Exposure to environmental tobacco smoke: association with personal characteristics and self reported health conditions

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Abstract

***Study objective*—To examine the association between exposure to environmental tobacco smoke (ETS) and demographic, lifestyle, occupational characteristics and self reported health conditions.**

***Design*—Cross sectional study, using data from multiphasic health checkups between 1979 and 1985.**

***Setting*—Large health plan in Northern California, USA.**

***Participants*—16 524 men aged 15–89 years and 26 197 women aged 15–105 years who never smoked.**

***Results*—Sixty eight per cent of men and 64 per cent of women reported any current ETS exposure (at home, in small spaces other than home or in large indoor areas). The exposure time from all three sources of ETS exposure correlated negatively with age. Men and women reporting high level ETS exposure were more likely to be black and never married or separated/divorced, to have no college or partial college education, to consume three alcoholic drink/day or more and to report exposure to several occupational hazards. Consistent independent relations across sexes were found between any current exposure to ETS and a positive history of hay fever/asthma (odds ratio (OR)=1.22 in men, 1.14 in women), hearing loss (OR=1.30 in men, 1.27 in women), severe headache (OR=1.22 in men, 1.17 in women), and cold/flu symptoms (OR=1.52 in men, 1.57 in women). Any current ETS exposure was also associated with chronic cough (OR=1.22) in men and with heart disease (OR=1.10) in women. Self reported stroke was inversely associated with any current ETS exposure in men (OR=0.27). No associations were noted for cancer or tumour and for migraine.**

***Conclusion*—ETS exposure correlated with several personal characteristics potentially associated with adverse health outcomes. Although the study design precluded causal inference, ETS exposure was associated with several self reported acute and chronic medical conditions.**

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Evidence that exposure to environmental tobacco smoke (ETS) is a health hazard has been mounting over the past two decades.[1] Clear associations have been identified between ETS exposure and lung cancer,[1–6] ischaemic heart disease,[7–11] asthma in children[12–16] and adults[17–20] and sudden infant death syndrome.[21 22]

However, an important methodological issue that arises when assessing associations between ETS exposure and health outcomes is the possibility of confounding by variables related both to the exposure and the outcome of interest.[23] This is of special concern with ETS exposure, as many of the relative risk estimates are less than 2.0 and then may be explained by lack of adjustment for confounding factors.

The aim of this report was twofold. Firstly, to examine the association between ETS exposure and demographic, socioeconomic, occupational and physiological characteristics and secondly, to ascertain the independent cross sectional association of ETS exposure with self reported common acute and chronic health conditions. The study sample was a large, well defined population of lifelong never smoking men and women. Study participants were enrollees of a health plan in the San Francisco Bay Area between the years 1979 and 1985, before statewide legislation (California State Assembly Bill 13) mandated smoke free workplaces starting on 1 January 1995 and smoke free bars and taverns starting on 1 January 1998.

Methods

STUDY DESIGN AND PROCEDURE

The study sample consisted of 16 524 male and 26 197 female subscribers of the Kaiser Permanente Medical Care Program of Northern California, 15 to 105 years of age who reported never using cigarettes, cigars or pipes. This sample was a subgroup of a larger population of 136 790 Kaiser Permanente members (76 270 women and 60 520 men) who underwent multiphasic health check ups between 1979 and 1985 in San Francisco or Oakland. Of those, 91 285 were excluded for reporting current or former use of cigarettes, cigars or pipes. An additional 2784 persons were excluded for missing data on ETS exposure. Those who had missing data on one or more of the ETS exposure variables (n=2784) and who were excluded from the analysis tended to be older, less educated and less likely to be white than counterparts with complete data on ETS exposure (data not shown).

Northern California Kaiser Permanente members constitute an ethnic and socioeconomic patient mix that is generally representative of the local population, except that the

Table 1 Exposure to ETS, by source and gender and inter-correlations between different sources of ETS exposure. Northern California Kaiser Permanente, 1979–85

	Men (n=16 524)					*Women (26 197)*				
	*Per cent exposed**	*Centiles among exposed (hours/week)*				*Per cent exposed*	*Centiles among exposed (hours/week)*			
Source of ETS exposure		25th	50th	75th	90th		25th	50th	75th	90th
Home	20	2	7	20	40	26	4	10	30	50
Small spaces other than home	43	2	5	20	40	41	3	8	32	40
Large indoor areas	53	2	4	9	21	45	2	4	8	22
Total exposure†	68	3	9	29	47	64	4	12	40	58
Spearman correlation coefficients										
Between home and small spaces other than home		0.19					0.27			
Between home and large indoor areas		0.19					0.21			
Between home and total exposure		0.47					0.57			
Between small spaces other than home and large indoor areas		0.36					0.37			
Between small spaces other than home and total exposure		0.71					0.73			
Between large indoor areas and total exposure		0.72					0.63			

*Exposure for at least 1 hour/week. †Sum of home, small spaces other than home and large indoor areas.

extremes of wealth and poverty are underrepresented.[24] If study participants attended more than one multiphasic health checkup, only the data from the first were used.

The multiphasic health check up collected information on several demographic factors (age, gender, ethnicity and education level), lifestyle (smoking, alcohol consumption and current on the job physical activity), physiological characteristics, medical conditions, and occupational exposures (both during the past year before the check up and before the past year) using written questionnaires and procedures previously described.[25 26] No data were available on leisure time physical activity. Personal histories of acute or chronic medical conditions were ascertained by affirmative answer to the question "Has a doctor ever said you had any of the diseases or conditions listed below?" These included: heart disease (heart attack or chest pain), stroke, intermittent claudication ("pain in legs which force you to stop walking"), cancer or tumour, chronic cough, emphysema, hay fever or asthma, hearing loss, severe headache, migraine, and number of days per year with cold or flu symptoms.

Body mass index was estimated as weight in kilograms divided by height (in metres^2) Hypertension was defined as systolic blood pressure > 140 mm Hg and diastolic blood pressure > 90 mm Hg and/or self reported history of hypertension. Diabetes mellitus was defined by self report of physician diagnosis of this medical condition. The multiphasic health check up questionnaire also contained 10 "Yes/No" items pertaining to self reported ever occupational exposures to: (1) chemicals, cleaning fluids or solvents; (2) insect or plant sprays; (3) plastics or resin fumes; (4) asbestos, cement or grain dusts; (5) silica, sandblasting, grinding/drilling dust; (6) radiographs or radioactivity; (7) ultraviolet radiation; (8) lead or metal fumes; (9) very loud noises; and (10) radar or microwave.

Exposure time of ETS exposure was assessed as the current average number of hours per week of exposure to cigarette, cigar or pipe smoke because of smoking by others: (a) at home; (b) in a small space other than home (such as airplanes, office, car, etc); and (c) in a large indoor area (such as restaurant, hotel lobby, lecture hall, etc). Examinees were instructed to enter "0" if the exposure was less than one hour per week. No information was available on cumulative lifetime duration of ETS exposure. We computed the total duration of current ETS exposure (in hours per week) by adding responses to ETS at home, in small spaces other than home and in large indoor areas. In a small test group (n=180), the total duration of ETS exposure was weakly but significantly correlated with serum thiocyanate level (r=0.15; p=0.04).[27] Informed consent was obtained from study participants and the study protocol was approved by the local Institutional Review Board.

STATISTICAL ANALYSIS

Because all the ETS variables were non-normally distributed, the correlations among the duration of ETS exposure from different sources (at home, in small spaces other than home, in large indoor areas and total) and with other continuous variables were estimated using the Spearman rank order correlation coefficient. We tabulated the characteristics of study participants according to levels of total duration of ETS exposure (0, 1–9, 10–39, ≥ 40 hours/week), separately for men and women. Bivariate relations were assessed using χ^2 analysis for contingency tables. Analysis of covariance (ANCOVA) was used to estimate age adjusted rates of self reported health conditions by increasing categories of ETS exposure, by gender and source of ETS. Gender specific logistic regression was used to assess the relation between ETS exposure, by source, and self reported health conditions with simultaneous adjustment for age, race/ethnicity, education level, marital status, alcohol consumption, on the job physical activity, serum total cholesterol, body mass index, hypertension, diabetes and individual occupational hazards. Multivariate adjusted odds ratios and associated 95% confidence intervals were computed for any (that is, > 0 hours/week) versus no exposure (that is, < 1 hour/week) and for heavy exposure (that is, ≥ 40 hours/week v no exposure) independently for each source and for total ETS exposure.

To ascertain misclassification of ETS exposure, we conducted a reliability analysis among a subset of persons classified as never smokers at the initial examination and who returned for

Table 2 Spearman correlations between continuous variables and exposure to ETS, by source and gender. Never smokers of any tobacco product. Northern California Kaiser Permanente, 1979–85

	Exposure to ETS			
	At home	In small spaces other than home	In large indoor areas	Total†
Men				
Age (n=16 524)	−0.10***	−0.08***	−0.10***	−0.13***
Total cholesterol (n=15 058)	−0.02*	−0.02*	−0.03**	−0.02*
Body mass index (n=14 973)	0.02*	0.01	−0.01	0.01
Women				
Age (n=26 197)	−0.10***	−0.19***	−0.19***	−0.21***
Total cholesterol (n=23 797)	−0.03**	−0.10***	−0.10***	−0.10***
Body mass index (n=23 663)	0.05**	−0.03**	−0.08***	−0.02*

*p<0.05; **p<0.01; ***p<0.001. †Sum of home, small spaces other than home and large indoor areas.

a second check up within five years of the first (n=6838; 2226 men and 4612 women). Of those, 424 reported current use of cigarettes, cigars or pipe. Thus, the misclassification of active smoking and/or initiation rate was 6.2%. The rank order autocorrelations between two measures of ETS exposure an average (SD) of 3.1 (1.3) years apart in the same subset were 0.43 for ETS at home, 0.42 for ETS in small spaces other than home, 0.40 for ETS in large indoor areas and 0.49 for total exposure.

Results

The mean age (range) of the study sample was 37 years (15–89) in men and 38 years (15–105) in women. Fifty nine per cent of men and 50 per cent of women were white.

Sixty eight per cent of men and 64 per cent of women reported any ETS exposure (table 1). However, the median exposure time of ETS exposure (among exposed subjects) was greater in women than in men (12 versus 9 hours/week). This was attributable to greater exposure time of ETS exposure at home and in small spaces other than home in women compared with men (table 1).

In men, the rank order correlations among different sources of ETS exposure ranged from 0.19 between home and small spaces other than home and between home and large indoor areas, and 0.72 between large indoor areas and total exposure. In women, the same correlations ranged between 0.21 between home and

Table 3 Race/ethnicity, education level and marital status according to level of total exposure to ETS, by gender. Never smokers of any tobacco product. Northern California Kaiser Permanente, 1979–85

	Total exposure to ETS (hours/week)					
	Men					
	0 (n=5354)	1–9 (n=5742)	10–39 (n=3239)	⩾40 (n=2189)	Number	p Value*
Race						
White	27.1	39.8	20.6	12.5	9 771	
Black	37.4	27.6	19.2	15.8	3 168	
Asian	43.6	27.3	16.2	12.9	2 543	
Latino	42.7	27.2	17.5	12.6	595	
Other, mixed, or missing	34.7	27.9	22.1	15.2	447	0.001
Education level						
No college	47.3	21.9	16.1	14.6	3 234	
Partial college	28.9	31.9	23.1	15.9	3 932	
Completed college or postgraduate	26.3	42.7	19.8	11.1	7 743	
Unknown	39.9	28.9	17.1	14.0	1 615	0.001
Marital status						
Never married	26.1	36.6	24.1	13.2	5 640	
Married or remarried	35.7	34.6	16.9	12.7	7 931	
Separated or divorced	28.6	35.5	20.1	15.7	1 257	
Widowed	58.9	20.1	13.4	7.5	134	
Unknown	38.9	29.3	17.3	14.5	1 562	0.001
	Women					
	0 (n=9391)	1–9 (n=7445)	10–39 (n=4848)	⩾40 (n=4513)	Number	p Value
Race						
White	31.8	32.7	18.9	16.5	13 040	
Black	36.9	23.8	20.1	20.2	6 711	
Asian	44.4	24.5	16.2	14.9	4 718	
Latino	42.3	25.5	14.8	17.5	996	
Other, mixed, or unknown	41.9	24.3	16.0	17.8	732	0.001
Education level						
No college	45.7	21.1	15.9	17.3	7 202	
Partial college	31.7	26.0	20.8	21.5	6 918	
Completed college or postgraduate	29.0	36.7	19.8	14.4	9 496	
Unknown	44.6	24.5	14.8	16.0	2 581	0.001
Marital status						
Never married	23.7	32.2	24.1	19.9	6 921	
Married or remarried	40.2	27.7	16.2	15.9	12 208	
Separated or divorced	30.2	28.7	20.6	20.4	3 407	
Widowed	60.8	20.2	10.5	8.4	1 188	
Unknown	43.9	24.9	15.0	16.1	2 473	0.001

Table entries are row percentages; *by χ^2 analysis.

Table 4 Alcohol consumption, physical activity at work, hypertension, diabetes and occupational hazards according to level of total exposure to ETS, by gender. Never smokers of any tobacco product. Northern California Kaiser Permanente, 1979–85

	Total exposure to ETS (hours/week)					
	Men					
	0 (n=5354)	*1–9 (n=5742)*	*10–39 (n=3239)*	*≥40 (n=2189)*	*Number*	*p Value**
Alcohol at least 3 drinks/day	29.8	24.3	15.5	30.4	181	0.001
Sedentary job	26.4	40.1	19.9	13.6	6 637	0.001
Hypertension	36.2	30.6	19.2	14.0	2 533	0.001
Diabetes	49.5	23.0	16.3	11.2	295	0.001
Exposure to occupational hazard(s)						
None	31.7	33.9	19.4	15.0	2 176	0.08
Cleaning fluids, solvents	28.1	36.7	21.5	13.6	4 140	0.001
Insect or plant sprays	29.2	32.8	22.5	15.5	711	0.03
Plastics or resin fumes	25.7	34.0	21.8	18.4	928	0.001
Asbestos, cement or grain dust	28.8	32.7	23.0	15.5	1 900	0.001
Silica (sandblasting, grinding)	28.9	31.9	22.3	16.8	1 549	0.001
Radiographs or radioactivity	24.3	42.0	20.6	13.0	921	0.001
Ultraviolet radiation	26.9	41.3	18.6	13.1	312	0.001
Lead on metal fumes	29.3	32.6	18.7	19.3	965	0.001
Very loud noise	27.7	27.0	24.8	20.4	563	0.001
Radar or microwave	21.9	35.0	21.8	21.2	862	0.001
One or more unknown	33.0	35.0	19.3	12.7	12 767	0.001
All unknown	37.9	29.4	18.3	14.4	1 648	0.001
	Women					
	0 (n=9391)	*1–9 (n=7445)*	*10–39 (n=4848)*	*≥40 (n=4513)*	*Number*	*p Value**
Alcohol at least 3 drinks/day	37.8	14.8	20.3	27.0	74	0.001
Sedentary job	28.3	28.7	20.7	22.2	11 742	0.001
Hypertension	44.7	23.7	15.5	16.0	4 069	0.001
Diabetes	49.8	21.7	12.9	15.5	566	0.001
Exposure to occupational hazard(s)						
None	36.7	27.3	18.9	17.0	4 978	0.19
Cleaning fluids, solvents	28.7	32.7	20.6	18.0	2 638	
Insect or plant sprays	26.5	31.1	23.5	18.9	408	0.001
Plastics or resin fumes	25.3	31.3	22.3	21.1	431	0.001
Asbestos, cement or grain dust	26.7	28.3	21.9	23.0	769	0.001
Silica (sandblasting, grinding)	24.9	29.3	21.9	23.8	461	0.001
Radiographs or radioactivity	26.0	36.9	21.8	15.2	1 072	0.001
Ultraviolet radiation	21.6	37.5	20.1	20.8	264	0.07
Lead on metal fumes	28.9	27.9	20.3	22.7	290	0.02
Very loud noise	28.2	23.5	23.5	24.8	451	0.001
Radar or microwave	23.2	28.5	22.3	25.9	1 045	0.001
One or more unknown	36.1	28.6	18.1	17.0	19 956	0.01
All unknown	43.1	24.8	15.1	17.0	2 628	0.001

Table entries are row percentages; *by χ^2 analysis.

large indoor areas and 0.73 between small spaces and total exposure.

Age was negatively correlated with all ETS variables in both genders, indicating a decline in exposure with advancing age (table 2). Total serum cholesterol also showed weak negative correlations with all ETS variables in both genders, suggesting lower ETS exposure with higher cholesterol levels, a likely consequence of the age related increase in total cholesterol concentration. Body mass index was inconsistently correlated with ETS exposure.

Total exposure to ETS (that is, the sum of home, small spaces and large indoor areas) differed significantly according to race/ethnicity, education level and marital status in both genders (table 3). Among those with the heaviest ETS exposure (≥ 40 hours/week), and regardless of gender, there was a larger proportion of participants who were black, with no college or partial college education and of persons who were never married or separated/divorced. Furthermore, study participants reporting high level ETS exposure were more apt to be drinkers of three or more alcoholic beverages per day and (particularly among women) to had a sedentary job, hypertension and diabetes (table 4). These persons were also more likely to have a positive history of occupational exposures, in particular exposure to plastic or resin fumes, lead or metal fumes, very loud noise and radar or microwave among men, and to most occupational hazards among women. Each source of ETS exposure was found to vary by race, education level, marital status, alcohol intake and on the job physical activity in a similar manner to total ETS exposure (data not shown). On the other hand, ETS exposure at home was not associated with hypertension or diabetes status in men, or to occupational exposures to insect or plant sprays, radiographs or radioactivity and ultraviolet radiation among women (data not shown).

There were statistically significant independent increased odds of chronic cough in men, heart disease in women, and of hay fever/asthma, hearing loss, severe headache and presence of cold/flu symptoms for more than 10 days per year associated with total ETS exposure in both men and women, with evidence of dose-response relations (tables 5 and 6). Heavy total ETS exposure was also significantly associated with emphysema in men and with intermittent claudication in women. In men, the odds ratios corresponding to any total ETS exposure ranged from 1.22 (chronic

Table 5 Association between exposure to ETS and self reported health conditions among men (n=16 524), by source. Never smokers of any tobacco product. Northern California Kaiser Permanente, 1979–85

		ETS exposure at home (hours/week)					
						Odds ratio (95% CI)	
	Number	*0*	*1–9*	*10–39*	*≥40*	*Any v no exposure*	*Heavy† v no exposure*
Heart disease	1856	10.8	12.1	13.6	13.0**	1.13 (1.00, 1.27)	1.07 (0.79, 1.43)
Stroke	42	0.3	0.1	0.3	0.2	0.25 (0.04, 0.82)	‡
Intermittent claudication	506	2.7	4.5	4.5	3.5**	1.43 (1.15, 1.76)	0.98 (0.54, 1.62)
Cancer or tumour	239	1.5	1.6	1.1	1.4	0.93 (0.65, 1.31)	0.89 (0.35, 1.88)
Chronic cough	514	3.0	2.9	4.3	4.3**	1.11 (0.89, 1.38)	1.33 (0.80, 2.08)
Emphysema	39	0.2	0.2	0.4	0.9*	1.79 (0.83, 3.63)	3.78 (1.07, 10.3)
Hay fever/asthma	3215	19.5	18.7	19.6	21.7	1.05 (0.95, 1.16)	1.21 (0.95, 1.52)
Hearing loss	588	3.2	5.1	4.3	4.8**	1.32 (1.07, 1.63)	1.02 (0.61, 1.65)
Severe headache	1384	7.9	9.4	10.0	13.8***	1.24 (1.08, 1.41)	1.57 (1.17, 2.08)
Migraine	41	0.2	0.3	0.4	0.2	1.37 (0.62, 2.78)	0.98 (0.05, 4.74)
Cold/flu >10 days/y	1390	7.7	10.6	11.1	13.3***	1.42 (1.25, 1.62)	1.69 (1.26, 2.23)
		ETS exposure in small spaces (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		10.7	11.6	12.0	13.3**	1.19 (1.08, 1.32)	1.32 (1.08, 1.61)
Stroke		0.3	0.1	0.2	0.2	0.47 (0.17, 1.10)	1.03 (0.16, 3.62)
Intermittent claudication		3.2	2.6	3.0	3.5	1.00 (0.82, 1.22)	1.19 (0.81, 1.69)
Cancer or tumour		1.2	1.8	1.8	1.2	1.27 (0.97, 1.68)	1.01 (0.52, 1.79)
Chronic cough		2.8	3.2	3.4	4.7**	1.25 (1.04, 1.50)	1.72 (1.23, 2.36)
Emphysema		0.2	0.3	0.3	0.3	1.51 (0.75, 3.02)	1.68 (0.39, 5.15)
Hay fever/asthma		18.2	21.6	20.7	20.0	1.09 (1.00, 1.18)	1.09 (0.93, 1.29)
Hearing loss		3.0	4.1	4.5	4.2*	1.33 (1.10, 1.60)	1.24 (0.85, 1.75)
Severe headache		7.9	7.6	10.6	12.3***	1.21 (1.08, 1.36)	1.68 (1.36, 2.06)
Migraine		0.2	0.4	0.2	0.1	1.70 (0.89, 3.30)	0.58 (0.03, 2.86)
Cold/flu >10 days/y		7.3	9.1	11.7	10.5***	1.38 (1.23, 1.55)	1.48 (1.18, 1.83)
		ETS exposure in large indoor areas (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		11.3	10.6	13.2	11.6	1.06 (0.96, 1.18)	1.01 (0.77, 1.31)
Stroke		0.4	0.1	0.2	0.1	0.35 (0.14, 0.78)	‡
Intermittent claudication		3.4	2.3	3.8	3.7*	1.01 (0.83, 1.22)	1.07 (0.65, 1.66)
Cancer or tumour		1.2	1.7	1.5	1.0	1.12 (0.85, 1.48)	0.71 (0.25, 1.60)
Chronic cough		2.8	3.1	4.2	3.7*	1.20 (0.99, 1.45)	1.26 (0.78, 1.94)
Emphysema		0.2	0.3	0.3	0.4*	1.73 (0.87, 3.51)	2.14 (0.33, 8.02)
Hay fever/asthma		17.1	22.2	19.9	18.0	1.16 (1.07, 1.27)	1.07 (0.85, 1.32)
Hearing loss		3.2	3.6	4.8	4.5*	1.16 (0.96, 1.40)	1.23 (0.77, 1.89)
Severe headache		8.3	7.8	10.3	10.6**	1.14 (1.01, 1.28)	1.28 (0.96, 1.67)
Migraine		0.2	0.2	0.5	0.2	1.06 (0.55, 2.07)	0.71 (0.04, 3.51)
Cold/flu >10 days/y		6.9	8.9	13.3	9.2***	1.46 (1.30, 1.65)	1.37 (1.02, 1.82)
		Total ETS exposure (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		11.2	10.1	12.1	12.7***	1.07 (0.96, 1.19)	1.17 (0.99, 1.37)
Stroke		0.5	0.1	0.2	0.2	0.27 (0.11, 0.57)	0.45 (0.10, 1.32)
Intermittent claudication		3.3	2.6	3.3	3.5**	1.11 (0.91, 1.36)	1.15 (0.86, 1.53)
Cancer or tumour		1.0	1.7	1.8	1.3	1.28 (0.94, 1.75)	1.08 (0.66, 1.73)
Chronic cough		2.7	2.9	3.3	4.4***	1.22 (1.00, 1.49)	1.60 (1.22, 2.10)
Emphysema		0.2	0.2	0.2	0.4**	1.60 (0.78, 3.42)	3.02 (1.22, 7.34)
Hay fever/asthma		16.2	22.0	19.8	20.2	1.22 (1.11, 1.34)	1.24 (1.09, 1.42)
Hearing loss		2.8	3.6	4.1	4.6***	1.30 (1.06, 1.61)	1.42 (1.07, 1.88)
Severe headache		7.8	7.2	9.1	11.7***	1.22 (1.07, 1.39)	1.58 (1.33, 1.88)
Migraine		0.2	0.2	0.3	0.2	1.28 (0.64, 2.76)	1.19 (0.37, 3.37)
Cold/flu >10 days/y		6.5	8.2	10.3	10.8***	1.52 (1.33, 1.74)	1.75 (1.46, 2.09)

Table entries are age adjusted rates per 100 persons by level of ETS exposure. *p linear trend <0.05; **p linear trend <0.01; ***p linear trend <0.001. †≥40 hours/week. Odds ratios are adjusted for age, race/ethnicity, education level, marital status, alcohol consumption, physical activity at work, serum total cholesterol, body mass index, hypertension, diabetes and individual occupational hazards. SD for home exposure = 19.9 hours/week; SD for small spaces exposure = 15.5 hours/week; SD for large indoor areas exposure = 13.4 hours/week; SD for total exposure: 24.7 hours/week. ‡Not estimable.

cough and severe headache) to 1.52 (cold/flu symptoms), whereas the odds ratios for heavy exposure were between 1.24 (hearing loss) and 3.02 (emphysema). In women, the odds ratios corresponding to any total ETS exposure ranged from 1.10 (heart disease) to 1.57 (cold/flu), whereas the odds ratios for heavy exposure were between 1.21 (hay fever/asthma) and 1.91 (cold/flu).

When the three different sources of ETS exposure were analysed separately, we found consistent relations with severe headache and cold/flu symptoms across sources and genders (tables 5 and 6). In men, ETS exposure in small spaces other than home was the only ETS source showing a consistent dose-response relation with heart disease and, in contrast with expectation, any ETS exposure at home and any total ETS exposure predicted significantly lower odds of stroke. In women, heart disease was related to any and to heavy ETS exposure at home and in small spaces other than home, and with heavy ETS exposure in large indoor areas.

Another noteworthy finding was the lack of association of self reported cancer or tumour with any source of ETS exposure individually or with total ETS exposure in either gender.

Table 6 Association between exposure to ETS and self reported health conditions among women (n=26 197), by source. Never smokers of any tobacco product. Northern California Kaiser Permanente, 1979–85

		ETS exposure at home (hours/week)					
						Odds ratio (95% CI)	
	Number	*0*	*1–9*	*10–39*	*≥40*	*Any v no exposure*	*Heavy† v no exposure*
Heart disease	2945	10.5	12.7	13.8	14.3***	1.20 (1.09, 1.30)	1.25 (1.05, 1.47)
Stroke	95	0.3	0.4	0.4	0.5	1.23 (0.75, 1.96)	1.40 (0.53, 3.04)
Intermittent claudication	1346	4.8	5.9	5.9	7.1***	1.18 (1.03, 1.34)	1.37 (1.08, 1.72)
Cancer or tumour	1220	4.6	4.9	4.2	5.4	0.94 (0.82, 1.08)	1.02 (0.78, 1.32)
Chronic cough	808	2.9	3.2	4.2	3.0	1.14 (0.97, 1.34)	0.93 (0.65, 1.28)
Emphysema	33	0.1	0.2	0.2	0.2	1.16 (0.48, 2.54)	‡
Hay fever/asthma	4702	17.7	18.6	17.1	20.9*	1.04 (0.97, 1.12)	1.17 (1.02, 1.35)
Hearing loss	705	2.5	3.3	3.4	2.5	1.18 (0.99, 1.41)	0.85 (0.57, 1.23)
Severe headache	4897	17.4	20.7	21.1	28.1	1.26 (1.17, 1.35)	1.64 (1.44, 1.87)
Migraine	246	0.9	1.1	0.9	1.4	1.17 (0.88, 1.55)	1.44 (0.86, 2.27)
Cold/flu >10 days/y	3503	12.3	15.4	15.7	20.4	1.38 (1.28, 1.50)	1.75 (1.52, 2.01)
		ETS exposure in small spaces (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		11.0	10.7	12.1	12.9***	1.12 (1.03, 1.22)	1.20 (1.04, 1.38)
Stroke		0.4	0.3	0.2	0.3	0.64 (0.36, 1.08)	0.58 (0.21, 1.65)
Intermittent claudication		5.4	4.6	4.3	5.8	0.95 (0.84, 1.08)	1.14 (0.93, 1.40)
Cancer or tumour		4.5	5.0	5.3	4.2	0.99 (0.87, 1.13)	0.86 (0.67, 1.09)
Chronic cough		2.8	3.2	4.1	3.4*	1.17 (1.01, 1.37)	1.17 (0.89, 1.51)
Emphysema		0.1	0.1	0.2	0.2*	1.33 (0.59, 2.93)	2.72 (0.83, 7.71)
Hay fever/asthma		16.8	19.4	19.8	19.8***	1.11 (1.04, 1.19)	1.17 (1.04, 1.31)
Hearing loss		2.4	3.0	3.5	2.9**	1.31 (1.10, 1.55)	1.23 (0.91, 1.63)
Severe headache		17.9	18.0	20.2	23.4***	1.18 (1.10, 1.26)	1.38 (1.24, 1.55)
Migraine		0.9	1.0	1.1	0.9	1.05 (0.80, 1.36)	1.00 (0.61, 1.57)
Cold/flu >10 days/y		11.4	15.3	17.0	17.4***	1.43 (1.33, 1.55)	1.55 (1.37, 1.75)
		ETS exposure in large indoor areas (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		11.9	9.7	11.7	15.2***	1.02 (0.93, 1.11)	1.27 (1.03, 1.57)
Stroke		0.4	0.3	0.3	0.2	0.68 (0.43, 1.11)	0.34 (0.02, 1.62)
Intermittent claudication		5.5	4.1	5.6	8.1**	1.03 (0.91, 1.17)	1.55 (1.15, 2.04)
Cancer or tumour		4.5	4.9	4.7	5.6	0.97 (0.85, 1.10)	1.08 (0.76, 1.50)
Chronic cough		2.9	3.1	3.6	5.1***	1.12 (0.96, 1.30)	1.68 (1.17, 2.34)
Emphysema		0.1	0.1	0.2	0.4*	1.52 (0.71, 3.21)	4.19 (0.91, 13.9)
Hay fever/asthma		16.2	19.8	20.7	21.7***	1.14 (1.07, 1.23)	1.25 (1.04, 1.49)
Hearing loss		2.6	2.7	3.0	3.0	1.10 (0.93, 1.30)	0.97 (0.60, 1.51)
Severe headache		19.2	17.1	19.9	24.2***	1.06 (0.98, 1.13)	1.27 (1.07, 1.51)
Migraine		0.8	1.1	1.0	1.5	1.37 (1.05, 1.80)	1.69 (0.88, 2.99)
Cold/flu >10 days/y		11.2	14.8	19.9	19.1***	1.44 (1.34, 1.56)	1.75 (1.45, 2.10)
		Total ETS exposure (hours/week)					
		0	*1–9*	*10–39*	*≥40*		
Heart disease		11.2	9.6	12.0	13.1***	1.10 (1.01, 1.20)	1.22 (1.08, 1.37)
Stroke		0.4	0.4	0.4	0.2	0.89 (0.57, 1.38)	0.52 (0.21, 1.12)
Intermittent claudication		5.4	4.3	5.1	6.0***	1.03 (0.91, 1.17)	1.19 (1.01, 1.41)
Cancer or tumour		4.3	4.9	4.8	4.7	0.95 (0.84, 1.08)	0.90 (0.75, 1.08)
Chronic cough		2.7	2.8	3.8	3.3**	1.12 (0.96, 1.32)	1.14 (0.92, 1.42)
Emphysema		0.1	0.1	0.1	0.2	1.21 (0.57, 2.63)	1.97 (0.73, 5.04)
Hay fever/asthma		15.7	19.1	18.8	19.9***	1.14 (1.06, 1.23)	1.21 (1.09, 1.33)
Hearing loss		2.3	2.7	3.0	3.1**	1.27 (1.07, 1.51)	1.29 (1.02, 1.64)
Severe headache		17.8	16.6	19.3	23.2***	1.17 (1.08, 1.26)	1.39 (1.27, 1.53)
Migraine		0.8	1.0	1.0	1.1	1.18 (0.88, 1.58)	1.23 (0.84, 1.79)
Cold/flu >10 days/y		9.9	13.3	15.6	18.1***	1.57 (1.44, 1.71)	1.91 (1.72, 2.13)

Table entries are age adjusted rates per 100 persons by level of ETS exposure. *p linear trend <0.05; **p linear trend <0.01; ***p linear trend <0.001. †≥40 hours/week. Odds ratios are adjusted for age, race/ethnicity, education level, marital status, alcohol consumption, physical activity at work, serum total cholesterol, body mass index, hypertension, diabetes and individual occupational hazards. SD for home exposure = 19.9 hours/week; SD for small spaces exposure = 15.5 hours/week; SD for large indoor areas exposure = 13.4 hours/week; SD for total exposure: 24.7 hours/week. ‡Not estimable.

Discussion

This analysis based on data collected in a large, representative sample of San Francisco Bay Area residents between 1979 and 1985 found that 68% of never smoking men and 64% of never smoking women reported current exposure to any ETS from at least one of three potential sources (home, small spaces other than home and large indoor areas). While current home ETS exposure was greater in women (26%) than in men (20%), ETS exposure in large indoor areas was greater in men (53%) than in women (45%). Moreover, the median exposure time of total ETS exposure (12 hours per week in women versus 9 hours per week in men) and the proportion of those reporting ETS exposure for ≥ 40 hours/week were greater in women (17.2%) than in men (13.2%). Estimation of lifetime exposure to ETS (that is, exposure time in hours per week multiplied by duration in years) was not possible in this cohort because duration of ETS exposure was not ascertained.

Our estimates of ETS exposure are somewhat higher than those reported by the 1991 National Health Interview Survey, where 20% of never smokers reported exposure to ETS at home or work.[28] Also, the prevalence of current

ETS exposure during 1993–1995 was 31% among never or former smoking women in Geneva, Switzerland, aged 35–74.[29] These differences between our study and these more up to date reports most probably reflect a secular decline in ETS exposure in recent years, particularly at the workplace.

We found that persons most heavily exposed to ETS were more likely to be young, never married or separated/divorced, black, of low education level, consumers of three or more alcoholic drinks/day, sedentary workers, and more likely to report exposure to several occupational hazards.

A methodological implication of our findings is that it is desirable to control (by stratification or multivariate techniques, as appropriate depending on the outcome) for the effects of sex, age, ethnicity, education level, marital status, alcohol consumption, physical activity level and occupational hazards when studying the health effects of ETS exposure. A detailed review of the issue of potential confounding of the relation between ETS exposure and health outcomes has been published.[30]

A noteworthy finding of our analysis was that black people were overrepresented among those most heavily exposed to ETS. Black men and women are known to smoke at a higher rate than white people in the Northern California Kaiser Permanente Medical Care Program.[31] The finding that sedentary type job occupations were related to ETS exposure may be attributable, at least in part, to the fact that sedentary jobs are typically performed in indoor settings.

Modest but significant cross sectional associations were found between ETS exposure and several self reported health conditions. The role of ETS exposure in both atherosclerosis and coronary artery disease is well documented.[7–11] However, less is known about its potential role in peripheral vascular disease, including mediating effects on platelet function and haemostatic parameters.[32]

We found, unexpectedly, significant lower odds of stroke among men reporting any ETS exposure at home or in large indoor areas. As the data are cross sectional (and thus longitudinal studies are needed to confirm or refute this result), this inverse association could be explained by men avoiding exposure after occurrence of stroke.

Most of the previous studies on ETS exposure as a risk factor for respiratory symptoms and lung disease have been conducted in children.[12–16] Thus, our results add to the limited data available documenting increased risk of respiratory health effects (including symptoms of upper respiratory tract irritation and asthma exacerbation) among adults.[17–20]

Active cigarette smoking has been more frequently reported in cluster headache patients than in the general population[33–35] and headache is a common complaint in volunteer subjects participating in experimental ETS challenge studies.[36] The relation of parental smoking to the risk of respiratory infection in children has been extensively investigated.[37 38] Moreover, active adult smokers have been shown to have higher viral respiratory infection rates than non-smokers.[39]

KEY POINTS
- Exposure to environmental tobacco smoke (ETS) was associated with socioeconomic and lifestyle factors potentially related to adverse health outcomes.
- However, the relation between ETS exposure and self reported medical conditions was independent of these factors.
- In cross sectional analysis, ETS exposure predicted higher odds of heart disease, chronic cough, hay fever/asthma, hearing loss, severe headache and cold/flu symptoms.
- The two sources of ETS exposure found to be more detrimental were "home" and "small spaces other than home".
- Interventions to ameliorate ETS exposure may benefit the health of people and may narrow the gap in health status across the socioeconomic spectrum.

In a previous Kaiser Permanente study and in the more recent Epidemiology of Hearing Loss Study, current cigarette smoking was an independent predictor of hearing loss.[40 41] Moreover, the later investigation found that non-smoking participants who lived with a smoker were more likely to have a hearing loss than those who were not exposed to a household member who smoked. In a cohort of infants, exposure to cigarette smoke was associated with a 4.9 times increase in the prevalence of hearing deficits.[42] Taken together, the results of these studies and ours reinforce the evidence that exposure to cigarette smoke may play a part in the aetiology of hearing loss (through effects on plasma antioxidant capacity, generalised atherosclerosis and cochlear ischaemia).

We found no cross sectional association between ETS exposure and cancers or tumours from all sites combined. However, this negative finding does not preclude the existence of a possible relation with site specific smoking related malignancies such as upper aerodigestive, lung, pancreas, bladder or kidney cancers. Prospective analysis of cancer outcomes in the cohort is planned.

The data presented here may have implications for the understanding of the important yet elusive relation between socioeconomic status and health. As ETS exposure was associated to both low socioeconomic status and to the presence of significant common illnesses, health policy aimed at ameliorating ETS exposure could help reduce health disparities across the SES spectrum. Furthermore, although not directly estimated in our analysis, our findings support earlier studies indicating that ETS exposure is a significant factor in utilisation of health care services and in absenteeism.[43]

Our study has several limitations. Firstly, the design was cross sectional, precluding temporal associations and inferences about cause and effect. The nature of the design may have also

introduced biased estimates (in the conservative or "protective" direction) if, for example, having a disease may have resulted in avoiding or reducing the amount of exposure. Thirdly, the assessment of medical conditions relied on self reports; no attempt was made to determine the sensitivity or specificity against a gold standard of care or serological markers. Finally, no information was available on site specific cancers or on dietary patterns.

In conclusion, ETS exposure correlated with several personal characteristics potentially associated with adverse health outcomes. However, after multivariate adjustment for these characteristics, ETS exposure was still associated with increased acute (such as severe headache and cold/flu) as well as chronic (such as heart, pulmonary disease and hearing loss) comorbidity. Prospective follow up and longitudinal analysis of outcomes in this cohort will further clarify the health effects of ETS.

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