

Secondhand Smoke and Health-Related Quality of Life in Never Smokers

Results From the SAPALDIA Cohort Study 2

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Background: Although secondhand smoke (SHS) has been linked with various respiratory conditions and symptoms, its association with health-related quality of life (HRQOL) is unknown.

Methods: A cross-sectional study was performed of 2500 never smokers in Switzerland who participated in the Swiss Cohort Study on Air Pollution and Lung Diseases in Adults and completed a 36-Item Short Form Health Survey (SF-36) in 2002. Using linear regression models adjusting for confounders, we measured the association between HRQOL and moderate or high SHS exposure (≤ 3 h/d or > 3 h/d) compared with no SHS exposure. Data from men and women were analyzed separately and further stratified by source of SHS (home, workplace, and public spaces).

Results: After adjustments, SHS was associated with reduced scores in all SF-36 domains. High SHS exposure

predicted a greater reduction in HRQOL. Compared with nonexposed women, those with high SHS exposure at home had significantly lower scores on the physical functioning (-7.8 , $P < .001$), role physical (-10.5 , $P = .02$), bodily pain (-9.2 , $P = .01$), and social functioning (-8.1 , $P = .007$) domains. Exposed men had lower scores for the role physical domain (-20.0 , $P < .001$) and a trend toward lower scores in other domains. In women, exposure to SHS at home was associated with a stronger negative effect on HRQOL than at work and in public spaces.

Conclusions: Secondhand smoke is associated with reduced HRQOL, more significantly so in women. Exposure to SHS at home and high levels of exposure are associated with lower SF-36 scores, suggesting a dose-response relationship.

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SECONDHAND SMOKE (SHS) EXPOSURE is widespread and affects between 6% and 65% of the population in the European Community Respiratory Health Survey 2.¹ In Switzerland, 25% of the adult population reported exposure to SHS in 2004. Secondhand smoke has been recognized as a risk factor for lung cancer,² coronary heart disease,³ chronic respiratory symptoms,^{4,5} and low pulmonary function.^{6,7} Cross-sectional and longitudinal studies reported an association between SHS and asthma.^{4,8}

Health-related quality of life (HRQOL) has been shown to be reduced among current smokers, with a greater reduction in physical and mental health domains.^{9,10} In a case-control study, even a short history of smoking was associated with a decrease in HRQOL scores in young smokers, which suggests that HRQOL decline may precede changes in pulmonary function tests.¹¹

Overall, HRQOL is considered an important tool to comprehensively assess physical, social, and mental functioning of a population. For example, in a large cohort of veterans, decline in the physical component summary of the 36-Item Short Form Health Survey (SF-36) increased the risk of death and of hospitalization.¹² This relationship was confirmed, independently of prevalent cardiovascular disease or cancer, in a large survey from the general population in Europe.¹³ Scores on the SF-36 also predicted total health care costs.¹⁴ Hence, even a minor reduction in HRQOL due to SHS may represent an early marker of a preventable increase in mortality, hospitalization, and health care costs at population levels. However, despite the known health effects of SHS among never smokers, the relationship between SHS and quality of life has not been delineated so far.

The goals of our study were (1) to investigate the association between SHS and

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HRQOL among never smokers, as evaluated by the SF-36, using a population-based survey: the Swiss Cohort Study on Air Pollution and Lung Diseases in Adults (SAPALDIA) and (2) to assess the association of various sources of SHS exposure with HRQOL.

METHODS

STUDY POPULATION

The SAPALDIA cohort (N=9651) was enrolled in 1991 and consisted of a random sample of the population aged 18 to 60 years across 8 study areas chosen to represent the diverse climate, degrees of urbanization, and levels of air pollution in Switzerland (Geneva, Basel, Lugano, Aarau, Wald, Payerne, Davos, and Montana).¹⁵ In 2002, the follow-up study included 8047 subjects (83.4%) from the 1991 sample. As part of this study, 5695 subjects (70.8%) returned the SF-36. During a person-to-person examination, trained interviewers administered an extensive health inventory questionnaire addressing the subject's history of respiratory symptoms, allergic diseases, living and working environment, smoking habits, socioeconomic status, and comorbidities as well as exposure to SHS. Because the effect of active smoking on HRQOL is considerable in current and former smokers, subtle additional changes due to SHS among those groups may be overlooked. Thus, to avoid confounding by smoking, we based our study sample on 2500 adults who answered the SF-36 and had never smoked.

SHS EXPOSURE

The primary predictor for this study was exposure to SHS during the 12-month period before the interview. Subjects were considered to have been exposed to SHS if they answered yes to the question, "Have you been regularly exposed to tobacco smoke in the last year?" Exposure to SHS was further detailed by collecting data on its sources ("Have you been regularly exposed to tobacco smoke at home during the last 12 months? [yes/no] At your workplace? [yes/no] In bars or restaurants? [yes/no]"), as well as the duration of exposures in hours per day ("During how many hours per day are you exposed to tobacco smoke at home? At your workplace? In bars or restaurants? In total?"). The duration of SHS exposure was categorized in the following groups: 0 h/d (reference group), 3 h/d or less (moderate exposure), and more than 3 h/d (high exposure) in accordance with a previous study.⁴ Few subjects reported exposure of more than 3 h/d in bars or restaurants; they were therefore included in the group of subjects reporting moderate exposure. Mean daily SHS exposure was also used as a continuous variable for each different source and for total exposure.

ADMINISTRATION OF THE HRQOL QUESTIONNAIRES

The subjects filled out SF-36 questionnaires between April 2001 and March 2003. Because Switzerland is a multilingual country, German, French, and Italian validated versions of the questionnaire were administered.

The outcomes of interest were the 8 domains of the SF-36 (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health). Each domain explores a different aspect of HRQOL. In particular, the physical functioning domain is related to the ability to perform physical activities, including strenuous effort. The role physical measures the extent of disability, such as problems with work, due to physical problems. The aspects of so-

cial life are addressed by the social functioning scale, which examines the ability to perform social activities given the potential interference of physical or emotional problems.

COVARIATES

Age, sex, nationality, education level, professional status, comorbid conditions, and physician-diagnosed asthma were derived from questionnaires. Body height and weight were measured with participants not wearing any shoes or coats. Pulmonary function tests were performed by trained pulmonary technicians, according to the American Thoracic Society standards.

STATISTICAL ANALYSIS

To assess for potential response bias, characteristics of subjects who did and did not answer the SF-36 were compared. The SHS-exposed and nonexposed subjects were compared with unpaired *t* test and χ^2 test when appropriate. Then, univariate and multivariate linear regression models were constructed using the 8 domains of the SF-36 as dependent variables and SHS exposure categories as the main independent variables. Ninety-two questionnaires (3.7%) had 1 or more missing answers and were excluded from the analysis.

Age was found to have a nonlinear effect and thus was entered into the models with a quadratic term. Low education, non-Swiss citizenship, low professional status, diabetes mellitus, body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared), and study area were found to be predictors of both SHS and HRQOL. Percentage of predicted forced expiratory volume in 1 second (FEV₁), as well as self-reported comorbid conditions (any chronic disease, congestive heart failure, hypertension, diabetes, osteoarthritis, stroke, and depression), were associated with HRQOL scores and controlled for. The study area was included as a random-effects variable in our multivariate models.

Further confounding was also assessed by introducing supplementary covariates into the model. Asthma, season of the year (questionnaire completion date), and occupational exposure were tested as variables. These factors did not modify the association between SHS and the different quality-of-life domains and were not included.

An analysis using an interaction term (sex \times SHS) showed an effect modification. Thus, subsequent models were stratified on sex.

Finally, to isolate a potentially more pronounced effect of one or another source of SHS exposure (at home, workplace, or in bars/restaurant), analysis stratifying on SHS sources was performed.

CLINICAL ANCHORS

To better anchor the clinical significance of SHS exposure and HRQOL in our population, odds ratios of reporting regular outpatient visits during the 12-month period preceding the survey were calculated, adjusted for the aforementioned covariates.

RESULTS

CHARACTERISTICS OF RESPONDERS

Of the 5695 SF-36 responders, 2500 (43.9%) had never smoked and were eligible for the analyses. Among those, 388 subjects (15.5%) reported regular exposure to SHS (**Figure 1**).

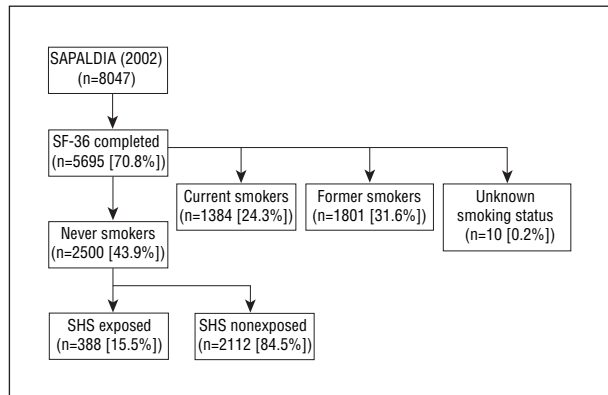


Figure 1. Flowchart of participants in the Swiss Cohort Study on Air Pollution and Lung Diseases in Adults (SAPALDIA) (2002) who are included in the present study. SF-36 indicates 36-Item Short Form Health Survey; SHS, secondhand smoke.

Comparison of subjects who completed the SF-36 ($n=5695$) and those who did not ($n=2352$) showed that responders were younger (51.8 vs 52.8 years; $P=.004$) and more likely to be male (2787 [48.9%] vs 1080 [45.9%]; $P=.01$), Swiss citizens (4988 [87.6%] vs 1865 [79.3%]; $P<.001$), and better educated (low education level, 774 [13.6%] vs 410 [17.4%]; $P<.001$). Asthma diagnosed by a physician was reported less frequently among responders (411 [7.2%] vs 204 [8.7%]; $P<.001$), but no difference in the FEV₁ to forced vital capacity ratio was observed. Responders were less likely to be current smokers 1384 [24.3%] vs 620 [26.4%]; $P<.001$), but SHS exposure among never smokers was similar (388 of 2500 [15.5%] vs 105 of 744 [14.1%]; $P=.35$).

EXPOSURE TO SHS AMONG NEVER SMOKERS

Table 1 compares the characteristics of subjects with ($n=388$) and without ($n=2112$) reported exposure to SHS during the last 12 months. Subjects exposed to SHS were generally younger, had a higher BMI, were non-Swiss citizens, were less educated, and had a lower professional status. They more frequently reported exposure to dust, gas, or fumes. In addition, comorbid conditions were slightly more frequent and reached statistical significance for diabetes.

The source and duration of SHS exposure by sex are described in **Table 2**. Although the total duration of SHS exposure was similar in women and men, there were some sex-related differences. Women were more exposed at home than men, whose exposure mainly took place at work. Mean SHS exposure time was 2 hours 54 min/d, independent of the source. Self-reported total exposure was lower than the sum of home, workplace, and bar/restaurant exposure. This was not unexpected because each question had been asked separately.

SHS EXPOSURE AND SF-36 SCORES

Table 3 provides the age-adjusted SF-36 scores by sex and SHS exposure for never smokers. In men, significantly lower HRQOL scores were present on the role

Table 1. Demographic Characteristics of 2500 Study Subjects

Characteristic	SHS	No SHS	P Value ^a
No. (%) of subjects	388 (15.5)	2112 (84.5)	
Age, mean (SD), y	48.9 (11.8)	51.8 (12.2)	<.001
Sex, No. (%) M	156 (40.2)	857 (40.6)	.90
Height, mean (SD), cm	168.4 (9.8)	168.1 (9.5)	.59
Weight, mean (SD), kg	74.7 (15.6)	72.6 (14.1)	.007
BMI, mean (SD)	26.4 (5.0)	25.7 (4.4)	.045
BMI, No. (%)			.03
<25	173 (44.6)	1031 (48.8)	
25-30	133 (34.3)	777 (36.8)	
>30	82 (21.1)	304 (14.4)	
Swiss citizenship, No. (%)	324 (83.5)	1886 (89.3)	.001
Low education, No. (%)	75 (19.3)	270 (12.8)	.001
Low professional status, No. (%)	106 (27.3)	448 (21.2)	<.001
Occupational exposure (dust, gas, or fumes), No. (%)	73 (18.8)	201 (9.5)	.005
Positive inhalant atopy screen, No./total No. screened (%)	111/344 (32.3)	593/1949 (30.4)	.49
FEV ₁ , mean (SD), % of predicted	108 (15)	109 (15)	.27
FVC, mean (SD), % of predicted	99 (13)	100 (13)	.07
FEV ₁ /FVC ratio, mean (SD)	0.76 (0.07)	0.76 (0.07)	.13
Physician-diagnosed asthma, No. (%)	30 (7.7)	143 (6.8)	.47
Chronic phlegm, No. (%)	25 (6.4)	129 (6.1)	.80
Chronic cough, No. (%)	17 (4.4)	72 (3.4)	.35
Chronic bronchitis, No. (%)	5 (1.3)	27 (1.3)	.80
Any respiratory symptom, No. (%)	37 (9.5)	178 (8.4)	.47
Hypertension, No. (%)	62 (16.0)	312 (14.8)	.23
Congestive heart failure, No. (%)	22 (5.7)	107 (5.1)	.88
Diabetes, No. (%)	15 (3.9)	41 (1.9)	.04
Depression, No. (%)	21 (5.4)	104 (4.9)	.65

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; SHS, secondhand smoke.

^aBy unpaired *t* test or χ^2 .

physical domain, whereas a trend toward lower scores was present on all 7 other domains. In women, significantly lower scores were present on all domains except bodily pain.

Adjusted differences in SF-36 scores comparing subjects with moderate or high SHS exposure with the nonexposed are detailed by sources of exposure and sex in **Table 4**. For women, SHS exposure at home was generally associated with lower HRQOL. Women with home exposure of more than 3 h/d were particularly affected. In contrast, SHS exposure in the workplace among women was associated with significantly lower HRQOL scores only for the physical functioning score. For SHS exposure in bars and restaurants, women reported a lower HRQOL than the nonexposed subjects on all domains, with statistical significance reached for physical functioning, vitality, and social functioning.

Table 2. Source and Duration of SHS Exposure by Sex

	Total	Men	Women	P Value ^a
Home exposure				
Duration, mean h:min per day (95% CI)	1:16 (1:05-1:27)	0:56 (0:45-1:07)	1:30 (1:13-1:47)	.003
% of total exposure	27.7	22.3	31.4	.05
Workplace exposure				
Duration, mean h:min per day (95% CI)	2:03 (1:46-2:21)	2:27 (1:56-2:58)	1:48 (1:26-2:09)	.03
% of total exposure	36.0	40.8	32.7	.10
Bar and restaurant exposure				
Duration, mean h:min per day (95% CI)	0:51 (0:42-1:01)	0:49 (0:34-1:04)	0:53 (0:40-1:05)	.72
% of total exposure	20.4	31.4	20.1	.85
Total exposure ^b				
Exposed, No. (%)	388 (15.5)	156 (15.6)	232 (15.7)	.92
Duration, mean h:min per day (95% CI)	2:54 (2:36-3:12)	2:57 (2:28-3:26)	2:52 (2:28-3:15)	.77

Abbreviations: CI, confidence interval; SHS, secondhand smoke.

^aBy unpaired *t* test, test of proportions (men vs women), or χ^2 .

^bThe self-estimated total duration of SHS exposure is different from the sum of the various sources of SHS exposure because of the different questions used to estimate SHS exposure.

Table 3. Age-Adjusted SF-36 Mean Scores (95% CI) by Sex and SHS Exposure Status for Never Smokers

	Men (n=1005)			Women (n=1470)		
	SHS (n=155)	No SHS (n=850)	P Value ^a	SHS (n=227)	No SHS (n=1243)	P Value ^a
PF	92.3 (90.1-94.6)	93.8 (92.7-94.9)	.21	85.3 (83.1-87.5)	91.2 (90.0-92.3)	.002
RP	88.3 (84.7-91.8)	92.9 (91.1-94.6)	.02	84.1 (80.3-87.9)	88.9 (87.0-90.8)	.02
BP	85.5 (82.2-88.8)	86.8 (85.2-88.4)	.46	77.5 (74.5-80.6)	80.4 (78.8-82.0)	.09
GH	66.0 (65.1-67.0)	64.2 (62.3-66.1)	.10	61.3 (59.6-62.9)	63.5 (62.7-64.3)	.01
VT	67.2 (64.6-69.8)	67.8 (66.5-69.0)	.68	60.3 (57.9-62.5)	64.1 (62.9-65.3)	.002
SF	87.3 (84.6-90.0)	89.5 (88.2-90.9)	.12	83.5 (81.1-86.1)	87.7 (86.4-88.9)	.002
RE	91.8 (88.0-96.6)	92.4 (90.5-94.2)	.79	83.6 (79.8-87.4)	88.0 (86.0-89.9)	.03
MH	77.5 (75.2-79.7)	77.6 (76.5-78.7)	.89	71.8 (69.8-73.9)	74.9 (73.9-76.0)	.005

Abbreviations: BP, bodily pain; CI, confidence interval; GH, general health; MH, mental health; PF, physical functioning; RE, role emotional; RP, role physical; SF, social functioning; SF-36, 36-Item Short Form Health Survey; SHS, secondhand smoke; VT, vitality.

^aP value comparing SHS-exposed subjects vs SHS-nonexposed subjects. Scores are age adjusted for 50-year-old subjects.

Multivariate regression models using the duration of SHS (in hours per day) as a continuous variable showed that, in women, each 1-hour increase in home SHS exposure resulted in a decrease in the domains of physical functioning (-1.16 points/h; $P=.02$), role physical (-1.52 points/h; $P=.03$), bodily pain (-1.54 points/h; $P=.07$), social functioning (-1.40 points/h; $P=.03$), and mental health (-0.80 points/h; $P=.02$). The relationship was similar but less marked and not significant for exposure in the workplace and in bars or restaurants. For men, although a similar negative effect of SHS was observed on almost all subscales, only total duration of home SHS was significantly correlated with role physical (-5.29 points/h; $P<.001$).

Mean adjusted differences in SF-36 scores associated with moderate and high SHS are shown in **Figure 2** for men and women separately. Women with moderate SHS exposure had a significantly lower HRQOL on physical functioning and vitality domains, whereas among those with high SHS exposure, the association was larger and significant on physical functioning and social functioning domains.

SHS EFFECT IN SUBJECTS WITH ASTHMA OR IMPAIRED LUNG FUNCTION

The potential role of asthma as an effect modifier of the association of SHS with HRQOL was explored for men and women separately. For men with a diagnosis of asthma (77 of 1011 [7.6%]), exposure to SHS was associated with a trend toward more physical limitations. For women, asthma (96 of 1488 [6.5%]) did not interact with SHS to lower HRQOL. Thus, an effect modification of SHS by asthma could be suspected but not confirmed, perhaps because of the small number of participants with asthma. In addition, testing the interaction term asthma \times SHS proved not to be significant in either men ($P=.17$) or women ($P=.10$). Similarly, FEV₁ did not show a statistical interaction with SHS exposure ($P=.22$ for men and $P=.59$ for women).

Table 5 shows the adjusted odds ratios of reporting regular physician visits among never smokers stratified by level of SHS exposure and physical functioning scores. In 3 nested models adjusting for only demographic variables (model 1), socioeconomic variables (model 2), and

Table 4. SF-36 Adjusted Mean Score Differences Associated With Moderate or High Exposure to SHS Among Never Smokers, Stratified by Sex and Source of Exposure^a

	Home SHS		Workplace SHS		Bar SHS
	≤ 3 h/d	> 3 h/d	≤ 3 h/d	> 3 h/d	≤ 3 h/d ^b
Men (n=994)					
No.	138	15	112	40	154
PF	-1.1	3.9	-0.4	0.5	-0.6
RP	-2.1	-20.0 ^c	-3.7	0.5	-3.7 ^d
BP	0.3	-2.5	-0.5	3.4	-0.4
GH	-1.1	-2.8	-0.3	-3.1	-1.2
VT	-0.5	5.5	1.2	-1.8	0.1
SF	-1.4	-2.0	-0.2	-3.9	-1.6
RE	0.3	-6.2	2.0	-3.8	-0.6
MH	0.6	-2.5	0.7	0.7	0.3
Women (n=1443)					
No.	188	35	182	41	220
PF	-3.2 ^e	-7.8 ^e	-4.0 ^c	-3.8	-4.2 ^c
RP	-2.4	-10.5 ^d	-3.4	-4.7	-4.0 ^d
BP	0.4	-9.2 ^d	-0.8	-2.8	-1.3
GH	-1.6	-1.3	-1.4	-2.4	-1.7
VT	-3.2 ^d	-1.5	-2.7	-3.3	-2.9 ^e
SF	-2.1	-8.1 ^c	-2.8	-3.8	-3.2 ^d
RE	-2.1	-6.2	-1.9	-5.5	-3.0
MH	-1.8	-2.6	-2.2	-0.3	-2.0

Abbreviations: BP, bodily pain; GH, general health; MH, mental health; PF, physical functioning; RE, role emotional; RP, role physical; SF, social functioning; SF-36, 36-Item Short Form Health Survey; SHS, secondhand smoke; VT, vitality.

^aAdjusted for age, age squared, education level, professional category, nationality, comorbid conditions, categorical body mass index, categorical forced expiratory volume in 1 second (percentage of predicted), and study area.

^bOnly 2 men and 8 women were exposed to SHS in bars/restaurants for more than 3 h/d; they were therefore included in the moderate SHS exposure group.

^c $P \leq .001$.

^d $P < .05$.

^e $P < .01$.

comorbidities, BMI, and lung function tests (model 3), subjects exposed to SHS were more likely to report regular outpatient visits. The relationship was significant and stronger for those exposed more than 3 h/d in models 1 and 2. Also, more frequent physician visits were reported in subjects with lower HRQOL, compared with those with physical functioning scores greater than 90 points.

COMMENT

Our study indicates that SHS exposure is associated with lower HRQOL scores in most SF-36 domains for women. In the physical domains, there was a dose-response relationship, with higher daily SHS exposure resulting in greater reduction of HRQOL, the association being stronger when women were exposed at home. The observed reduction in HRQOL was large enough to be perceived.

SEX DIFFERENCES

Other studies have reported sex differences in the effects of SHS and smoking. Langhammer et al¹⁶ have shown that exposure to SHS during childhood led to a higher risk of wheezing or breathlessness in women but not in men. In the same study, more respiratory symptoms and lower self-rated health were reported by women, after controlling for smoking status and lung function. Cross-sectional stud-

ies found lower lung function among women exposed to smoking, as well as a lower cough threshold and higher smoking-related bronchial hyperresponsiveness.¹⁷⁻²⁰

The association between SHS and bodily pain in women is intriguing. It may be due to a true relationship mediated by conditions that eventually cause pain. It could be confounded by some socioeconomic factors (eg, housekeepers carrying heavy loads) that are related to SHS and bodily pain, or it may be due to chance alone. Further studies are needed to elucidate this association.

SOURCE AND DURATION OF SHS EXPOSURE

Sources of SHS exposure were an important determinant of HRQOL in our study. In an earlier report, Leuenberger et al⁴ found a particularly strong effect of SHS exposure on respiratory symptoms at work, although this exposure has been drastically reduced ever since because of smoking bans in many workplaces. Recent studies have shown that home SHS exposure was the strongest predictor of serum or ambient cotinine level compared with workplace or social exposure.^{21,22} The negative effect of SHS exposure at home is likely to be caused by a higher concentration of side-stream smoke due to the relatively small size of private houses or apartments, and possibly by a greater number of cigarettes smoked in a close environment.²³ This hypothesis is supported by our data showing that the negative effect on HRQOL of 1 hour of

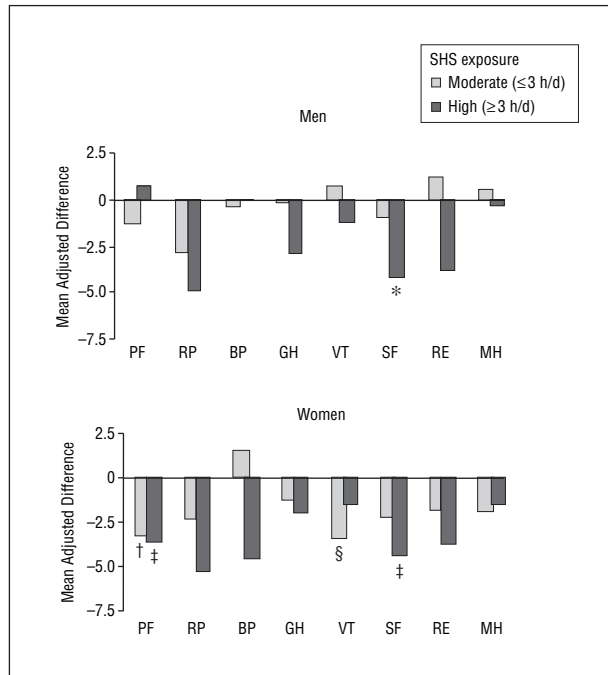


Figure 2. 36-Item Short Form Health Survey mean score differences in men and women associated with moderate and high secondhand smoke (SHS) exposure, adjusted for age, age squared, education level, professional category, nationality, comorbid conditions, categorical body mass index, categorical forced expiratory volume in 1 second (percentage of predicted), and study area. BP indicates bodily pain; GH, general health; MH, mental health; PF, physical functioning; RE, role emotional; RP, role physical; SF, social functioning; and VT, vitality. * $P=.048$. † $P=.01$. ‡ $P=.03$. § $P=.02$. For all P values, the group of subjects not exposed to secondhand smoke was the reference group.

SHS at home is greater than the same duration of exposure in the workplace or in bars/restaurants. This fact may explain the larger HRQOL score differences seen in women, mainly exposed at home, compared with men.

ASTHMA AND SHS

Previous epidemiologic studies have shown an association between the risk of having a diagnosis of asthma and SHS exposure, especially in women.^{4,8} Lung function of patients with asthma was worse when exposed to SHS in one study.⁷ In a recent report, our group²⁴ was able to show that silent bronchial hyperresponsiveness is a risk factor for the development of respiratory symptoms and lung function decline in otherwise healthy individuals persistently exposed to SHS.

In this study, few subjects reported having asthma, and they were apparently not affected by SHS in terms of HRQOL. One explanation could be that asthmatic subjects, in particular those who are more sensitive to SHS, try to avoid SHS exposure and thus paradoxically report an equal HRQOL.

RESIDUAL CONFOUNDING

The cross-sectional design of our study cannot exclude the effects of unmeasured confounders. For instance, cardiovascular disease and cancer have both been associated with SHS and are important predictors of SF-36

Table 5. Adjusted Odds Ratio (95% CI) of Regular Outpatient Visits Among Never Smokers by SHS Exposure or PF Score Category

	Regular Outpatient Visits ^a		
	Model 1	Model 2	Model 3
SHS exposure			
None	1 [Reference]	1 [Reference]	1 [Reference]
≤3 h/d	1.42 (1.05-1.93)	1.38 (1.01-1.88)	1.35 (0.97-1.89)
>3 h/d	1.58 (1.07-2.35)	1.56 (1.05-2.31)	1.31 (0.85-2.02)
PF score category			
>90	1 [Reference]	1 [Reference]	1 [Reference]
80-90	1.83 (1.38-2.43)	1.83 (1.37-2.43)	1.52 (1.11-2.05)
<80	2.90 (2.23-3.77)	2.83 (2.17-3.71)	1.67 (1.23-2.26)

Abbreviations: CI, confidence interval; PF, physical functioning; SHS, secondhand smoke.

^aModel 1, adjusted for age, age squared, sex, and study area; model 2, same as model 1 plus education level, professional category, and nationality; model 3, same as model 2 plus comorbidities, categorical body mass index, and categorical forced expiratory volume in 1 second (percentage of predicted).

scores.^{2,3} However, the prevalence of these 2 conditions is low among nonsmokers, and particularly women, who experienced the larger reduction in HRQOL associated with SHS. In our multivariate models, self-reported congestive heart failure, hypertension, and diabetes mellitus were controlled for and only slightly changed the coefficients of SHS exposure. We cannot exclude the effects of undiagnosed chronic obstructive pulmonary disease or asthma interacting with SHS to reduce HRQOL. Nevertheless, such an effect is unlikely to have been of significant magnitude in our study given that FEV₁ was adjusted for in the multivariate models. Finally, socioeconomic differences not entirely captured by our control for study area, level of education, professional category, and citizenship may have played a role.

Our study has several limitations. First, responders to the SF-36 questionnaires had a lower BMI and a higher socioeconomic status than did nonresponders and thus may not be representative of the whole population of subjects exposed to SHS, who have a lower socioeconomic status and a higher BMI. However, such a selection bias would lead to an underestimation of the true effect of SHS on HRQOL. Second, SHS exposure was assessed by questionnaires, which could lead to misclassification of true exposure. In particular, self-reported duration of exposure is subject to recall errors and may mirror the perceived burden of SHS more than actual duration. Nonetheless, previous studies found a linear correlation between self-reported SHS exposure and biomarkers such as salivary or serum cotinine, indicating that questionnaires about reported SHS exposure correctly classify the relative levels of SHS exposure among nonsmokers.^{21,25} Third, it is possible that a tobacco- or respiratory disease-specific questionnaire would be more sensitive to detect the effects of SHS exposure than the SF-36 generic instrument applied in this study.

Strengths of our study include the size of the sample and its random selection from the general population of Switzerland. The multicultural and geographic diversity of the sample reinforces the external validity of our results. Furthermore, the nonspecific interview-based

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questionnaire, centered on a variety of potential environmental hazards and not only on SHS, reduces the risk of a recall bias. Finally, in our sample of never smokers, lower HRQOL and SHS were both associated with health care utilization, which suggests that the health effects of SHS are clinically meaningful.

In conclusion, results of our study suggest that SHS is associated with a significant decrease of HRQOL scores in women, particularly in the physical health domain, as measured by the SF-36. This observed association seems dose dependent, notably in women exposed to SHS at home. These findings may contribute to prompting future public health policy to focus on counseling about SHS at home and not only on controlling SHS in public places.

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