Secondhand Smoke Exposure Among Women and Children: Evidence From 31 Countries

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Objectives. We sought to describe the range of exposure to secondhand smoke (SHS) among women and children living with smokers around the world and generate locally relevant data to motivate the development of tobacco control policies and interventions in developing countries.

Methods. In 2006, we conducted a cross-sectional exposure survey to measure air nicotine concentrations in households and hair nicotine concentrations among nonsmoking women and children in convenience samples of 40 households in 31 countries.

Results. Median air nicotine concentration was 17 times higher in households with smokers (0.18 μg/m^3) compared with households without smokers (0.01 μg/m^3). Air nicotine and hair nicotine concentrations in women and children increased with the number of smokers in the household. The dose–response relationship was steeper among children. Air nicotine concentrations increased an estimated 12.9 times (95% confidence interval = 9.4, 17.6) in households allowing smoking inside compared with those prohibiting smoking inside.

Conclusions. Our results indicate that women and children living with smokers are at increased risk of premature death and disease from exposure to SHS. Interventions to protect women and children from household SHS need to be strengthened. (*Am J Public Health.* 2008;98:672–679. doi:10.2105/AJPH.2007.126631)

Extensive research shows that secondhand smoke (SHS) exposure places adults and children at increased risk for premature death, diverse illnesses, and other adverse effects, such as reduced lung-function growth in children.[1] Worldwide, over 40% of men smoke tobacco, compared with only about 12% of women.[2] This global profile implies that women and children constitute the bulk of the population exposed to SHS. The World Health Organization (WHO) conducted the Global Youth Tobacco Survey between 1999 and 2005 and found that approximately 44% of youths were exposed to tobacco smoke at home and that 47% had at least 1 parent who smoked.[3] There is insufficient information, however, regarding levels of SHS in households and the range of exposures among women and children throughout the world. Questionnaires have been the most commonly used tool to assess the prevalence and intensity of SHS exposure at home.[3–5] Although questionnaires can confirm that SHS exposure is taking place, they are not highly informative as to the specific level of exposure because of inherent limitations of the data collected.[1]

For our study, we sought to quantify the levels of SHS exposure among women and children living with smokers in diverse climates and cultures. Measuring air nicotine and hair nicotine concentrations are validated methods of quantifying airborne levels of SHS and the uptake of SHS in the body, respectively.[6,7] We carried out a multicountry study measuring nicotine concentrations in the air of households with and without smokers and in the hair of women and children living in these households. Survey data were also collected to evaluate smoking behaviors and smoking policies in the households and around the children, as well as perceptions and attitudes about SHS.

METHODS

Overview

We conducted a cross-sectional exposure survey among adult nonsmoking women and children younger than 11 years in Latin America, Asia, Eastern Europe, and the Middle East. We used passive air monitors to measure household air nicotine concentrations and a hair nicotine test to measure personal exposure to SHS.[8,9]

Household Sampling

In each country, we selected at least 40 households that had a child younger than 11 years. In 80% of the households, at least 1 male was currently smoking and living in the house at the time of the study; we preferred that this person be the father or primary male caregiver, because he would have the most direct contact with the exposed child. Active smoking was defined as having smoked within the past 30 days. In most of the countries, we selected our convenience sample from the country's capital city, because sampling frames were not available. Some country teams chose to select the households from previous or ongoing studies (Dominican Republic, Mexico, Nepal, Peru, and the Philippines). Other teams reached out through health clinics (Armenia, Georgia, Guatemala, Hong Kong, Latvia, Panama, and Uruguay), schools (Poland, Romania, Russia, Ukraine, and Venezuela), community workers (Argentina, Cambodia, China, Egypt, India, Indonesia, Laos, Taiwan, Thailand, and Vietnam), and through their organizational staff (Brazil, Malaysia, and Turkey). Whenever possible, households were selected from different socioeconomic levels and different neighborhoods. All sampling strategies and recruitment procedures were reviewed and approved by the Johns Hopkins research team.

Data Collection

Trained field staff administered questionnaires to the primary male and female caregivers in each household. The questionnaire had 4 main sections, including personal and socioeconomic characteristics, smoking history, exposure to SHS, and attitudes and beliefs about the harms of smoking and tobacco control policies. We considered a woman to be exposed to SHS outside the household if she reported SHS exposure at any of the following places: at work, in any indoor place that was not the household, during transportation, or outdoors. We considered a child to be exposed to SHS outside the household if the child's caregiver reported witnessing the child's SHS exposure at any of the following places: in school, in daycare, in any indoor place that was not the household, during transportation, or outdoors. We classified a household as having a no-smoking policy if the respondents indicated that smoking was not permitted anywhere inside the household.

Sample Collection

Passive air monitors were installed in each household to measure air nicotine for 7 days. Monitors were placed in the main room in which the family congregated and were not highly visible or accessible to the residents.

Hair samples were collected from the primary female caregiver and from 1 child younger than 11 years in each household. In households where the mother or primary female caregiver was a smoker, hair samples from women were not taken. A small sample of hair (approximately 30–50 strands) was cut near the hair root from the back of the scalp where the growth pattern is the most uniform. Hair samples were immediately placed in a labeled plastic bag that was sealed for storage and transportation. Information was also collected on prior chemical treatments of the hair and on time–activity patterns in relation to SHS exposure.

Laboratory Analysis

Air Nicotine. The nicotine collected by each passive sampler was extracted into heptane with an internal standard (isoquinoline; Aldrich Chemical Company, Milwaukee, Wis), and then injected into a gas chromatograph, coupled with a nitrogen phosphorus detector (5890A; Agilent, Santa Clara, Calif) and a capillary column (30 m × 0.32 mm id, 0.5-µm film thickness, [HP–5; Agilent]).[8,10] We started the gas chromatograph oven temperature at 130°C, increased the temperature to 160°C at a rate of 5°C per min, then again increased the temperature to 180°C at a rate of 10°C per min. For quality control purposes, 10% of samples were duplicates and blanks. The correlation coefficient between the duplicate and original samples was 0.92 (n=95). Using the analytic results from blank samples, we found the median limit of detection to be 0.001 µg/m^3 for a 7-day sample. Final concentrations were provided after subtraction of background levels from the blank samples.

Hair Nicotine. Nicotine in a 30-mg sample of hair taken from within 3 cm of the hair root was extracted using an isotope dilution method with an internal standard (Nicotinine-d3; Supelco, Bellefonte, Pa). Our method was modified from that developed by Kintz.[9] Hair nicotine analysis was conducted using gas chromatography and mass spectrometry (GC–17/MS- QP5000; Shimadzu, Kyoto, Japan) in SIM and splitless mode. The gas chromatograph oven temperature was maintained at 70°C for 1 minute, increased to 280°C at a rate of 25°C per minute, and held for 1 minute. Nicotine was separated using a capillary column (30 m × 0.25 mm id, 0.25-µm film thickness [Rtx–624, Restek, Bellefonte, Pa]).

For quality control purposes, measurement performance of hair nicotine was examined with respect to bias and precision. Bias was evaluated by calculating recovery (percentage), and precision was determined as the relative standard deviation (percentage) using nonsmokers' hair samples spiked with 2 different concentrations (e.g., 0.67 and 3.33 ng/mg; n=5 within batch; n=30 between batches). The recoveries from within batch were 84.8% and 88.1% with relative standard deviations of 8.5% and 6.3% for the 2 concentrations, respectively; recoveries from between batches were 73% and 83% with relative standard deviations of 21% and 11%, respectively. In addition, 10% of the hair samples from each batch went through duplicate analyses. The coefficient of intersample correlation was 0.97 (n=172). Blank samples were used to determine the limit of detection and blank-corrected hair nicotine concentration. The median limit of detection was 0.02 ng/mg for a 30-mg hair sample.

Data Analysis. Microsoft Access version 2003 (Microsoft Corporation, Redmond, Wash) was provided to each country investigator for data entry using a common format. The data collected in the country databases were checked and reviewed centrally for completeness and consistency and merged with air nicotine and hair nicotine data from the laboratory. We calculated percentages, means, medians, and interquartile ranges for demographic and housing characteristics, smoking behavior, and self-reported SHS exposure. Hair and air nicotine concentrations were skewed and log^{-10} transformed for statistical analysis. We examined the relationship between air and hair nicotine concentrations using the Pearson correlation coefficient. Multilevel linear models that allowed for country-specific intercepts were used to identify factors associated with differences in concentrations of air nicotine and hair nicotine. Factors of interest were the number of smokers in the household, number of cigarettes smoked per day by the smokers in the household, smokers' behavior (smoking inside their household and smoking in the presence of their child), and women's and children's exposures to SHS outside their households. SAS version 9 was used for data checking and statistical analysis.[11]

RESULTS

A total of 1284 households from 31 countries were surveyed; these included 208 households with no smokers, 784 households with only 1 male smoker, and 292 households with 2 or more smokers (Table 1). Participants in the households covered a range of socioeconomic levels within and between countries. In Europe, 53% of the male caregivers living in the households had completed some education beyond high school, followed by 39% in Latin America and 16% in Asia. Approximately 50% of women in all regions worked outside of the household. Among smoking households, 38% of households in Europe and the Middle East had 1 or more smokers in that household, compared with 24% in Latin America and 21% in Asia. In Europe, smokers consumed a median of 18 cigarettes a day compared with 14 in Asia and 12 in Latin America. Most smokers indicated that they smoked in their households, which varied little between regions. Across all regions, approximately 82% of smokers

TABLE 1—Characteristics of Households in Which Women and Children are Exposed to Secondhand Smoke (SHS): International Survey, 2006

		Households		Smokers			Nonsmoking Women		
Country	No. of Participant Households	Mean Outdoor Temperature, °C	Smoking Households With ≥ 2 Smokers, %	No. Cigarettes Smoked/ Day, Mean	Smokes in the Home, %	Smokes Near Child, %	No. Working Outside the Home	Exposed to SHS Outside the Home, %	Children Exposed to SHS Outside the Home, %
North and South America	364	21	24	12	81	81	48	64	48
Argentina	40	13	22	18	83	92	20	47	20
Brazil	40	22	16	21	94	90	50	78	70
Dominican Republic	40	24	19	11	75	75	22	66	63
Guatemala	40	20	9	11	85	79	69	69	50
Mexico	41	28	27	7	74	83	15	78	61
Panama	40	28	31	9	63	66	45	55	48
Peru	40	16	38	6	83	74	65	57	30
Uruguay	42	13	26	16	86	91	70	53	24
Venezuela	41	24	29	13	91	88	41	73	63
Asia	509	23	21	14	91	82	50	64	46
Cambodia	40	28	33	11	85	68	87	68	73
China	60	–5	5	19	98	98	41	73	43
Hong Kong	40	27	23	15	96	76	50	94	83
India	40	29	13	15	91	97	53	10	8
Indonesia	40	28	15	11	94	79	32	92	73
Laos	46	28	30	14	100	84	50	58	13
Malaysia	40	29	10	12	78	63	70	93	63
Nepal	40	2	34	12	87	80	28	29	13
Philippines	42	29	26	14	83	69	28	92	93
Taiwan	40	25	27	24	100	100	50	33	23
Thailand	40	29	21	9	82	82	68	50	33
Vietnam	41	26	21	12	97	88	54	71	44
Europe and Middle East	411	12	38	18	84	82	47	68	50
Armenia	51	8	41	25	98	98	30	76	65
Egypt	40	19	17	16	100	86	18	60	63
Georgia	40	7	19	19	97	89	35	84	50
Latvia	40	12	57	16	98	85	78	40	35
Poland	40	18	61	17	98	92	81	56	28
Romania	40	1	17	22	90	78	91	74	33
Russia	40	7	52	14	79	72	67	63	58
Syria	40	20	50	17	97	91	19	67	67
Turkey	40	20	26	16	78	62	30	79	55
Ukraine	40	12	31	14	53	69	62	57	40
All Regions	1284	19	27	15	88	82	49	65	48

indicated that they smoked around their children. The majority of women indicated that they were exposed to SHS outside the household (Europe, 68%; Asia, 64%; Latin America, 64%). In all regions, approximately half of the children in the study were reported as being exposed to SHS outside the household.

Air nicotine concentrations were detected in 88% of households with at least 1 smoker and in 60% of households with no smokers. Median air nicotine concentrations within households with smokers were highest in Europe (0.58 μg/m^3), followed by Latin America (0.16 μg/m^3) and Asia (0.09 μg/m^3; Figure 1). Hair nicotine concentrations were detected in 78% of women and children living with a smoker, and in 59% of women and children not living with a smoker. Median hair nicotine concentrations for both women and children living with smokers were highest in Asia (0.50 ng/mg and 0.87 ng/mg, respectively), followed by Europe and the Middle East (0.37 ng/mg, 0.72 ng/mg), and Latin America (0.26 ng/mg, 0.50 ng/mg; Figure 2). Air nicotine concentrations in countries with mean outdoor temperatures lower than 20°C at the time of measurement were over 3 times higher (95% confidence interval [CI] = 1.35, 8.90) than countries with warmer temperatures.

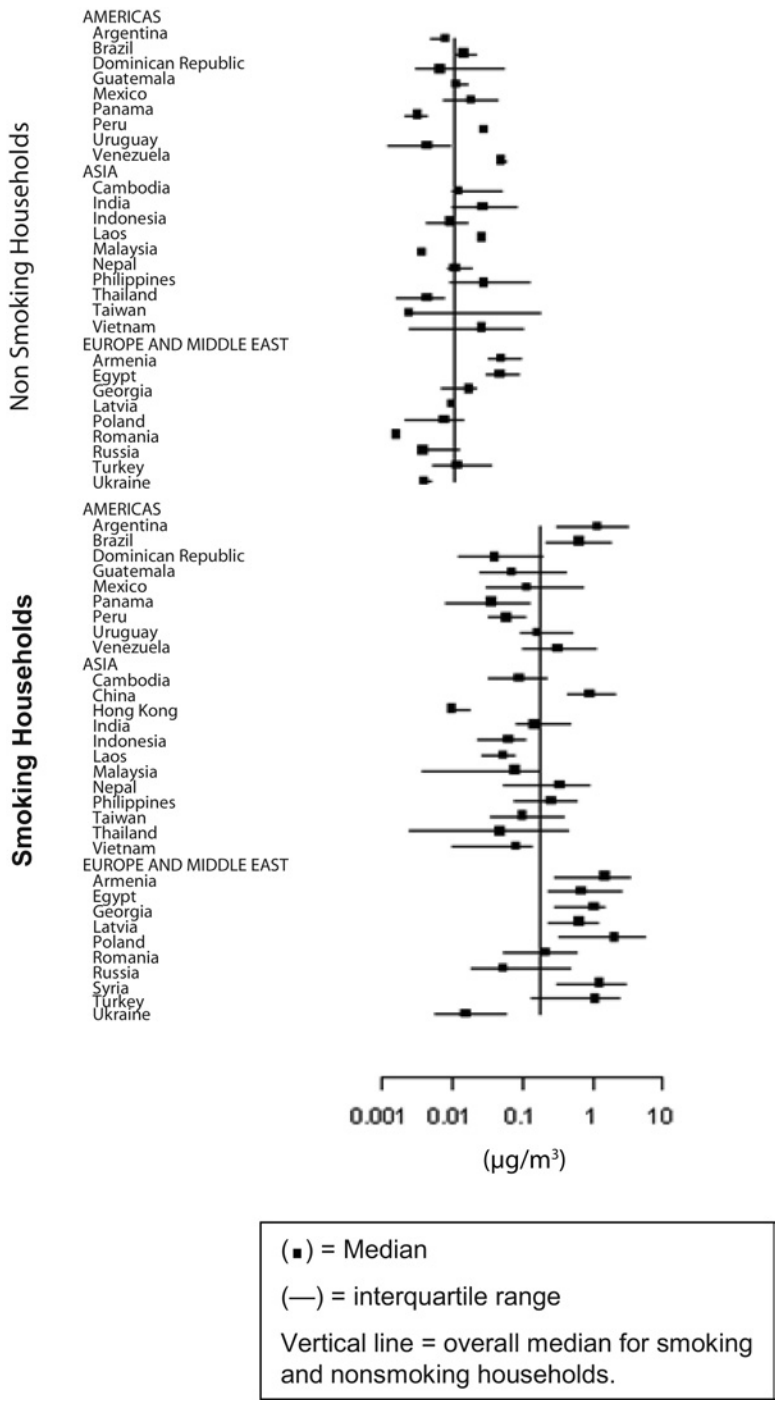

FIGURE 1—Median and interquartile range of air nicotine concentrations in homes, by country in nonsmoking households (a) and smoking households (b).

Hair nicotine concentrations were positively correlated with the concentration of air nicotine in the households. The correlation was stronger among children ($r=0.36$, $P<.001$) than among their mothers ($r=0.25$, $P<.001$). Hair nicotine concentrations of women and children living in the same household were also positively correlated ($r=0.50$, $P<.001$). Median hair nicotine concentrations in children (0.68 ng/mg) were generally higher than those found in women (0.40 ng/mg; Figure 2). Children younger than 5 years living with smokers had hair nicotine concentrations that were nearly twice as high (estimated geometric mean ratio [GMR]=1.93; 95% CI=1.19, 3.12) as children 5 years or older living with smokers.

With a multilevel linear model that allowed for a country-specific random intercept, we evaluated determinants of geometric mean values of air and hair nicotine concentrations (Table 2). A dose–response group relationship was evident between air nicotine concentration and the number of smokers living in a household. We found an estimated 21.6 times increase (95% CI=15.7, 29.6) in air nicotine concentration inside households with 2 or more smokers compared with households with no smokers. Households allowing smoking inside had an estimated 12.9 times increase (95% CI=9.4, 17.6) in air nicotine concentrations compared with households with a no-smoking policy.

A dose–response group relationship was also found between hair nicotine concentrations among women and children and the number of smokers living in a household (Table 3). The increase in hair nicotine concentration among participants living with 2 or more smokers compared to those living with no smokers was greater among children (estimated GMR=3.8; 95% CI=3.0, 4.9) than among women (estimated GMR=2.1; 95% CI=1.7, 2.9). A child whose father and mother smoked had a 2.9 times increase (95% CI=2.1, 4.0) in hair nicotine concentrations compared with a child whose father smoked but whose mother did not.

DISCUSSION

We initiated this project to gain a better perspective of the range of exposures among women and children living within households with smokers, to encourage increased tobacco research capacity in developing countries, and to generate locally relevant data to motivate the development of approaches for reducing household SHS exposure. The resulting

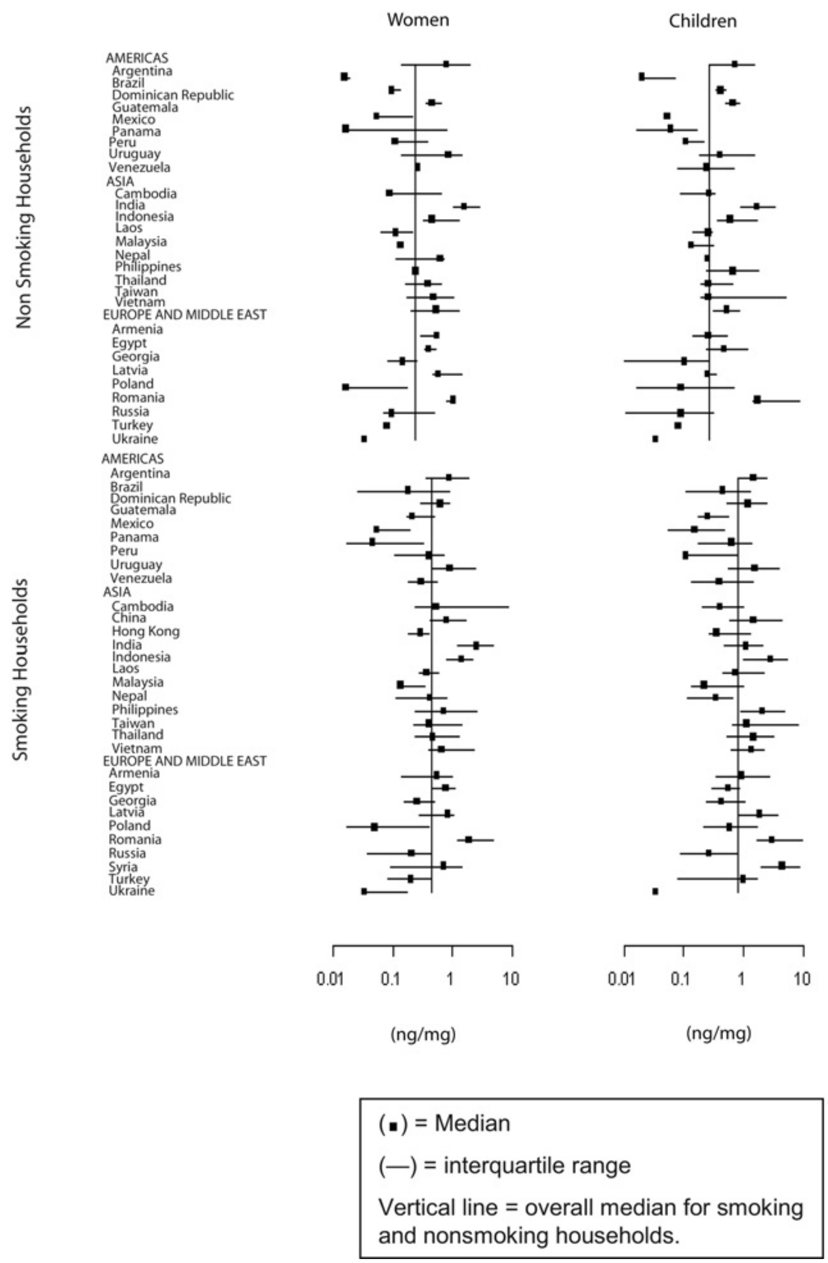

FIGURE 2—Median and interquartile range of hair nicotine concentrations in women and children, by country in nonsmoking households (a) and smoking households (b).

information regarding the level of SHS exposure among women and children and the relative risks associated with that exposure can be used to strengthen and design interventions to protect women and children.

Using a common protocol in 31 countries, we measured concentrations of airborne nicotine in households and concentrations of nicotine in the hair of women and children living in those households. We found that exposure to SHS is ubiquitous in households with smokers and that smokers smoke around their children with little restraint. Concentrations of air nicotine were higher in households with a smoker and increased with the number of smokers residing in the household. The hair nicotine biomarker confirmed the uptake of SHS by women and children living with smokers.

Our results expand the body of information on levels of SHS in households, as previous studies were limited largely to developed countries.[1] The countries we surveyed encompassed a wide range of housing types, climates, and smoking profiles, and these differences were reflected in our measurements. Air nicotine concentrations were higher for measurements made at colder temperatures. This inverse association is most likely indicative of housing type. In some of the warmer countries, (e.g., Vietnam, Thailand, and Malaysia), many households had walls and floors that you could see through and through which air could easily pass, so smoke was probably rapidly diluted by natural ventilation. The highest levels of SHS were generally found in countries with high prevalence and high consumption of cigarettes (e.g., Poland, Syria, Turkey, Argentina, and Georgia).[12] The countries with the highest levels of air nicotine positively corresponded with the countries having the highest percentage of youth reporting SHS exposure at home in the Global Youth Tobacco Survey.[3]

Hair nicotine levels provide information complementary to that obtained from the questionnaire on exposure and reflect direct contact with SHS by children and women, whether at home or elsewhere. In some countries with low concentrations of air nicotine, hair nicotine concentrations were in the same range as in the countries with higher airborne nicotine. Children in Vietnam, for example, had a median hair nicotine concentration of 1.21 ng/mg, in the midrange for the 31 countries. The apparent discrepancy between air and hair nicotine concentrations is likely to reflect the closeness of interactions of the children and women with smoking household members, as well as differences in nicotine uptake and metabolism. Closeness of interactions and differences in nicotine uptake and metabolism are also likely to explain the higher concentrations of nicotine found in younger children.

Several studies in Western countries have measured hair nicotine concentrations in young children or women,[13–18] and the range of values was similar to our findings. Across

TABLE 2—Geometric Means (GMs) and Geometric Mean Ratios (GMRs) of Air Nicotine Concentrations in Households in Which Women and Children are Exposed to Secondhand Smoke (SHS), by Household Characteristics: International Survey, 2006

Characteristic	Unadjusted GM, μg/m^3	GMR (95% CI)
Smokers in household, no.		
None (Ref)	0.01	1.0
1	0.13	10.3 (7.9,13.6)
≥2	0.3	21.6 (15.7, 29.6)
Cigarettes smoked per day,[a] no.		
<10 (Ref)	0.07	1.0
10–19	0.15	2.1 (1.5, 2.8)
≥20	0.34	3.2 (2.4, 4.3)
Policy restricting smoking in the home		
Yes (Ref)	0.01	1.0
No	0.15	12.9 (9.4, 17.6)
Mean outdoor temperature, °C		
>20 (Ref)	0.09	1.0
10–20	0.32	3.47 (1.35, 8.90)
<10	0.35	3.51 (1.24, 9.93)

Note. CI = confidence interval. GMRs obtained from the regression model that allowed for country-specific random intercepts.
[a]Among respondents who smoked in the household.

the 31 countries we surveyed, median concentrations of hair nicotine in women ranged from 0.02 to 2.5 ng/mg (Figure 2). Similarly, in 2001 Jaakkola et al. found that Finnish women's hair nicotine concentrations ranged from 0.9 ng/mg to about 2 ng/mg, depending on exposure in the household.[18] In children, median concentrations across the 31 countries ranged from 0.02 ng/mg to 4.5 ng/mg. In 2003, a study among Latino children in the United States found a median of 0.5 ng/mg in children exposed to parental smoking.[19] Similar to our findings, studies in New Zealand[14] and Norway[13] found dose–response group relationships between hair nicotine concentration and the number of smokers in the house and the amount smoked by the mother, respectively.

Our multilevel linear regression model showed a strong effect of smoking on nicotine concentrations in the household and the results of limiting smoking in the household. There was a strong dose–response group relationship between the number of smokers living within a household, the number of cigarettes being smoked, and air nicotine concentration (Table 2). Voluntary smoking bans in households with smokers were associated with substantial reductions in the concentration of nicotine in the air.

Our findings are potentially limited by the selection of households on a convenience basis and by the number of households included in each country. These aspects of the design reflected our intent of reaching as many countries as was feasible, given the resources available. Other studies, such as the Global Youth Tobacco Survey, provide data pertaining to the percentage of children living with smokers. Although the samples in our study were not necessarily representative of women and children living with smokers within a country as a whole, our sampling approach would not have introduced bias with regard to the relation between smoking in the households and the outcome measures. For assessing airborne nicotine, the passive sampling method we used is well standardized.[8] The monitors measured nicotine continuously, not just while the household was occupied, so reported concentrations are likely to be lower than those present during the period of actual exposure.

Hair nicotine concentrations have been used increasingly during the past decade to assess personal SHS exposure; hair is easier and less expensive to sample, store, and transport than is urine, saliva, or serum.[7] Moreover, hair nicotine has the advantage of characterizing SHS exposure over a longer period of time than does blood or urine cotinine, with each centimeter of hair length representing a month of exposure.[9] Measuring hair nicotine concentration provides an unbiased indicator of exposure not subject to the reporting bias that may have affected questionnaires or to behavior changes by smokers influenced by active monitoring.

For hair samples, a majority (60%) of the women sampled had applied some form of chemical treatment to their hair (dyes or permanents). The effect of hair treatment on nicotine concentrations is not yet well characterized, although reports from the literature indicate that hair treatments tend to reduce the measured concentration.[7,20] On the basis of prior studies of the effect of chemical treatments on hair nicotine concentrations, the hair nicotine concentrations measured for women in our study may be underestimations. Nevertheless, we found good reproducibility and the expected relationships between the reported level of smoking in the household, airborne nicotine concentration, and hair nicotine concentration (Table 2).

A growing number of countries have banned smoking in public places, and more are contemplating new smoking restrictions as they meet their commitments under the WHO Framework Convention on Tobacco Control (FCTC).[21] Article 8 of the FCTC legally binds all ratifying nations to implement effective measures to protect people from exposure to tobacco smoke, to the extent they have the power to do so at the national level. The language further specifies that these measures must apply to "indoor workplaces, public transport, indoor public places, and, as appropriate, other public places."[22] However, as with other formal regulatory measures aimed at eliminating SHS exposure in public areas, SHS exposure in households is not covered under the FCTC. If protection from SHS is to be complete, particularly for women and children, SHS exposure should be eliminated in public areas by government authorities through smoke-free legislation and by families in their households.

TABLE 3—Geometric Means (GMs) and Geometric Mean Ratios (GMRs) of Hair Nicotine Concentrations Among Women and Children Living in Households Exposed to Secondhand Smoke, by Household Characteristics: International Survey, 2006

	Women		Children	
Characteristic	Unadjusted GM, ng/mg	GMR (95% CI)	Unadjusted GM, ng/mg	GMR (95% CI)
Smokers in household, no.				
None (Ref)	0.2	1.0	0.26	1.0
1	0.45	1.9 (1.5, 2.3)	0.68	2.3 (1.8, 2.8)
≥2	0.43	2.2 (1.7, 2.9)	1.04	3.8 (3.0, 4.9)
Cigarettes smoked per day,[a] no.				
<10 (Ref)	0.3	1.0	0.49	1.0
10–19	0.44	1.4 (1.1, 1.7)	0.85	1.5 (1.2, 1.9)
≥20	0.59	1.7 (1.4, 2.2)	0.97	1.5 (1.2, 1.9)
Policy restricting smoking in the home				
Yes (Ref)	0.18	1.0	0.22	1.0
No	0.44	1.8 (1.4, 2.3)	0.77	2.6 (2.0, 3.3)
At least 1 smoker smokes near child				
No (Ref)	...	...	0.64	1.0
Yes	...	...	0.77	1.1 (0.9,1.5)
Smokers sharing child's bedroom, no.				
None (Ref)	...	...	0.46	1.0
1	...	...	0.91	2.1 (1.6, 2.5)
2	...	...	1.6	3.4 (2.3, 5.0)
3	...	...	1.91	4.7 (1.5, 14.2)
Mother also smokes				
No (Ref)	...	...	0.60	1.0
Yes	...	...	1.42	2.9 (2.1, 4.0)
Cigarettes smoked per day,[b] no.				
<10 (Ref)	...	...	0.69	1.0
10–19	...	...	1.59	2.6 (1.6, 4.4)
≥20	...	...	3.17	3.7 (2.3, 6.1)
Child's age, y				
≥5 (Ref)	...	...	0.61	1.0
<5		...	1.08	1.93 (1.19, 3.12)

Note. CI = confidence interval. GMRs obtained from the regression model that allowed for country-specific random intercepts. Ellipses indicate that the characteristic does not apply to women.
[a]Among respondents who smoked in the household.
[b]Among female smokers only.

SHS exposure is a cause of premature death and disease among women and children.[1] As shown in this and other studies, household SHS exposure makes a dominant contribution to the cumulative SHS exposures among women and children. In the United States, the majority of households with smokers now claim to have some policy restricting smoking inside.[1,23] Such policies, which preferably allow smoking outside only, have been shown to reduce or even eliminate SHS exposure.[1]

The data we collected show that household policies are not commonly in place in many countries. Instead, the data demonstrate a nearly universal lack of voluntary restrictions on smoking in households and a high percentage of smokers smoking around their children. Some evidence suggests that legislation for smoke-free public places has a positive effect on voluntary smoke-free households,[24] and smoke-free activities mandated by the FCTC may be beneficial for promoting smoke-free environments. Education is also a necessary and effective strategy in promoting protection from household SHS.[25] To protect the health of millions of women and children throughout the world, all individuals should be made aware of the adverse consequences of SHS exposure and encouraged to make their households smoke-free. ■

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This article was accepted November 27, 2007.

Contributors

H. Wipfli, A. Navas-Acien, and J.M. Samet designed the study and wrote the article. S. Kim, J. Yuan, and P. Breysse conducted the lab analysis. H. Wipfli, E. Avila-Tang, A. Navas-Acien, and G. Onicescu analyzed the data.

Acknowledgments

Support for this project was provided by the Flight Attendants Medical Research Institute (FAMRI) in the United States through a Dr William Cahan Distinguished Professors award to J.M. Samet, and a Center of Excellence Award to the Johns Hopkins Medical Institutions. Support was also provided by the National Institutes of Health through the Fogarty International Center (grant ROI HL 73699).

The FAMRI Homes Study Investigators were responsible for the acquisition of the data and the analysis and interpretation of the data within their country. The FAMRI Homes Study Investigators includes Marta Angueira (Argentina); Arayik Sargsyan (Armenia); Valeska Figueiredo (Brazil); Sin Sovann (Cambodia); Gonghuan Yang, Shao-jun Ma (China); Sergio Diaz, Deborah Ossip-Klein, Essie Sierra (Dominican Republic); Mostafa Mohamed, Christopher Loffredo (Egypt); Giorgi Magradze, George Bakhturidze (Georgia); Joaquin Barnoya (Guatemala); Sophia S.C. Chan, T.H. Lam, Y.W. Mak (Hong Kong); Mira Aghi (India); Rita Damayanti (Indonesia); Janis Caunitis (Latvia); Maniphanh Vongphosy (Laos); Foong Kin (Malaysia); Luz Myrian Reynales (Mexico); M.R. Pandey (Nepal); Reina Roa (Panama); Alfonso Zavaleta (Peru); Maria Lourdes Reuillida (Philippines); Witold Zatonski, Krzysztof Przewozniak, Jakub Gumkowski, Pawel Polak, Malgorzata Zagroba, Janina Fetlinska (Poland); Florin Mihaltan (Romania); Vladimir Levshin (Russia); Wasim Maziak (Syria); Wayne Kao (Taiwan); Naowarut Charoenca (Thailand); Zeynep Onder (Turkey); Tatiana Andreeva (Ukraine); Adriana Blanco (Uruguay); Natasha Herrera (Venezuela); and Bao Chau (Vietnam).

Human Participant Protection

Participation in the study was voluntary and the study and consent procedures were approved by the Johns Hopkins Bloomberg School of Public Health human subjects institutional review board and by the appropriate ethics committee at the individual country level.

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