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Prevalence of respiratory symptoms in an unpolluted area of Northern Italy

G. Viegi*, P. Paoletti*, R. Prediletto*, L. Carrozzi*, P. Fazzi*, F. Di Pede*, G. Pistelli*, C. Giuntini*, M.D. Lebowitz**

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ABSTRACT: Using a multistage stratified geographic cluster sample of households living in an unpolluted area of Northern Italy (near Venice), we enrolled 3289 inhabitants (aged 8–64 yr) for a longitudinal respiratory study. During the first cross-sectional survey, before the start of operation of a large oil-burning thermoelectric power plant, they completed a standardized administered questionnaire and performed several lung function tests. In the whole sample, dyspooea grade 1 (11%), chronic cough and chronic phlegm (9%) were the most frequent respiratory symptoms; all the symptoms except dyspnoea were more prevalent in males than in females. Smokers (S) showed higher prevalence rates than ex-smokers (ES) and nonsmokers (NS), especially in males. In both sexes, the frequency of respiratory symptoms increased with increasing smoking as assessed by pack-years. An inverse relationship between prevalence of symptoms and socio-economic status was also observed. All tests of lung function were significantly impaired in S compared with NS in males; single-breath CO diffusing capacity and slope of alveolar plateau but not spirometric indices were significantly impaired in female S compared to female ES and NS. Finally, our prevalence rates were lower than in other epidemiological surveys: this result may be ascribed to the low levels of air pollution measured in the area.

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The prevalence rates of respiratory symptoms and diseases in population samples have been widely reported [1–7]. However, the results of community studies may yield significantly different results because of differences in respect to climate, air pollution, socio-economic status (SES), genetic and ethnic factors. In addition, occupational exposures and smoking habits may differ among populations.

The aim of this paper is to analyse the relationships of the prevalence rates of respiratory symptoms and diseases with sex, age, smoking habit and SES in a general population sample, investigated during the first cross-sectional survey of a longitudinal epidemiological study in the unpolluted area of the Po River Delta (near Venice). In addition, preliminary results of the influence of smoking on lung function tests in both sexes are reported.

Material and methods

The study was carried out in 1980–1982, before the start of operation of a large oil-burning thermoelectric power plant.

The characteristics of the population sample, the methodology and the reference equations for the lung function tests have been previously described [8, 9]. Briefly, the population sample (age 8–64 yr) was a multistage stratified family cluster design. Data on the population were obtained from the last census before the study. Stratification was performed using two indexes of SES: 1) 'crowding', *i.e.* subjects living in the house divided by the number of rooms and 2) the percentage of those in higher occupational groups; according to the frequency distribution, each household was assigned to high, medium or low SES. Stratification was also performed on the basis of the age of the head of household (three categories). 4201 subjects were selected and 3289 (78.3%, 1580 males and 1709 females) were studied.

A modified National Heart Blood and Lung Institute (NHBLI, USA) questionnaire was developed by the Consiglio Nazionale delle Ricerche (CNR) Special Project on chronic obstructive lung disease (COLD) (CNR questionnaire). It contains 67 questions regarding respiratory symptoms, diseases and risk factors that were described elsewhere [8, 10]. The questionnaire was administered, by trained nurses, using a standard protocol, whose reproducibility was tested previously. For children under 10 yr, the answers were obtained from the mothers; over 10 yr, each subject answered personally. Completed questionnaires were coded and entered on a magnetic computer tape.

Nonsmokers (NS) were defined as those who had

never smoked any kind of tobacco regularly. Smokers (S) were those who were currently smoking at least one cigarette daily. Ex-smokers (ES) included those who had formerly smoked regularly until six months or more before the examination. Among men, there were 32.2% NS, 49.2% current S (mean pack-years, *i.e.* number of cigarettes per day/20, multiplied by the number of years of smoking: 17.3±14.8) and 18.6% ES (mean pack-years: 23.3±22.5). Among women, there were 65.9% NS, 26.9% current S (mean pack-years: 7.1±7.6) and 7.1% ES (mean pack-years: 8.6±11.7).

The following symptoms were considered for the analysis: chronic cough (or phlegm), if the subject coughed (or had phlegm) for as much as three months of the year for at least two years; persistent wheeze or attacks of shortness of breath with wheezing (SOBWHZ), if the subject had wheeze (or SOBWHZ) as much as six months of the year, apart from common colds; dyspnoea, if the subjeet felt short of breath when hurrying on level ground or walking up a slight hill (grade 1) or when walking on level ground with persons of the same age (grade 2) or if the subject had to stop for a breath while walking at his own pace on level ground (grade 3); allergic rhinitis, if the subject complained of hay fever or any other allergy making the nose runny or stuffy, apart from common colds. Emphysema, chronic bronchitis, asthma, tuberculosis and pleurisy were taken into account if the diagnosis was confirmed by a physician.

Each subject also performed flow-volume curves, single-breath diffusing capacity for carbon monoxide ($D_{LCO_{sb}}$), single-breath nitrogen test ($DN_2\% \cdot l^{-1}$): the methods and the prediction equations for normal reference values have been described previously [8, 10, 11].

Statistical Package for the Social Sciences (SPSS) routines were used at the University of Pisa Computer Centre (CNUCE) for analyses: the chi-square test was used for comparing the prevalence rates of symptoms and diseases, and the analysis of variance for the comparison of lung function tests.

Results

The prevalence rates of respiratory symptoms and diseases are shown in table 1. Males had significantly

Table 1. - Prevalence % of respiratory symptoms and diseases by sex and age

	All		8-19 yr		20+ yr	
	Male	Female	Male	Female	Male	Female
n	1580	1709	415	439	1165	1270
Cough	13.7***	4.7	1.7	2.5	18.0***	5.4
Phlegm	13.6***	4.3	2.7	2.3	17.5***	5.0
Cough and phlegm	9.8***	2.3	0.5	1.1	13.1***	2.8
Chronic bronchitis	2.2***	0.6	0	0.2	2.9***	0.8
Emphysema	0.8*	0.2	0	0	1.1**	0.2
Wheeze	5.3***	3.0	2.2	1.8	6.4***	3.5
SOBWHZ	2.1	2.2	1.0	1.4	2.6	2.5
Asthma	2.9	2.2	2.2	1.6	3.2	2.4
Dyspnoea grade 1	8.9***	13.2	1.9*	0.7	11.3***	17.5
grade 2+	1.6	4.0	0	1.4	2.1	4.9
Tuberculosis	4.6*	3.2	2.2	0.9	5.4	3.9
Pleuritis	5.3	5.1	0.5	0.7	7.0	6.6
Rhinitis	3.0	3.9	2.7	1.6	3.2	4.6

SOBWHZ: shortness of breath with wheezing. *p<0.05; **p<0.01; ***p<0.001: significant differences between males and females by chi square analysis.

higher prevalence rates of most symptoms and diseases; only dyspnoea was more prevalent in females. These sex-related differences were still present when only those over 20 yr were considered, whereas among those 8–19 yr only the prevalence of dyspnoea was significantly different: higher values were shown by males for dyspnoea grade 1 and by females for dyspnoea grade 2+.

The relationships between smoking habit and symptoms prevalence rates are reported in table 2. Under 19 yr, few differences were found among the smoking groups in both sexes. Over 20 yr, among males, cough, phlegm and dyspnoea were significantly more frequent in S, wheeze, asthma and pleuritis in ES; among females, cough, phlegm and wheeze were significantly more frequent in S. When comparing NS of the same age groups, significant differences were found only between male and female adults in the prevalences of phlegm (8 *vs* 3%) and dyspnoea (grade 1: 5 *vs* 18%; grade 2+: 2 *vs* 6%).

Increasing prevalence rates with age, generally more evident in men, were found especially in S. Chronic cough and phlegm both increased rapidly in S with age (fig. 1) to about 40%, compared to about 20% in NS. Increasing female values with age were significant also, but to a lesser extent, about 20% in S. A less linear trend was exhibited by ES, whose values were closer to those of NS than of S in males, and intermediate in females. Also wheezing (fig. 2) and dyspnoea (fig. 3) showed a trend to increase with age in males and females, but differences by smoking habits were much less. Moreover, among subjects over 20 yr, a significantly higher body weight (% predicted according to Lorenz formula) was present in those with dyspnoea grade 2+ ($126 \pm 15\%$ in males; $136 \pm 25\%$ in females) when compared to those with dyspnoea grade 1 ($120 \pm 16\%$ and $120 \pm 22\%$) and to those without dyspnoea ($113 \pm 15\%$ and $112 \pm 20\%$).

Significant trends for prevalence rates to increase with cigarette consumption were found considering three groups both in male S (<8, 8–20, >20 pack-years) and in female S (<3, 3–6, >6 pack-years).

Table 2. - Prevalence % of respiratory symptoms and diseases by smoking habit

	8-19 yr						20+ yr					
	Male			Female			Male			Female		
	NS	ES	S	NS	ES	S	NS	ES	S	NS	ES	S
n	313	21	81	356	12	71	195	273	697	770	110	390
Cough	1	-	4	1	17	7***	5	10	25***	3	6	10***
Phlegm	2	5	5	1	-	7*	8	11	23***	3	5	10***
Cough and phlegm	0.5	-	-	0.6	-	4	4	8	18***	1	3	6
Chronic bronchitis	-	-	-	0.3	-	-	2	4	3	0.8	1	-
Emphysema	-	-	-	-	-	-	1	2	0.7	0.3	-	0.3
Wheeze	3	-	-	1	8	3	3	8	7**	3	0.9	5***
SOBWHZ	1	-	-	1	8	1	2	3	2	2	2	3
Asthma	3	-	-	2	8	-	4	6	2**	3	2	2
Dyspnoea grade 1	2	5	1	0.6	-	1**	5	12	13**	18	14	17
grade 2+	-	-	-	0.3	8	6	2	4	1	6	3	4
Tuberculosis	3	-	-	0.8	8	-*	5	7	5	4	4	3
Pleuritis	0.6	-	-	0.6	-	1	5	11	6*	7	7	6
Rhinitis	3	9	1*	1	-	4	5	4	2	5	1	5

NS: nonsmoker; ES: ex-smoker; S: smoker; SOBWHZ: shortness of breath with wheezing. ***p<0.001; **p<0.01; *p<0.05: significant differences among smoking groups by chi-square analysis.

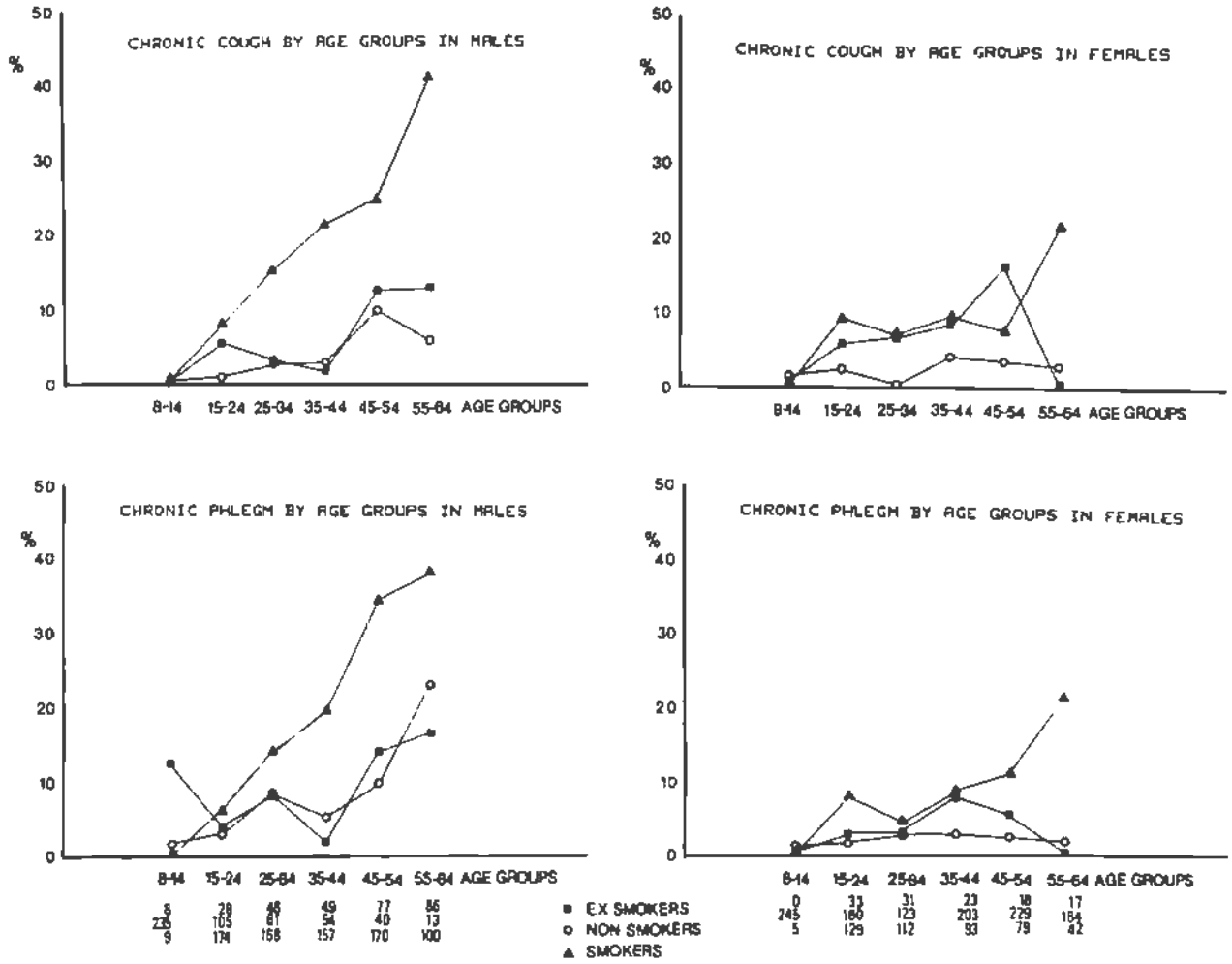

Fig. 1. Prevalence rate (%) of chronic cough and phlegm by sex, age groups and smoking habit. Numbers of ES (upper position), NS (middle), S (lower) are reported for each age group.

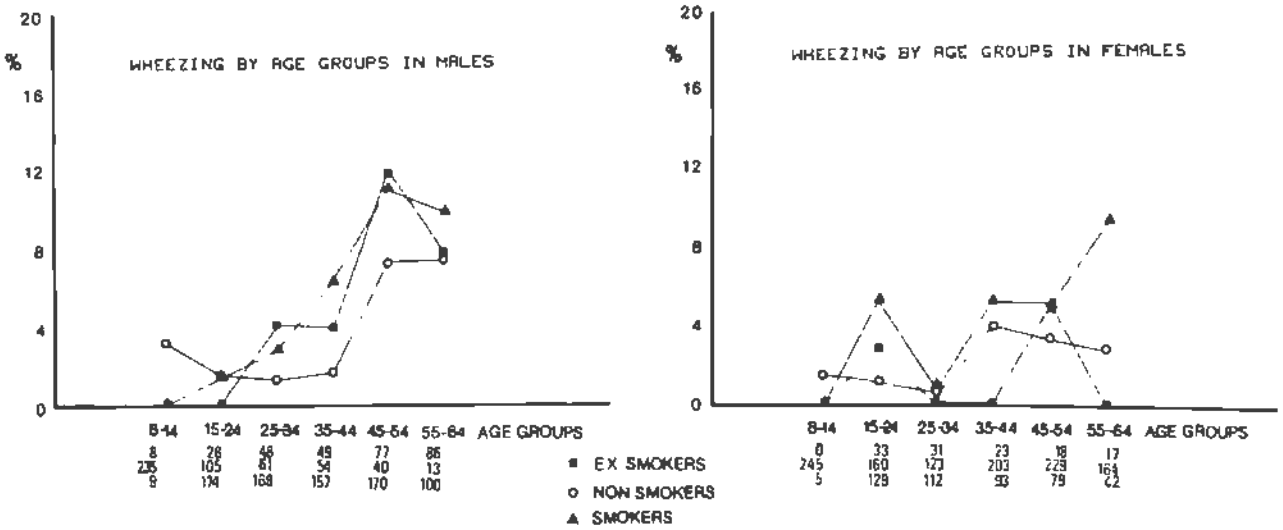

Fig. 2. Prevalence rate (%) of wheezing by sex, age groups and smoking habit.

In males, the prevalence rates of chronic cough and chronic phlegm increased significantly from high to medium to low SES: 12, 16, 17% and 12, 14, 19% respectively. In females, only prevalence rates of wheeze were significantly higher in low (6%) than in medium (2%) and in high (3%) SES. This analysis

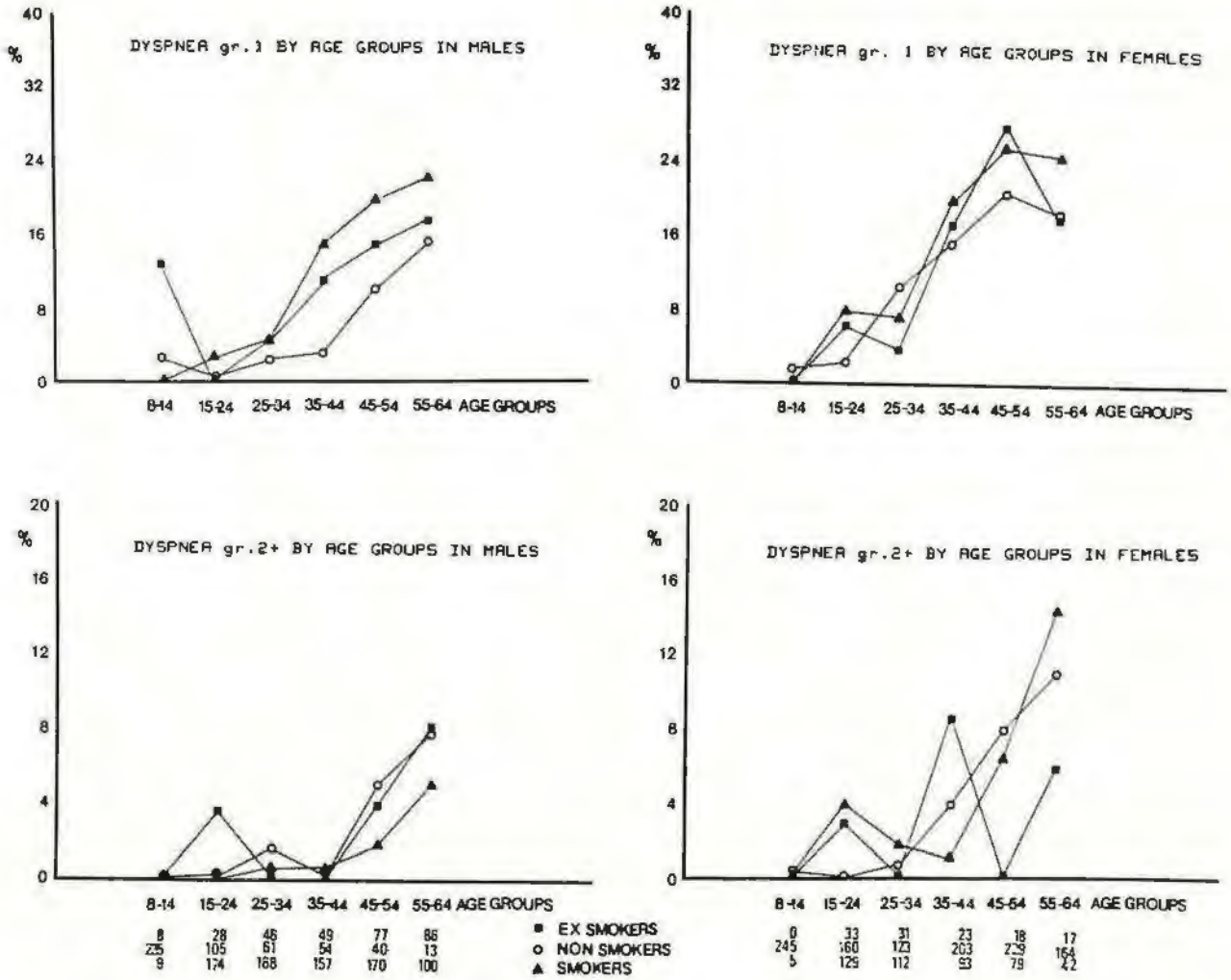

Fig. 3. Prevalence rate (%) of dyspnoea by sex, age group and smoking habit.

was performed in the overall sample, since in both sexes the three SES groups were not significantly different by age and smoking habits.

In table 3, the mean and standard deviation for lung function values are reported: in males all the parameters showed significant differences among S, ES and NS, while in females only the comparison for $DLCO_{sb}$ and $DN_2\% \cdot l^{-1}$ reached the level of statistical significance.

Discussion

In our study, sex-related differences were evident in symptom prevalence rates. Males showed a higher prevalence of most respiratory symptoms and diseases than females. These differences completely disappeared when only NS were considered. However, phlegm appeared to be a male characteristic and dyspnoea a female characteristic symptom regardless of smoking. These findings are in agreement with those of previous studies [3, 5, 6]: different smoking habits (*e.g.* inhalation, life-time cigarette consumption) and the added effect of occupational exposure in men may be hypothesized to explain these differences. On the other hand, the excess of breathlessness in females may be attributable to sex-related variations in life style, 'meaning' of the symptom and also to the slight female excess of cardiac troubles (5.3 *vs* 4%). Moreover, the weight excess may be an additional factor in determining the presence of dyspnoea, especially grade 2+, regardless of sex. In addition, in the age group 8–19 yr, dyspnoea grade 1 in males and dyspnoea grade 2+ in females appeared to be a possible factor in inducing young subjects to give up smoking.

The relationship between age and increase of respiratory symptoms in NS may be ascribed to the effect of ageing: for instance, WANNER [12] has demonstrated a slower tracheal mucous velocity in NS elderly subjects that might explain the need for more frequent coughing. Moreover, a relationship between the increased interalveolar wall distance and the decreased diffusing capacity with ageing was found by PAOLETTI *et al.* [8] this might be one explanation, like cardiovascular diseases or life style, of the increased prevalence of dyspnoea in elderly NS.

Table 3. - Mean and standard deviations of lung function tests

	Male			Female		
	NS	ES	S	NS	ES	S
n	473	272	746	1047	114	427
FVC %	100±12	96±13	98±14*	99±12	98±11	99±12
FEV_1 %	103±15	95±18	98±17**	98±12	98±12	99±12
FEF_{25-75} %	99±25	86±32	86±29**	97±24	98±26	96±25
FEF_{75-85} %	99±35	85±42	82±36**	98±41	99±46	94±38
MEF_{50} %	98±25	86±32	88±30**	98±24	98±25	97±25
MEF_{75} %	93±32	80±37	76±33**	97±35	99±39	95±34
n	427	226	633	884	102	366
$DLCO_{sb}$ %	101±16	97±17	90±17**	99±15	95±15	94±17**
n	325	200	572	414	65	236
DN_2 %·l^{-1}	0.8±0.4	1.3±1.1	1.3±1.0**	1.1±0.7	1.1±0.6	1.3±1.0**

FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; MEF: maximal expiratory flow at 50% and at 75% of FVC; FEF: forced expiratory flow between 25% and 75% and between 75% and 85% of FVC. Forced expirograms and $DLCO_{sb}$ are expressed in percent of predicted values [8, 10]; DN_2 %·l^{-1} is expressed in absolute values. **p<0.01; *p<0.05: significant differences among smoking groups by variance analysis.

Table 4. - Prevalence (%) of some respiratory symptoms in males 40–59 yrs: comparison with other studies.

	Chronic cough	Chronic phlegm	Wheezy	Dyspnoea	
				gr. 1	gr. 2+
Po River delta	23	22	9	19	2
Tucson (6)	28	29	12	33	15
Jersey City (26)	32	32	11	33	10
California (25)	30	30			14
London (27)	39	40	18	59	9
GB country towns (27)	35	30	15	34	3
Harjavata (28)	25	30	2	34	10
London (2)	41	40		25	7
East France (23)	30	23		21	
Canadian towns ": (24)					
– Beauharnois	43	22	46	67	18
– Pointe aux Trembles	30	23	29	59	11
– St. Eustache	18	11	34	54	9

Notes: numbers in parentheses are those of the reference lists; ": age range 45–64 yrs.

The prevalence rates of diagnosed diseases, such as emphysema, chronic bronchitis and asthma, may have been influenced by diagnostic habits of family practitioners, as shown in other studies [13, 14]. In particular, it seems that doctors underestimated the diagnosis of chronic bronchitis in respect of the presence of chronic phlegm. The higher prevalence of pleuritis in male ES suggests that this disease, probably related to the past frequency of tuberculosis in this area, may have been the stimulus for cessation of smoking.

Our findings on the SES-related prevalence rates of chronic cough, phlegm and wheeze confirm that SES

may be an independent risk factor for the development of symptoms characteristic of chronic obstructive lung disease [15–17].

The preliminary analysis on the relationships among lung function tests and smoking habit confirms that this is one of the most important risk factors affecting ventilatory function [18, 19]. A more detailed analysis will be reported in another paper. It is interesting to note that the highest ability to discriminate among smoking categories is shown in both sexes by $DLCO_{sb}$ and $DN_2\% \cdot l^{-1}$, which appear to be sensitive indices [9, 11, 20, 21], able to detect minor functional changes even in presence of low cigarette consumption (see female S and ES).

Our symptom prevalence rates in males 40–59 yr were lower in respect of those of many other studies reporting comparable values (table 4). On the other hand, our prevalences of chronic bronchitis in the overall sample were similar to those found in Scandinavian population samples unexposed or exposed to low levels of air pollution (between 2.1 and 2.8% in males and between 1 and 1.8% in females) [22].

In conclusion, our findings, beside SES, smoking habits and ethnic-genetic differences, may be ascribed to the rural characteristics of the area, where levels of air pollution were low during the survey [8]. It will be useful to evaluate in the future possible adverse effects of the thermoelectric power plant.

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RÉSUMÉ: En utilisant un échantillon multistratifié en grappes géographiques des familles résidentes dans une région non polluée

du Nord de l'Italie (près de Venise), 3289 sujets (8 à 64 ans) ont fait l'objet d'une enquête épidémiologique longitudinale respiratoire. Lors de la première étude transversale, menée avant l'entrée en fonction d'une très puissante centrale thermo-électrique à houille combustible, les sujets ont rempli un questionnaire standardisé et ont exécuté des épreuves fonctionnelles respiratoires. Dans l'échantillon global, les symptômes les plus fréquents sont: la dyspnée de premier degré (11%), la toux et l'expectoration chroniques (9%); la prévalence des symptômes, à l'exception de la dyspnée, est plus fréquente chez les hommes que chez les femmes. Les fumeurs (S) montrent un taux de prévalence plus élevé que les ex-fumeurs (ES) et les non-fumeurs (NS), en particulier chez les hommes. Dans les deux sexes, la fréquence des symptômes respiratoires augmente en fonction de l'exposition au tabac, estimée en paquets/années. Une relation entre la prévalence des symptômes et les conditions socio-économiques est également observée. Tous les paramètres fonctionnels respiratoires sont, chez les hommes, significativement inférieurs pour les fumeurs que pour les ex-fumeurs et les non-fumeurs; par contre, chez les femmes, seuls le transfert du CO en apnée et la pente du plateau alvéolaire sont inférieurs chez les fumeuses que chez les ex-fumeuses et les non-fumeuses. Enfin, nos taux de prévalence sont plus bas que ceux publiés dans d'autres enquêtes épidémiologiques; ces résultats pourraient être attribués au faible niveau de pollution dans cette région.