,883	6.2 (5.5, 7.0)		0.37 (0.31, 0.44)	<0.001	6,099	3.6 (2.9, 4.4)		0.45 (0.32, 0.58)	<0.001	−41.9

Table 2 (continued). Prevalence of secondhand smoke exposure[a] at home and adjusted odds ratios of exposure for U.S. nonsmoking adults, by sociodemographic characteristics, National Health Interview Survey, 2000 and 2010[b]

Characteristics	2000					2010					Percent change in home SHS exposure from 2000 to 2010[c]
	Number of nonsmoking adults	Prevalence of SHS exposure at home (95% CI)	P-value (χ^2)	AOR (95% CI)	P-value (logistic regression)	Number of nonsmoking adults	Prevalence of SHS exposure at home (95% CI)	P-value (χ^2)	AOR (95% CI)	P-value (logistic regression)	
Poverty status[d]											
Poor (0.00–0.99)	2,494	17.8 (15.6, 19.9)	<0.001	Ref.		3,119	4.0 (3.0, 5.0)	0.420	Ref.		−77.5
Low income (1.00–1.99)	3,653	15.2 (13.5, 16.8)		0.93 (0.77, 1.13)	0.500	3,427	4.8 (3.8, 5.7)		1.21 (0.86, 1.71)	0.258	−68.4
Middle income (2.00–3.99)	5,401	14.0 (12.8, 15.1)		0.89 (0.74, 1.08)	0.273	5,177	4.9 (4.0, 5.8)		1.26 (0.88, 1.81)	0.181	−65.0
High income (≥4.00)	6,848	9.1 (8.2, 9.9)		0.67 (0.55, 0.81)	<0.001	6,312	4.1 (3.4, 4.8)		0.94 (0.67, 1.34)	0.857	−54.9
Unknown	5,269	11.2 (10.2, 12.3)		0.72 (0.60, 0.87)	<0.001	2,349	4.1 (3.0, 5.1)		1.01 (0.69, 1.480)	0.355	−63.4
Region											
Northeast	4,466	12.4 (11.2, 13.6)	<0.001	Ref.		3,301	4.3 (3.2, 5.3)	<0.001	Ref.		−65.3
West	5,452	7.9 (6.8, 9.0)		0.62 (0.51, 0.75)	<0.001	5,381	2.8 (2.2, 3.4)		0.71 (0.50, 1.00)	0.044	−64.6
Midwest	5,327	13.8 (12.8, 14.9)		1.10 (0.95, 1.28)	0.207	4,356	5.6 (4.6, 6.7)		1.30 (0.93, 1.81)	0.236	−59.4
South	8,420	13.2 (12.2, 14.2)		1.00 (0.87, 1.16)	0.848	7,346	4.8 (4.1, 5.5)		1.09 (0.82, 1.46)	0.769	−63.6

[a]SHS exposure at home: nonsmoking adults living in a household where residents smoked inside the home at least one day per week

[b]2000 and 2010 National Health Interview Survey: Centers for Disease Control and Prevention (US), National Center for Health Statistics. National Health Interview Survey [cited 2015 Dec 9]. Available from: http://www.cdc.gov/nchs/nhis/methods.htm

[c]All changes were statistically significant at p<0.05 based on chi-squared statistics from bivariate analyses.

[d]Ratio of self-reported family income to federal poverty thresholds

SHS = secondhand smoke exposure

CI = confidence interval

AOR = adjusted odds ratio

Ref. = reference group

GED = general educational development

were less likely to be exposed to SHS than those whose parents had at most high school diplomas/GEDs in 2000. However, this difference did not exist in 2010, suggesting that all education subgroups benefited from SHS reductions. Similarly, adults with the lowest education levels were no longer more likely to be exposed to SHS than those with at most a high school diploma or GED in 2010. Children and adults living below the federal poverty threshold were more likely to be exposed to SHS than those living in middle- or high-income households in 2000, but the difference in exposure between these groups disappeared in 2010. This finding might reflect the positive impact of implementing tobacco prevention programs designed for low-income populations (e.g., The Head Start Tobacco Cessation Initiative, which brings tobacco prevention support to low socioeconomic status populations[23]).

We found that children and adults living in the West had the lowest odds of being exposed to SHS for both years. These reduced odds of exposure are likely because western states have lower smoking prevalence and a higher proportion of homes with 100% smoke-free rules than other states. For example, in 2012, Utah and California had the lowest adult smoking prevalence in the United States (10.6% and 12.6%, respectively).[24] In 2009–2010, Utah had the highest proportion of homes with 100% smoke-free rules (92.9%), followed by Idaho (91.5%) and California (90.1%).[22] We also found increasing regional disparities in SHS exposure for children living in the Midwest and South compared with those living in the Northeast in 2000 and 2010. This finding may be because the increase in the population covered by strong smoke-free laws was mostly in the West and Northeast,[25] and that states in these regions (e.g., West Virginia, Kentucky, and Ohio) had the lowest rates of home smoking bans as of 2006.[9,22,24] A recent study showed that several states have smoke-free laws that include all restaurants and bars, but many states and communities, especially in the South and Midwest, still fail to provide such protections.[26] This increasing regional disparity in SHS exposure for the Midwest and South regions is concerning, and SHS exposure interventions should target these regions.

Policy impact

A number of policies have had an impact on SHS exposure. An increasing number of municipalities in the United States adopted smoke-free laws in public places and workplaces from 2000 to 2010, resulting in a large increase in the proportion of the U.S. population covered by strong smoke-free laws.[10,25] The number of states with comprehensive smoke-free laws in effect for worksites, restaurants, and bars increased from zero on December 31, 2000, to 26 on December 31, 2010.[27] A spillover effect on home SHS exposure from prohibiting smoking in public places and workplaces has been demonstrated.[28–31] The prevalence of U.S. homes with smoke-free home rules increased from 60.2% in 1998–1999 to 72.2%[32] in 2003 and 83.0%[33] in 2010–2011. In addition, a number of programs aimed at reducing SHS exposure among children have been implemented, such as the Smoke-free Homes Programs developed by the U.S. Environmental Protection Agency, which educates parents and the public about health risks associated with exposure to SHS and helps create smoke-free homes.[34]

Limitations

This study was subject to several limitations, which may have led to an underestimation of home SHS exposure. First, self-reported SHS exposure might not accurately reflect actual SHS exposure because of recall bias. Second, SHS exposure was defined as having a resident who smoked inside the home at least one day per week, but it was unknown whether visitors smoked inside homes. Third, this study assessed only the exposure from cigarette smoke and did not examine SHS exposure from other tobacco products, such as cigars. Fourth, we were not able to include exposure to smoke drifting from neighboring housing units for those who lived in multiunit housing. Fifth, we could not measure the extent of exposure. Sixth, our measure of SHS exposure was self-reported home exposure; biomarker-measured exposure (e.g., serum cotinine level) would have yielded a higher exposure rate.

CONCLUSION

Our study found that all population subgroups had reduced SHS exposure but that some subgroups benefited more than others. Sociodemographic differences persist in age, ethnicity, and region for children and in age, education, ethnicity, region, and marital status for nonsmoking adults. Thus, some successes have been achieved in eliminating sociodemographic disparities, but work remains to be done. Current tobacco control policies need to be improved to reach all populations so that the SHS exposure can be further reduced, especially among particularly vulnerable populations.

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