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Passive Smoking among Schoolchildren in Israel

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A health survey was carried out among 8259 second- and fifth-grade schoolchildren living in three towns along the Israeli coast. The schoolchildren performed the following pulmonary function tests: forced vital capacity, forced expiratory volume in 1 sec, and peak expiratory flow, their parents filled out an American Thoracic Society–National Heart and Lung Institute health questionnaire. The aim of the survey was to study the impact of environmental and home exposures on the prevalence of respiratory conditions and on pulmonary function tests among Israeli schoolchildren. The health effects of exposure to passive smoking are discussed in detail. A trend of a higher frequency of reported respiratory conditions was found among schoolchildren whose fathers or mothers are smokers compared with children whose parents do not smoke. A statistically significant excess between 1.4% (for wheezing without cold) and 4.7% (for cough with cold) was found for children of smoking fathers; the excess for children of smoking mothers was between 1.6% (for wheezing with cold) and 3.6% (for cough with cold) compared with children of nonsmokers. A gradual excess in symptoms was found among children with none, one, and two smoking parents. Relative risks were found to be between 1.13 (for bronchitis) and 1.28 (for wheezing without cold) for children of smoking fathers, and between 1.24 (for asthma) and 1.41 (for cough with sputum) for children of smoking mothers, compared with 1.00 for children of nonsmokers. There was no consistent trend of reduced pulmonary function tests among children of smokers compared with nonsmokers' children.

Introduction

The effects of passive smoking on health have been intensively studied during the last decades. Because young children have immature lungs and less immunity to respiratory infections, they may be more vulnerable to adverse pulmonary effects of passive smoking. Most studies in which possible effects of passive smoking have been investigated showed a higher occurrence of respiratory symptoms and diseases among children exposed to parental smoking (*1–11*). The effect of maternal smoking on respiratory illness and hospital admissions in infancy is also well documented (*5,12–17*). A dose–response relationship between exposure to parental smoking and respiratory conditions has been demonstrated by a few investigators (*3,5,9,10*), but not by others (*4,12,13*).

Studies of the relationship between parental smoking and children's lung function tests have also yielded variable results. Impaired lung function as a result of exposure to parental smoking were observed in some studies; the effect of maternal smoking being greater than that of paternal smoking (*3,7,18–21*). Conversely, other studies have shown little or no link between parental smoking and childhood lung function (*2,22–24*).

In our study we tried to find out whether, in data sets collected in environmental surveys in Israel, there is a link between parental smoking and respiratory conditions among their children. We studied simultaneously the effects of passive smoking and of other home and environmental exposures, such as that of socioeconomic status (by crowding and by parental education), heating of homes, oriental origin, paternal and maternal respiratory diseases, and community air pollution, on the prevalence of respiratory symptoms and diseases as well as on pulmonary function tests.

By using multivariate analysis methods, we could show the effects of different background variables, especially the effect of exposure to parental smoking on pulmonary conditions among their children. The study was carried out in different communities regarding home as well as environmental exposures, especially to air pollution. This multicity study design enabled us to find out whether an effect of exposure to environmental tobacco smoke characterizes communities with different home and environmental exposures or can be found only in certain set ups.

Materials and Methods

This survey was carried out among schoolchildren living in three towns located along the Israeli coast (Fig. 1). One group lives in Ashdod, which is a relatively heavy industrialized town in the southern part of the country, the second lives in Hadera, which is a small town in the center of Israel (with no heavy industries in 1983, when the survey was carried out), and the third group lives in Haifa, which is a quite heavy industrialized town in the northern part of the country.

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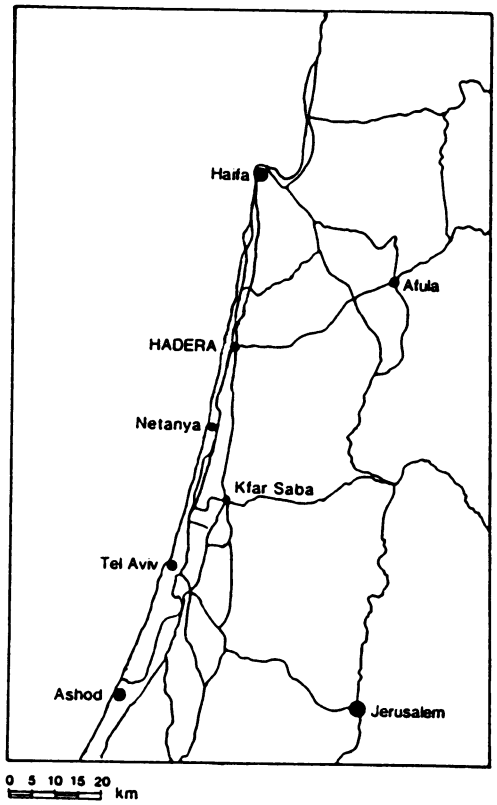


FIGURE 1. Sites of the study.

Study Population

All second- and fifth-grade schoolchildren living in the studied areas of these three towns (located along the Israeli Mediterranean coast) were studied. Eight thousand two hundred fifty-nine schoolchildren participated in this survey, 1672 from Ashdod (studied in 1982), 2253 from Hadera (studied in 1983), and 4334 from the Haifa Bay area (studied in 1984). The survey was carried out during April–June in the participating schools.

Health Questionnaire

The health questionnaire (*25*) used in the study is a translation into Hebrew of the ATS-NHLI (American Thoracic Society–National Heart and Lung Institute) health questionnaire to be self-administered by the children's parents. The questionnaires were distributed in the three towns by the school nurses, who also collected them after they had been filled out. From the health questionnaires, the following information was obtained: respiratory symptoms and diseases of the children, socioeconomic status, type of household fuel used, smoking habits of the parents, and respiratory problems in the families. Of the 2626 questionnaires distributed in the Hadera area, 2253 were returned—a response rate of 85.8%. In Ashdod, 1826 questionnaires were distributed and 1672 were filled out—a response rate of 91.6%. In Haifa, 4458 questionnaires were distributed, out of which 4334 were returned—a response rate of 97.2%.

The effects of environmental and home exposures on the prevalence of respiratory conditions among schoolchildren was studied. This is a summary of the observed relationships between exposure to passive smoke and prevalence of respiratory conditions among children. Smoking categories were defined as follows: *a*, fathers ever smoked regularly; *b*, mothers ever smoked regularly; *c*, none of the parents ever smoked, one of them ever smoked regularly, both of them ever smoked regularly (ever = currently or in the past).

Pulmonary Function Tests

Pulmonary function tests (forced vital capacity, FVC; forced expiratory volume in 1 sec, $FEV_{1.0}$; peak expiratory flow, PEF) were carried out by a trained technician using a Minato AS-500 portable spirometer (ATS approved). The expiratory maneuver was carried out while the subject was standing and was repeated at least three times until two similar tests (agreed within 10%) were achieved. The best test (highest FVC + $FEV_{1.0}$) was chosen. All the participants were weighed and their height measured before carrying out the expiratory maneuver.

Analytical Procedure

Statistical analysis of the data was carried out by means of the SPSS and BMDP (*26,27*) programs. Prevalence of reported respiratory symptoms and diseases according to smoking habits of the children's parents was analyzed by means of the χ^2 test for examining independence between two variables. The possible effect of a different distribution of background variables in the different smoking categories was examined by stratification. To examine the combined effect of different background variables in each smoking category, a nonhierarchical logistic model (*27*) was fitted for the expected frequency of each respiratory symptom or disease.

Those background variables that were included in the logistic regression for each subpopulation (by smoking) and the smoking category were included in the logistic model fitted for the respiratory condition in the pooled data set of the subpopulations. The equation for the predicted proportion of the respiratory condition $E(f/n)$ according to the logistic regression is

$$E(f/n) = \frac{e^u}{1 + e^u}$$

in which f is the frequency of the respiratory condition; n is the sample size; $u = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_m x_m$, in which x_1, $x_2 \ldots x_m$ are the background (binary) variables and $\beta_1, \beta_2 \ldots \beta_m$ are the coefficients. The logistic regression estimates the coefficients of the background variables (such as fathers' country of origin, socioeconomic status, type of household fuel used, mothers' respiratory diseases, community air pollution and exposure to fathers' and mothers' smoking) in a stepwise manner.

The relative risk (RR) to suffer from a respiratory condition for children exposed versus nonexposed to passive smoke was calculated from the backwards logistic regression as follows: $RR = e^{\beta_1}$, where β_1 is the coefficient for passive smoking. The logistic regressions included air pollution categories (low, medium, and high) according to air pollution measurements routinely carried out in the studied communities. The definitions for other background variables are as follows: parental respiratory diseases include bronchitis, asthma or spastic bronchi-

tis; low parental education means ≤ 8 years; high crowding index means ≥ 1.5 persons/room.

Pulmonary function tests (PFTs) in the different smoking categories were analyzed by means of one-way analysis of variance. The possible effect of other background variables on PFT was analyzed by multiple regression analysis, which took into account those variables whose frequencies differed significantly between the subpopulations (as regards passive smoking). Passive smoking was entered last into the multiple regression, thus its effect could be demonstrated after the effect of other background variables (such as crowding, heating of houses, respiratory diseases in the family, fathers' country of origin, and community air pollution), which could act similarly, was eliminated.

Results

In Table 1, the study population by town, class, and sex is presented. The age and sex distribution in the three studied towns is similar (each age and sex group composes about 25% of the town population). Second graders are somewhat more highly represented compared with fifth graders. The total Haifa population is larger than that of Hadera, and the last one larger than that of Ashdod.

The frequency of reported respiratory symptoms as related to fathers' smoking habits was found to be higher among children whose fathers smoke than among children of nonsmoking fathers. The excess in respiratory symptoms among children exposed to smoking fathers (Fig. 2) is statistically significant for cough with cold, cough accompanied by sputum and wheezing with and without cold, and for wheezing accompanied by shortness of breath ($p = 0.0626$).

Respiratory diseases are also more common among children whose fathers smoke than among children of nonsmoking fathers; for bronchitis the difference in prevalence is statistically significant (Fig. 3). This trend characterizes the relationships found in the analysis for each town separately; it characterizes especially Hadera and Haifa, the trend in Ashdod being less obvious and statistically not significant. About 50% of the fathers in each of the three studied towns are smokers.

Most respiratory symptoms are more common among children of smoking mothers compared with children of nonsmoking mothers. For part of the symptoms, such as cough with cold, cough accompanied by sputum, and wheezing accompanied by shortness of breath, the excess in prevalence is statistically significant (Fig. 4).

Table 1. Study population by town, class, and sex.

	Haifa			Hadera			Ashdod		
Class	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Second	1145	1189	2334	594	570	1164	440	404	844
	(26.5)[a]	(27.4)	(53.9)	(26.4)	(25.3)	(51.7)	(26.3)	(24.2)	(50.5)
Fifth	981	1019	2000	531	558	1089	413	415	828
	(22.6)	(23.5)	(46.1)	(23.5)	(24.8)	(48.3)	(24.7)	(24.8)	(49.5)
Total	2126	2208	4334	1125	1128	2253	853	819	1672
	(49.1)	(50.9)	(100)	(49.9)	(50.1)	(100)	(51.0)	(49.0)	(100)

[a]Numbers in parentheses are percentage of the town population.

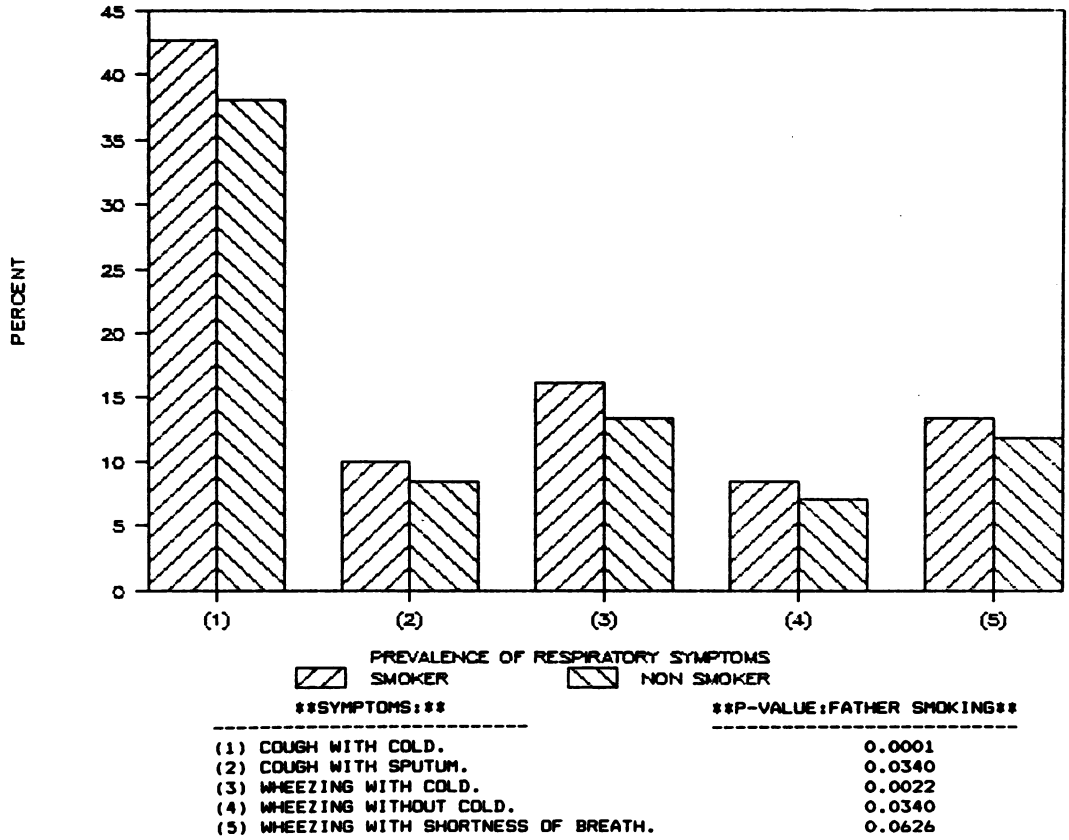
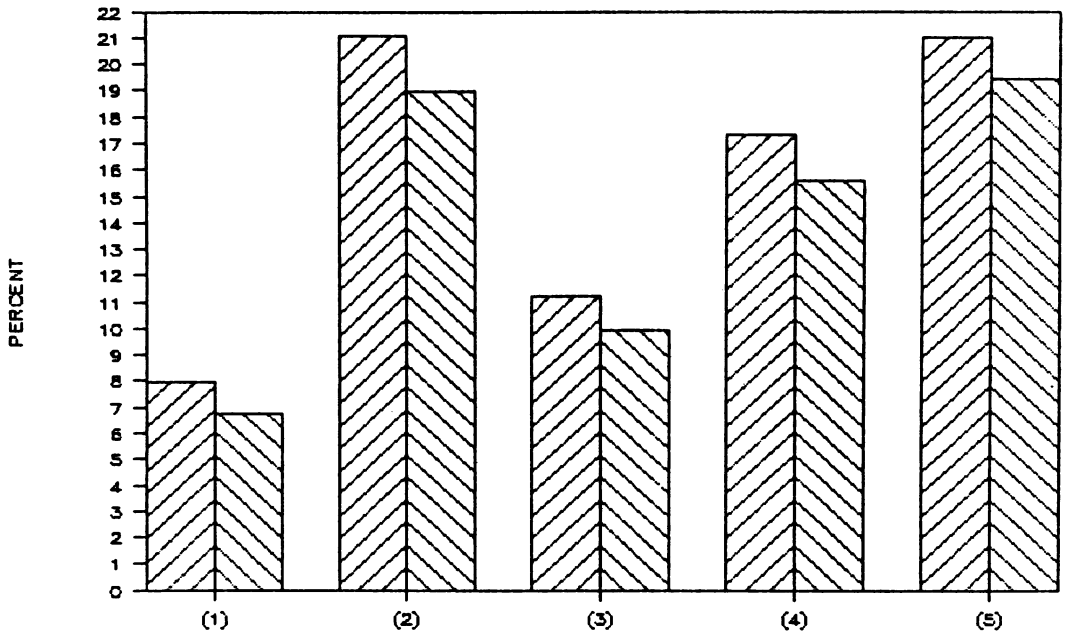
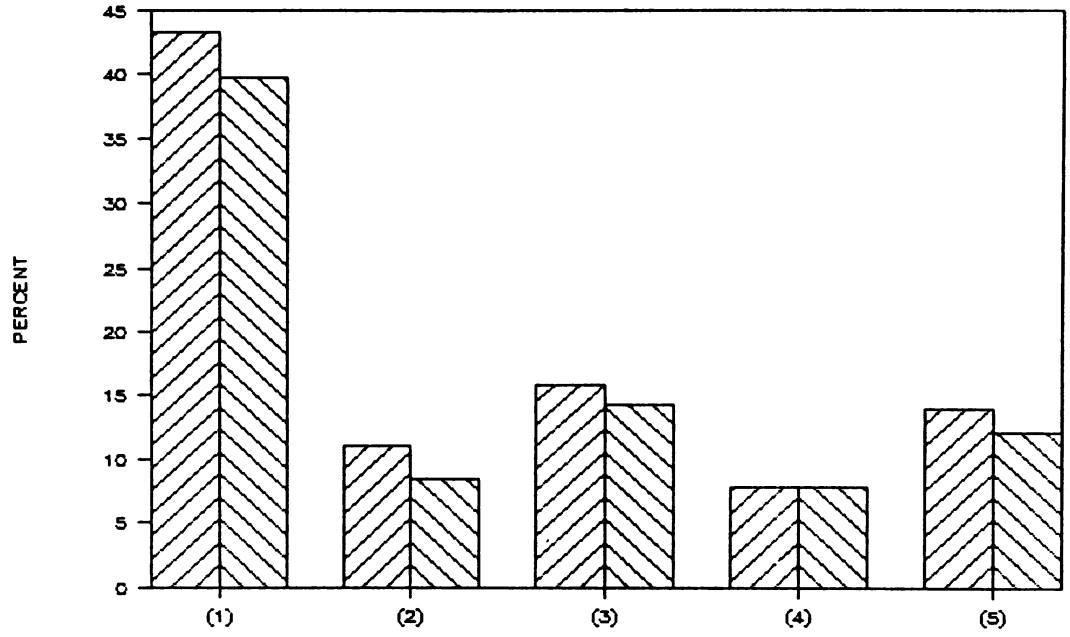


FIGURE 2. Prevalence of respiratory symptoms among schoolchildren related to their fathers' smoking habits.



DISEASES:	**P-VALUE:FATHER SMOKING**
(1) LUNG DISEASE.	0.0575
(2) BRONCHITIS.	0.0350
(3) ASTHMA.	0.0917
(4) PNEUMONIA.	0.0845
(5) RESPIRATORY DISEASES OF SIBLINGS.	0.0977

FIGURE 3. Prevalence of respiratory diseases among schoolchildren related to their fathers' smoking habits.



SYMPTOMS:	**P-VALUE:MOTHER SMOKING**
(1) COUGH WITH COLD.	0.0056
(2) COUGH WITH SPUTUM.	0.0006
(3) WHEEZING WITH COLD.	0.1050
(4) WHEEZING WITHOUT COLD.	0.9611
(5) WHEEZING WITH SHORTNESS OF BREATH.	0.0331

FIGURE 4. Prevalence of respiratory symptoms among schoolchildren related to their mothers' smoking habits.

Respiratory diseases are also more common among children of smoking mothers; the higher prevalence of asthma and pneumonia among children whose mothers smoke is statistically significant (Fig. 5). This trend of a higher prevalence of respiratory conditions among children of smoking mothers characterizes the populations of each town, the differences being most significant in Haifa, which is characterized by the highest rate of smoking mothers (31.3% in Haifa versus 25% in Hadera and 16.1% in Ashdod).

The prevalence of most respiratory symptoms rises gradually according to the children's exposure to passive smoking, from those whose parents do not smoke to children with one smoking parent towards children whose parents are both smokers. Part of the differences in prevalence of symptoms, e.g., cough with cold, cough accompanied by sputum, wheezing with cold, and wheezing accompanied by shortness of breath (Fig. 6), are statistically significant. Regarding the extent of exposure to passive smoking and the frequency of respiratory diseases, a gradual significant rise exists in the prevalence of asthma ($p = 0.0389$), pneumonia ($p = 0.0155$), lung diseases ($p = 0.0322$), and bronchitis ($p = 0.060$) among the exposed children (Fig. 7).

As can be seen from Table 2, the distribution of background variables (crowding index, heating of houses, mothers' education, mothers' respiratory diseases, fathers' origins and environmental pollution in the community) differ significantly between the various smoking categories. Hence, multivariate analysis was carried out, using logistic models that enabled us to study simultaneously the effect of passive smoking and the effects of other home and community exposures on the prevalence of respiratory symptoms and diseases. The relative risks calculated from the logistic models that were built for the respiratory conditions that differed significantly between children exposed to passive smoking and those not exposed are presented in Table 3.

Most of the logistic models demonstrate very well the frequency of the symptoms and diseases; most of them include at least one smoking parent. As can be seen from Table 3, the relative risk for children exposed to parents' smoking to suffer from respiratory conditions is between 1.13 (for bronchitis) and 1.28 (for wheezing without cold) for children of smoking fathers compared with 1.00 for children of nonsmokers. For children of smoking mothers the range is between 1.24 (for asthma) and 1.41 (for cough with sputum) as compared with 1.00 for children whose mothers are not smokers.

The models include, besides the effect of passive smoke exposure, the effects of other factors such as mothers' respiratory diseases, high home crowding, fathers' origin, heating, and community pollution. All the logistic regressions describing the prevalence of respiratory conditions among children include mothers' respiratory diseases as an important and highly significant factor in the models. The effect of community pollution on the prevalence of respiratory conditions among children is highly significant in many models; the magnitude of relative risks to suffer from respiratory conditions when exposed to community air pollution is similar to that connected with exposure to passive smoke and is much smaller than that connected with mothers' respiratory diseases.

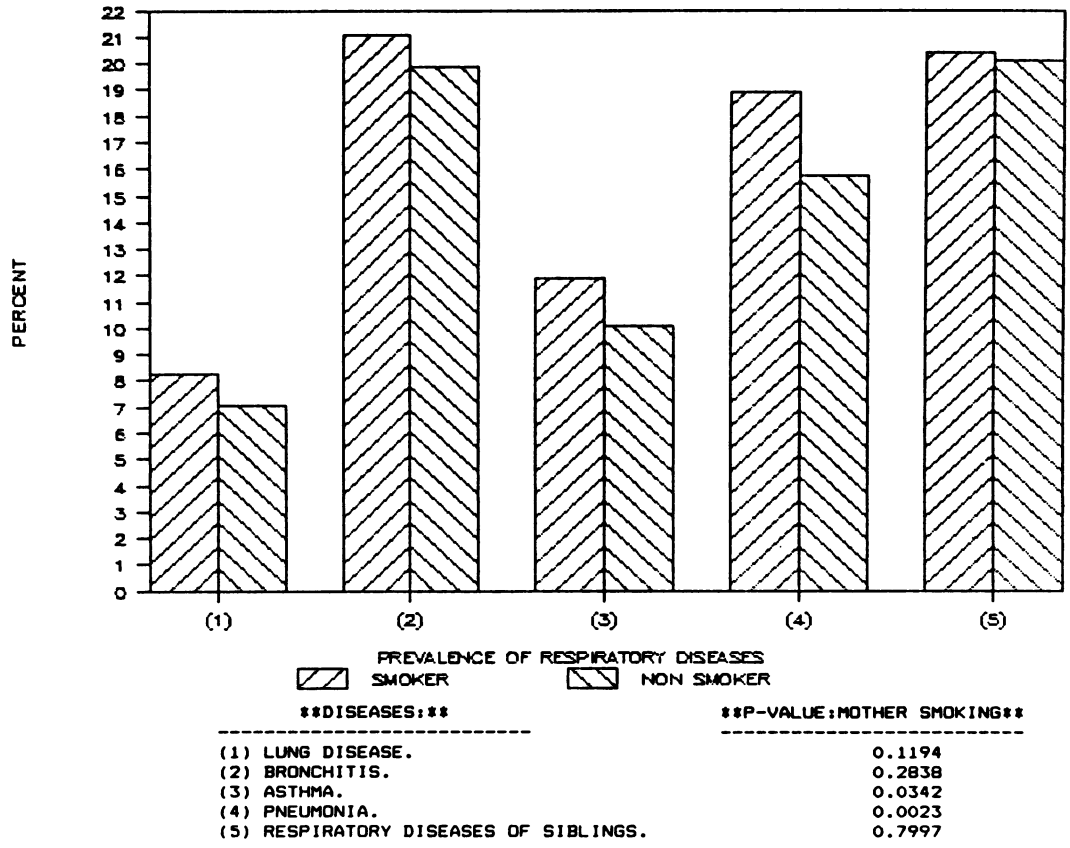
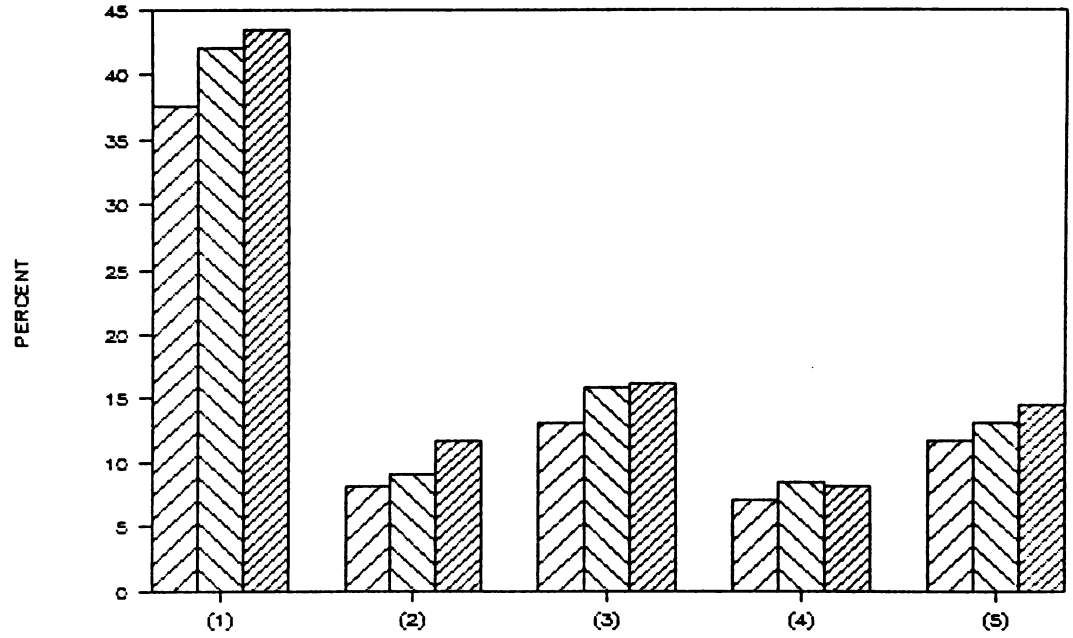
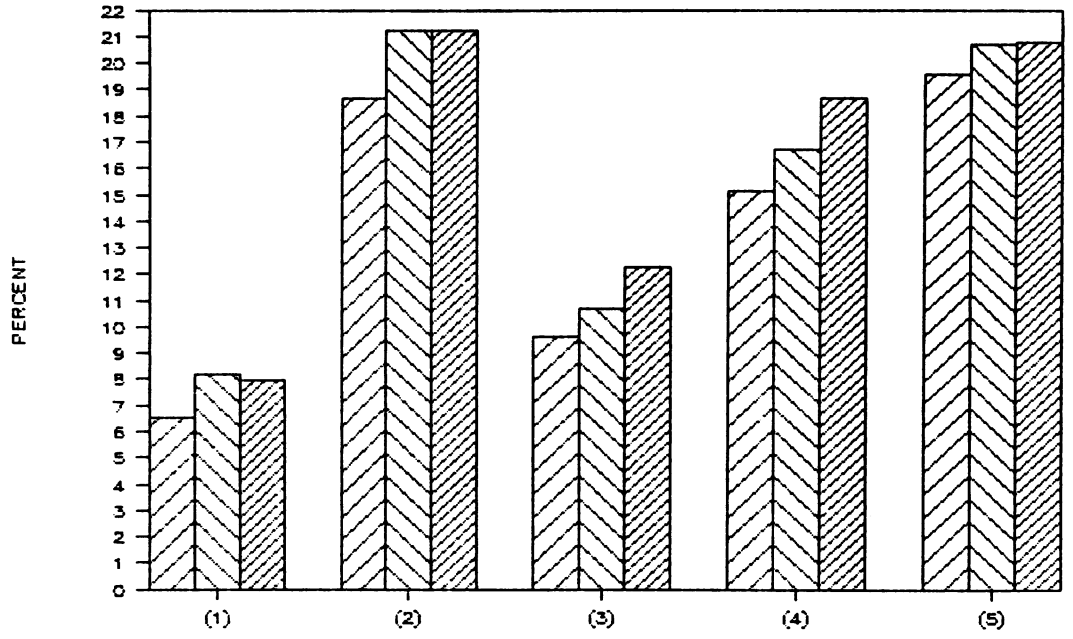


FIGURE 5. Prevalence of respiratory diseases among schoolchildren related to their mothers' smoking habits.



SYMPTOMS:	**P-VALUE:PARENTS SMOKING**
(1) COUGH WITH COLD.	0.0001
(2) COUGH WITH SPUTUM.	0.0006
(3) WHEEZING WITH COLD.	0.0059
(4) WHEEZING WITHOUT COLD.	0.1749
(5) WHEEZING WITH SHORTNESS OF BREATH.	0.0264

FIGURE 6. Prevalence of respiratory symptoms among schoolchildren related to their parents' smoking habits.



DISEASES:	**P-VALUE:PARENTS SMOKING**
(1) LUNG DISEASE.	0.0322
(2) BRONCHITIS.	0.0600
(3) ASTHMA.	0.0389
(4) PNEUMONIA.	0.0155
(5) RESPIRATORY DISEASES OF SIBLINGS.	0.5339

FIGURE 7. Prevalence of respiratory diseases among schoolchildren related to their parents' smoking habits.

Table 2. Distribution of background variables by parents' smoking.

Background variable	Fathers' smoking habits			Mothers' smoking habits		
	+	−	*p*-value[a]	+	−	*p*-value[a]
High crowding (≥ 1.5 persons/ room)	44.2 (3601)[b]	41.2 (3453)	0.0101	35.3 (1924)	45.0 (5236)	<0.0001
No heating	13.1 (3719)	10.6 (3563)	0.0024	10.3 (1990)	12.7 (5402)	0.0004
Father's education ≤ 8 years	18.6 (3722)	15.6 (3568)	0.0008	16.3 (1992)	17.3 (5409)	0.3254
Mother's education ≤ 8 years	19.5 (3722)	17.3 (3568)	0.0174	16.1 (1992)	19.2 (5409)	0.0026
Respiratory disease, father	9.2 (3318)	9.2 (3169)	0.9413	8.6 (1774)	9.4 (4736)	0.3135
Respiratory disease, mother	10.1 (3333)	9.0 (3195)	0.1114	10.7 (1834)	9.2 (4798)	0.0673
Father oriental	41.0 (3670)	41.4 (3501)	0.7612	34.2 (1952)	43.8 (5325)	≤0.0001
High community pollution	33.2 (3722)	34.6 (3568)	0.1956	26.8 (1992)	36.6 (5409)	≤0.0001

[a]A *p*-value ≤0.05 is considered significant.
[b]Number of persons in group in parentheses.

No consistent and significant trend of reduced FVC, $FEV_{1.0}$, PEF, or $FEV_{1.0}$/FVC could be observed among children of smoking parents compared with children of nonsmokers, in each town separately or in the pooled data set.

Discussion

In this health study carried out among schoolchildren in Israel a higher prevalence of both respiratory symptoms and respiratory diseases was observed among those children whose fathers or mothers are smokers than among children of nonsmokers. Part of the differences were statistically significant. These findings cohere with results reported by others (*1–11*) regarding respiratory conditions among schoolchildren as related to parental smoking. According to Bland et al. (*8*), schoolchildren of smokers more often reported cough first thing in the morning or later during day, and breathlessness was also more common among them. Lebowitz (*1*) found that symptoms of children were related to smoking habits within households. Charlton (*4*), in a health study carried out in England, found a significantly higher prevalence of cough among children exposed to parental smoking, especially to maternal smoking, compared with nonexposed children. Ware et al. (*7*), in their six cities U.S. health study, also found substantial increases in respiratory conditions among children exposed to maternal and, to a lesser extent, paternal smoking. Our results do not show any substantial excess in respiratory conditions related to maternal rather than paternal smoking. Also, our multivariate analyses resulted in the same number of logistic models in which the effect of fathers' smoking and that of mothers' smoking is included.

The dose–response relationship that we found between exposure to parental smoking and respiratory symptomatology has also been shown by others (*3,5,10*). Weiss and associates (*3*), in their study among 5- to 10-year-old children showed a significant trend in the reported prevalence of chronic wheezing with parental smoking; in our study a similar significant trend, although smaller in size, could be observed. Colley (*10*), in a health study carried out among British schoolchildren, found a gradual increase in the prevalence of cough as related to the number of smoking parents, similar to the increase we observed.

As found in a family study carried out by Cameron et al. (*9*), smokers' children were reported sick more frequently than nonsmokers' children. Schenker and associates (*5*) found a significant linear correlation between chest illness in the past year and the number of parental smokers. Similarly, our findings regarding gradual increase in prevalence of respiratory diseases such as bronchitis, asthma, and pneumonia correlate with the number of parental smokers.

Table 3. Relative risk for respiratory symptoms and disease for second- and fifth-grade schoolchildren as related to their parents' smoking habits and other exposure variables (calculated from logistic models).

Respiratory symptom or disease	Factors included in model	Relative risk	*p*-value for the factor
Cough with cold[a]	Father smokes	1.20	0.0007
	High crowding index	1.14	0.0242
	Respiratory disease, mother	1.51	<0.0001
	Father oriental	0.90	0.0584
Cough with sputum	Mother smokes	1.41	0.0006
	Respiratory disease, mother	1.99	<0.0001
	Medium pollution	1.18	0.0687
	High pollution	1.23	0.0687
Wheezing with cold	Father smokes	1.25	0.0035
	Respiratory disease, mother	2.19	<0.0001
	Medium pollution	1.17	0.0472
	High pollution	1.23	0.0472
Wheezing without cold	Father smokes	1.28	0.0204
	Respiratory disease, mother	1.80	0.0005
	Medium pollution	1.05	0.0714
	High pollution	1.31	0.0714
Wheezing with shortness of breath	Respiratory disease, mother	2.02	<0.0001
Lung diseases	Father smokes	1.23	0.0885
	Mother smokes	1.49	0.0368
	Heating	0.68	0.0424
	Respiratory disease, mother	2.42	<0.0001
Sinusitis	Mother smokes	1.40	0.0259
	Respiratory disease, mother	1.75	0.0119
	Father oriental	0.66	0.0168
	Medium pollution	0.89	0.0350
	High pollution	1.42	0.0350
Bronchitis[a]	Father smokes	1.13	0.0773
	High crowding index	0.77	0.0003
	Respiratory disease, mother	3.17	<0.0001
	Medium pollution	1.01	<0.0001
	High pollution	1.45	<0.0001
Asthma	Mother smokes	1.24	0.0296
	Respiratory disease, mother	1.79	0.0001
	Medium pollution	1.16	0.0110
	High pollution	1.37	0.0110
Pneumonia	Respiratory disease, mother	1.82	<0.0001
Ear infections	Mother smokes	1.28	0.0007
	High crowding index	0.65	<0.0001
	Respiratory disease, mother	1.81	<0.0001
	Father oriental	0.74	0.0001
Respiratory disease in siblings[a]	High crowding index	1.21	0.0155
	Respiratory disease, mother	6.23	<0.0001
	Medium pollution	0.97	<0.0001
	High pollution	1.54	<0.0001

[a]The model does not fit well ($p < 0.10$).

We found the effects of both fathers' and mothers' smoking only in the logistic model regarding lung diseases among the studied children. For all other respiratory conditions, the smoking effect of only one parent appeared in the model. The magnitude of relative risk values to suffer from respiratory conditions, when exposed to paternal or maternal smoking (1.13–1.41), were similar to those found for exposure to high community air pollution levels (1.23–1.54). The highest relative risk values calculated from logistic models were found to be associated with mothers' respiratory diseases (1.51–6.23).

As regards PFTs, we could not find a significant trend of reduced FVC, $FEV_{1.0}$, PEF, or $FEV_{1.0}$/FVC among children exposed to passive smoking compared with nonexposed children. These findings are in accord with results of other studies (*2,22–24*), in which no effect of parental smoking on their children's pulmonary function measurements could be determined. Contrary to these findings are the positive significant effects of passive smoking on PFTs of children in east Boston (*3,20,21*); the findings of Hasselblad and his group (*18*), who found significantly reduced $FEV_{0.75}$ among children exposed to maternal smoking, but not among those exposed to paternal smoking; and the findings of Tashkin and his group (*17*), who found an association between maternal smoking and reduced flows, especially among young boys. In other studies the findings were not clear cut. For instance, Ware and his group (*7*) found that FVC of children exposed to passive smoking was higher than that of nonexposed, while $FEV_{1.0}$ was lower. Vedal and associates (*19*) also observed reduced flows, especially among girls exposed to maternal smoking, but did not find a reduction in FVC associated with passive smoking.

Our study, as well as other studies, does not have quantitative estimates of passive smoking exposure. Naturally, in warm areas, the actual amount of indoor exposure of children is significantly smaller, either because they spend a greater part of their time outdoors or because the ventilation rates due to climate are higher than in colder areas. All the variables, such as ventilation, room size, number of rooms in the home, duration of contact with the active smoke, and number of cigarettes smoked at home, significantly influence the total exposure of children to passive smoke. Differences in these exposure variables and inadequate characterization of the amount of exposure of children to smoking parents may at least be partly responsible for the conflicting results of the reported studies.

Although lacking adequate exposure assessment, it should be stressed that our findings showing higher occurrence of respiratory conditions connected with passive smoking characterize children living in well-ventilated houses in a country with a warm climate and a relatively short winter. The magnitude of the effect of community air pollution on prevalence of respiratory conditions is similar to that observed for home exposure to passive smoke.

Due to highly ventilated homes, community exposure occurs together with home exposure to passive smoking during most days of the year. The striking effect of mothers' respiratory diseases on the frequency of respiratory conditions among their children is demonstrated by the magnitude of calculated relative risk values (1.51–6.23) compared with relative risk values found for passive smoking (1.13–1.41) and community pollution (1.23–1.54). It seems that relative risk values in this magnitude characterize home exposures to passive smoke as well as community exposure to air pollution typical to local conditions prevailing in Israel.

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