

## Secondhand Smoke and CVD in Low- and Middle-Income Countries

### A Case for Action

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Secondhand tobacco smoke (SHS) is an environmental toxin and an established cause of cardiovascular disease in nonsmokers. Smoke-free laws reduce SHS and its downstream cardiovascular disease, but until recently, evidence to support smoke-free law implementation in low- and middle-income country settings was limited. In 14 low- and middle-income nations surveyed by the Global Adult Tobacco Survey, active smoking prevalence in adults ( $\geq 15$  years old) was universally higher in men (range 21.6–60.2%) than in women (0.5–24.4%), and the highest burden of SHS exposure was in women (strong positive association between male/female active smoking ratio and female SHS exposure prevalence). A systematic review was conducted of MEDLINE-indexed studies of self-reported SHS exposure and cardiovascular harms in low- or middle-income nations. Eight papers reported the association of SHS with ischemic heart disease, and four reported the association of SHS with stroke. For all the studies, and almost all sources of SHS surveyed, a strong positive association between SHS and ischemic heart disease (main relative odds ratio range 1.17–2.36) and SHS and stroke (odds ratio or hazard ratio: 1.41–1.49). Prevalence of SHS exposure is high in low- and middle-income nations, especially among women. Epidemiologic evidence supports the conclusion that SHS harms are the same across low-, middle-, and high-income nations. Governments have an obligation to protect citizens from SHS exposure, enforcing smoke-free legislation and providing public education about SHS harms.

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Involuntary exposure to secondhand tobacco smoke (SHS) increases the risk of ischemic heart disease (IHD) and lung cancer in nonsmoking adults and likely increases stroke risk [1,2]. Reduced myocardial infarction rates after implementation of smoke-free policies in specific jurisdictions support the hypothesis that IHD risk declines rapidly when SHS exposures are reduced [3]. Therefore, SHS is a cause of cardiovascular disease (CVD) preventable by public health policy.

Most past studies of the public health burden attributable to tobacco smoking have underestimated tobacco's contribution to global morbidity and mortality by neglecting SHS [4,5]. Likewise, past tobacco-control policy analyses have often underestimated the policy impact of workplace and public space smoking bans by projecting reductions in active smoking exposures alone [6–9].

One in 10 CVD deaths are attributable to active smoking, and approximately 40% of the global tobacco-related CVD burden is borne by

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low- and middle-income nations [4]. Furthermore, many of the low- and middle-income nations have high male smoking rates, but substantially lower female rates so that nonsmoking women may be more likely to be exposed in the home. A 2010 study of the burden of disease attributable to SHS in 192 countries estimated that 603,000 deaths, including 379,000 IHD deaths and 1% of global mortality were due to SHS exposures in 2004 [10]. That study relied on incomplete exposure data in adults and SHS effects on IHD estimated mostly from high-income nation studies, gaps filled in part by recent publication exposure estimates from the Global Adult Tobacco Survey (GATS) [11], and recent epidemiologic studies of the association between SHS and IHD and stroke in low- and middle-income nations [12–18].

Smoke-free laws are a cornerstone policy arm of global tobacco-control policy, incorporated in the World Health Organization (WHO) Framework Convention for Tobacco Control [19]. In this paper, we review adult SHS prevalence data from the GATS and studies of SHS and CVD in low- and middle-income nations in order to present the case for preventing CVD by implementing smoke-free laws worldwide. We present evidence that SHS is an important public health problem in low- and middle-income nations, where women are often the main “innocent victims” of SHS.

### PREVALENCE OF SECONDHAND SMOKE EXPOSURES IN LOW- AND MIDDLE-INCOME NATIONS: THE GLOBAL ADULT TOBACCO SURVEY

In the United States, in 2010, 19.3% of adults  $\geq 18$  years were active smokers [20]. When a sensitive biomarker such as serum cotinine  $\geq 5$  ng/ml was used to define SHS exposure, approximately 37% of U.S. adults were estimated to be exposed to SHS (prevalence was higher in ages  $< 20$  years, the poor, and African Americans) [21]. However, SHS exposure has declined along with active smoking in high-income nations [21].

Active smoking declines have not been replicated in many low- and middle-income nations, and until recently, SHS prevalence was unknown in these nations. In 2007, WHO sponsored the nationally representative GATS in 16 low- and middle-income nations (Bangladesh, Brazil, China, Egypt, India, Indonesia, Mexico, Pakistan, Philippines, Poland, Russian Federation, Thailand, Turkey, Ukraine, Uruguay, and Vietnam). Data from

only 14 sites were available for this review (Pakistan and Indonesia data not available) [11]. GATS comprised multistage stratified samples of urban and rural men and women  $\geq 15$  years of age in each country. Prevalence of self-reported active smoking and SHS exposures were weighted in order to provide nationally representative estimates (Table 1, Supplemental Table 1). Most countries elicited self-reported public place SHS exposure among persons visiting those places within the prior 30 days.

Active smoking prevalence was higher in men than in women in all the GATS nations, but home SHS exposures were common in men and women alike (Table 1, Supplemental Table 1). Though the exposure denominator in Table 1 was smokers and nonsmokers, a similar prevalence was found in nonsmokers (Supplemental Table 2). The GATS nations with the lowest levels of SHS have the most active tobacco-control policies (Brazil, Mexico, Thailand, and Uruguay). The nations listed as having smoke-free legislation have expanded the scope of their laws to cover more public spaces since GATS was conducted [22].

Male active smoking was the driver of female SHS exposures at home or at work, especially in countries with high male and low female active smoking prevalence (high male/female active smoking ratios) (Figs. 1 and 2). The same strong association between male/female active smoking ratio and SHS among female nonsmokers was observed in the nations reporting SHS exposures in nonsmokers only (Supplemental Fig. 1). Variability in female SHS among nations with similar male/female ratios, such as Mexico and Turkey, could be explained by different male smoking patterns, relatively higher rates of both male and female smoking in some nations (e.g., Turkey), or SHS under- or over-reporting.

### HOW DOES SHS CAUSE CVD?

SHS is also known as environmental tobacco smoke or passive smoking. SHS is a combination of mainstream smoke exhaled by active smokers and side stream smoke given off by smoldering cigarettes or other smoked tobacco sources. Human subjects studies have documented that SHS exposure leads to both acute and chronic damage to the cardiovascular system. Acutely, SHS causes platelet activation, causes coronary artery endothelial dysfunction [23,24], and impairs heart rate variability [25] similar to the effects of active smoking

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