

Prevalence and Correlates of Passive Smoking

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Abstract: The duration per week of exposure to others' tobacco smoke in different locations was tabulated from the questionnaire responses of 37,881 non-smokers and ex-smokers who received multiphasic health checkups in 1979 and 1980. Altogether 63.3 per cent of subjects reported some exposure, 34.5 per cent were exposed at least 10 hours per week, and 15.9 per cent at least 40 hours per week. Duration of exposure per week was weakly correlated with serum thiocyanate level in a small test group. Exposure was strongly related to age with a peak of 78.2 per cent in the twenties decade and an accelerating decline thereafter to 13.9 per cent in those age 80 and over. Sex and race were related to passive smoking only to a relatively

small degree. Persons reporting longer exposures were more apt to report greater use of alcohol and marijuana, exposure to occupational hazards, and being currently not married. Lack of college education was most frequent among those denying exposure but was directly related to exposure duration among those reporting some passive smoking. Studies of the health effects of passive smoking should take into account these associated factors. Although the reported passive smoking of married persons was strongly related to their spouses' habits, categorization by spouses' smoking resulted in considerable misclassification. (*Am J Public Health* 1983; 73:401-405.)

Many questions have been raised about possible detrimental health effects of exposure to the tobacco smoke of others (passive smoking).^{1,2} However, little is known about the magnitude of such exposure. We here report the prevalence and duration per week of passive smoking as reported on a questionnaire by a large group of persons who have recently taken multiphasic health checkups. We also describe some other characteristics of those reporting passive smoking, and the relationship of reported exposure to spouses' habits.²⁻⁴

Methods

The Kaiser-Permanente Medical Care Program provides comprehensive prepaid medical services to a large heterogeneous subscriber population.⁵ Since 1964 an automated multiphasic health checkup has been provided to about 50,000 adults per year at the program's San Francisco and Oakland facilities,⁶ and the computer-stored data from these checkups have been used to study the effects of, and factors associated with, cigarette smoking.⁷⁻¹⁰ In mid-1979, a detailed questionnaire on various aspects of smoking was added to the checkup, primarily to study the health effects of

low yield cigarettes. The questionnaire also contained three items aimed at ascertaining passive smoking. The first item was: "On the average, how many hours per week are you exposed to cigarette, cigar or pipe smoke in your home because of smoking by others? (Write in 000 if less than 1 hour per week) _____ hours." The other two items were the same except that for "in your home," the words "in a small space other than your home (such as airplane, office, car, etc.)" and "in a large indoor area (such as restaurant, hotel lobby, lecture hall, etc.)" were substituted.

A total of 53,697 people completed this questionnaire in 1979 and 1980. To study passive smoking we looked only at 37,881 persons who did not report current smoking themselves. Of these, 8.0 per cent did not answer one or more of the passive smoking questions so we were left with 35,169 in whom we could study home exposure, 35,201 in whom we could study small space exposure, 35,135 in whom we could study large area exposure, and 34,861 in whom we could study all three. Each of these study groups consisted of 71-72 per cent persons who never smoked and 28-29 per cent persons who smoked only in the past.

The examinees answering all three questions were 42.5 per cent male, 21.5 per cent Black, 58.9 per cent White, and 19.6 per cent of other and unknown race. All the data concerning sex, race, and other health-related variables were age adjusted by the direct method using the group answering all three questions as the standard (age distribution in Table 4).

To identify married couples in this data set, we selected all pairs of reportedly married or remarried persons with the same last name, opposite sex, adjacent medical record numbers (issued sequentially as persons join the program), and birth year difference no greater than 17 years. A check of

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TABLE 1—Overall Percentages of Subjects Reporting Various Places and Degrees of Passive Smoking of at least One Hour per Week

Place and Degree of Passive Smoking Exposure	Total Number Studied	Positive Response	
		Number	Per Cent
Place (1+ hrs/week)			
Home	35,169	8,383	23.8
Other Small Area	35,201	14,223	40.4
Large Area	35,135	16,336	46.5
Degree (all places)			
1+ hrs/wk	34,861	22,069	63.3
10+ hrs/wk	34,861	12,034	34.5
40+ hrs/wk	34,861	5,551	15.9

the program's administrative files regarding 97 (every 25th) pairs who met these criteria indicated that all had the same account number and lived at the same address, providing further evidence that they were indeed married couples. To make sure that the spouses' reported smoking habits and married state were contemporaneous we further selected those who were examined on the same day.

Results

Table 1 shows the percentages of subjects reporting varying types and degrees of exposure.* The distribution of the total number of hours per week of any reported exposure is shown in Table 2. About one third of subjects reported ten or more hours of exposure.

Correlation with Physiologic Measures

Serum thiocyanate (SCN) levels and expired-air carbon monoxide (CO) concentrations were determined on 267 persons who completed the questionnaire¹²—176 adult female twins who volunteered to participate in a special study and 91 men recruited from those receiving routine health checkups. There were 181 persons who were not current smokers; the simple coefficients of correlation between reported hours of passive smoking and their SCN and CO values were determined (Table 3). (One or at most two subjects were excluded from some of these correlations because of missing data.) The correlations were all positive but small. The correlations of SCN level with non-home small area, large area, and total exposure were at, or close to, the $p < 0.05$ level of statistical significance. The mean SCN levels for the four duration groups of total exposure, 0, 1–9, 10–39, 40+ hours/week, were 40.0, 47.7, 43.8, and 49.9 $\mu\text{mol/L}$, respectively. For CO each correlation coefficient was smaller than the corresponding coefficient for SCN, and

*We also looked at the persons who never smoked and those who were past smokers separately; both subgroups showed rates of passive smoking very similar to those shown for all subjects combined. No percentage differed from the corresponding one in Table 1 by more than 2.0 per cent.

TABLE 2—Distribution of Total Hours per Week of any Reported Passive Smoking: Sum of the Hours in Each of the Three Areas

Total Hours per Week	Per Cent (N = 34,861)
0	36.7
1–9	28.8
10–39	18.6
40+	15.9
TOTAL	100.0

none approached statistical significance. In another study of determinants of SCN and CO in the same subjects,** non-home small area exposure was the second variable to enter a multivariate stepwise linear regression analysis for each physiologic measure but statistical significance was not observed for this partial assessment of passive smoking.

Demographic Characteristics

There were only minor differences in reported exposure between men and women. Altogether slightly more men, 65.5 per cent, than women, 61.6 per cent, reported any exposure. The difference almost disappeared when only home or other small space exposure was considered—49.7 per cent of men and 49.4 per cent of women.

Modest racial differences were noted. Whites were most apt to report some exposure—68.8 per cent vs 56.8 per cent for Blacks and 55.2 per cent for others, and to report home or small space exposure—52.1 per cent vs 47.8 per cent for Blacks and 44.9 per cent for others. Most of the excess in Whites was in the 1–9 hour category, not in the larger time periods.

Age bore a strong relation to the prevalence of passive smoking (Table 4). From the peak proportion reporting exposure in the twenties decade, there was an accelerating decline with age both for home or small space exposure and for total exposure. After the fifties decade, the decline was quite marked and only one-fourth or less of persons age 70 or older reported passive smoke exposure. For higher levels of exposure, in hours per week, the age trends were quite similar.

Other Health-Related Characteristics

As shown in Table 5, hours per week of passive smoking were directly correlated with the proportion of subjects reporting alcohol consumption of at least three drinks per day, marijuana smoking at least once per week, and positive response to at least one of 10 questions*** about exposure to hazardous substances or energy at work. Passive smoking also bore a direct relationship to not being currently married, although the highest proportion not currently married was in

**Petitti DB, Friedman GD, Kahn W: Predictors of serum thiocyanate and expired carbon monoxide in smokers and nonsmokers—manuscript submitted for publication.

***Details available on request to author.

TABLE 3—Simple Correlations between Hours per Week of Passive Smoke Exposure and Serum Thiocyanate and Expired Air Carbon Monoxide Levels among Persons not Currently Smoking Themselves (Number of Subjects = 180 ± 1)

Type of Exposure	Thiocyanate		Carbon Monoxide	
	Correlation Coefficient	P value*	Correlation Coefficient	P Value*
Home	.07	.35	.01	.90
Other small area	.14	.06	.10	.18
Large area	.14	.05	.05	.50
TOTAL	.15	.04	.06	.39

*Probability of observing a correlation coefficient with an absolute value at least this large if there were truly no correlation.

TABLE 4—Relation of Age to Reported Exposure of at least One Hour per Week to any Passive Smoking and to Home or Small Area Passive Smoking

Age	Total Number*	Home or Small Space Exposure	Any Exposure
15-19	1,170	56.6%	65.6%
20-29	6,881	63.8	78.2
30-39	7,854	59.8	75.4
40-49	5,184	52.4	67.5
50-59	6,095	46.2	60.1
60-69	5,131	31.1	43.6
70-79	2,169	16.7	25.1
80+	375	9.5	13.9
TOTAL	34,859**	49.6	63.3

*Number with responses to all three passive smoking questions. Slightly (0.4%) more responded to both the home and other small space exposure questions.

**Total on this and subsequent tables differs from total on preceding tables (34,861) because two persons with unknown age, sex, or race were excluded.

the 10-39 hour group rather than the 40+ hour group. The relation to lack of any college education was U-shaped with the highest proportion in the no-passive-smoking group. On the average, there was an inverse relation between no college education and passive smoking but, among those reporting passive smoking of at least one hour per week, the correlation was positive.

We repeated these tabulations, excluding ex-smokers and thus limiting our attention to those who had never smoked. The trends were very similar.

Spouse Pairs

As shown in Table 6, more hours of passive smoking, both at home and at all sites combined, were reported by subjects married to regular smokers (of cigarettes, cigars, or a pipe) than by those married to non-smokers. Over 90 per cent of all persons married to non-smokers reported no home exposure and between 50 and 60 per cent reported no exposure at all. These percentages were roughly twice as great as those found for persons married to smokers. Correspondingly, the percentages reporting 10 or more hours of home or total exposure (combining the two highest categories in Table 5) were always over three times greater in those whose spouses smoked than in those whose spouses did not. Mean (and to a lesser extent median) hours of exposure was also quite different according to whether the spouse smoked.

Although duration of passive smoking was strongly related to spouses' smoking habits, substantial percentages of subjects married to smokers reported zero hours of exposure at home (47 per cent of women and 39 per cent of men). Most of the smoking spouses of persons reporting zero (less than one) hours of exposure at home reported substantial amounts of smoking: 76 per cent of the smoking female spouses reported smoking 10 or more cigarettes per day. Among the male spouses who smoked cigarettes, 83 per cent reported 10 or more per day; among those who smoked cigars, 41 per cent reported three or more per day; and among those who smoked a pipe, 83 per cent reported three or more pipesful per day. Thus, it seems likely that many of the subjects who were married to these individuals were exposed at least one hour per week at home.

Being married to a non-smoker did not assure that a subject was not exposed to the smoke of others. Altogether 40.5 per cent of women and 49.2 per cent of men married to non-smokers reported some passive smoking. Not surprising though was the low prevalence among these subjects of exposure at home—8.1 per cent in women and 6.2 per cent in men.

Discussion

These data show that passive smoking is a highly prevalent phenomenon, particularly among those below age 70. Our data should not be extrapolated uncritically to the general population, however, since persons who take health examinations tend to be more health conscious¹⁴ and may be more apt to avoid smoke or to live in homes where fewer people smoke. On the other hand, these subjects may be more sensitive to, and tend to overreport, exposure to the smoke of others.

The range of possible health effects of this form of smoke exposure has not yet been fully explored, but suspicion has been raised about its contribution to aggravation of angina pectoris,¹⁵ to lung cancer development,² to dyspnea accompanying chronic lung disease,¹⁶ and to asthma¹⁷ and respiratory infections in infants and children, as well as to minor complaints such as eye and nose irritation.¹ The concentration of carbon monoxide can be substantial in the atmosphere of poorly ventilated rooms where people are smoking¹ and the concentrations of carcinogens in side-stream smoke frequently exceed those in mainstream smoke.¹⁸ Should all or even a portion of the suspected health problems be clearly related to passive smoking the potential public health problem could be great, in view of the large numbers of persons exposed. Of course, some effects may require a greater intensity and/or duration of passive smoke exposure than most passive smokers experience.

TABLE 5—Percentages of Persons with Certain Characteristics Classified According to Duration per Week of any Passive Smoking, All Races and Sexes Combined, Age-Adjusted

Characteristic	Hours per week				p*
	0	1-9	10-39	40+	
Not currently married	36.5	41.4	45.7	42.2	<.001
No college education	40.0	26.3	28.7	35.0	<.001
Occupational hazard exposure	30.4	34.7	36.5	37.3	<.001
Marijuana at least once/week	3.8	5.4	7.0	7.0	<.001
Alcohol at least 3 drinks/day	4.0	5.0	6.2	7.5	<.001

*P values based on Mantel-extension test for linear trend.¹¹ Trends in age-specific percentages were similar for age groups <30, 30-49, and 50-69 but for most variables not for 70+ years.

Our data also indicate that studies of the effects of passive smoking should consider the correlates of this form of smoke exposure before concluding that it is responsible for some observed effect. Perhaps, for example, the greater alcohol consumption of passive smokers may be at least partly responsible if they experience more time off work. Or, persons with higher degrees of passive smoking may experience a greater frequency of upper respiratory infections not because of the smoke but because they are exposed to more people.

The strong relation of passive smoking to age points out the need for age specification or adjustment of data concerning passive smoking and health. The probably greater exposure of older persons when they were younger should be taken into account in studies of long-term effects.

The findings for spouses show that whether married persons' spouses smoke is strongly correlated with reported duration of passive smoking, both at home and over all. However, using the spouse's smoking status to classify persons resulted, as far as can be discerned with our

relatively crude questionnaire, in a considerable amount of misclassification. About 40-50 per cent of persons with non-smoking spouses reported some passive exposure and, conversely, 30-35 per cent who were married to smokers surprisingly reported no exposure. Thus, although traditional Greek³ and Japanese⁴ wives' passive smoking exposure may have depended almost completely on their husbands' smoking habits, contemporary US spouses' smoking habits are a very inaccurate index of passive smoking. They should only be used when no better data are available and with full recognition that true relations between passive smoking and health outcomes will be attenuated by such an assessment.

We were concerned that surprisingly high proportions of persons reporting zero (less than one) hours of passive smoking were married to smokers. Possible explanations, other than errors in completing the questionnaire, include: all or most of the smoking by the spouse was done away from home; and some couples reporting being married may not have been living together but for some reason did not report that they were separated.

TABLE 6—Distribution of Hours per Week of Passive Smoking (at home and total) among Married Persons not Currently Smoking According to Whether Spouse Was Currently a Non-smoker or a Smoker of Cigarettes, Cigars, or a Pipe; Married Couples Examined on the Same Day

Hours per Week	Female Non-smokers				Male Non-Smokers			
	Home Exposure if Married to		Total Exposure if Married to		Home Exposure if Married to		Total Exposure if Married to	
	Smoker	Non-smoker	Smoker	Non-smoker	Smoker	Non-smoker	Smoker	Non-smoker
0	47.4%	91.9%	35.4%	59.4%	39.4%	93.8%	28.8%	50.8%
1-9	20.0	5.5	23.4	27.8	18.2	5.4	15.2	32.3
10-39	17.1	2.1	20.0	6.7	27.3	0.0	33.3	13.8
40+	15.4	0.5	21.1	6.0	15.2	0.8	22.7	3.1
TOTAL	99.9*	100.0	99.9*	99.9*	100.1*	100.0	100.0	100.0
Total Number	175	579	175	579	66	130	66	130
Median hours	1.0	0.0	6.0	0.0	5.0	0.0	14.0	0.0
Mean hours	12.7	1.0	20.5	5.6	14.8	0.4	23.3	4.8
p**	<.001		<.001		<.001		<.001	

*Total not 100.0% because of rounding.

**P value for linear trend of proportions married to smokers by four categories of passive smoking. Calculated according to Fleiss.¹³

In the absence of direct measurements of smoke exposure, which are impractical for large population studies, questioning the subjects would appear to be the best approach for assessing their own passive exposure. As suggested by some of the spouse data in this study, our questionnaire is far from ideal. Nevertheless, there was a weak positive correlation of exposure duration with physiologic effects of smoking, particularly SCN levels, suggesting both that this questionnaire does provide an assessment of passive smoking that has some validity and that passive smoking involves physiologically measurable degrees of smoke exposure in non-smokers. We recommend that further effort be devoted to improving methods for assessing passive smoking by questionnaire.

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Summer Program in Epidemiology

The University of Massachusetts will host a three-week summer program in Epidemiology, July 31-August 20, 1983 at the Amherst campus in western Massachusetts. The program includes both methodologic and substantive courses, with classes for those seeking an introduction to modern epidemiologic concepts as well as those desiring a review of recent developments in epidemiologic thinking.

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