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One-year longitudinal study of young apprentices exposed to airway occupational sensitizers

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Abstract *Background:* The prevalence of diagnosed asthma and wheezing in young subjects is increasing; among environmental risk factors, occupational exposure can play a relevant role. *Study objectives:* The purpose of the study was to evaluate the effects of occupational exposure to a large variety of irritants and/or sensitizers on the incidence of respiratory symptoms and pulmonary function impairment in a group of young apprentices during the first year of work exposure, and to determine the prevalence of asthma-like symptoms and the role of different risk factors (gender, smoking habit, atopy and occupational exposure) in this young population. *Design and methods:* We studied 448 young apprentices at the first pre-employment evaluation with a standardized questionnaire, spirometry and skin prick tests; in 244 of them clinical and functional evaluation was repeated after 1 year exposure to respiratory irritants or sensitizers. *Results:* At the first examination, males had higher prevalence of attacks of shortness of breath with wheeze, diagnosis of asthma, smoking habit and atopy than females. At the second examination there was no significant increase in the prevalence of respiratory symptoms. However, incident cases for cough, phlegm, wheezing, shortness of breath with wheeze (SOBWHZ) and asthma were all higher than remittent cases. Incidence of respiratory symptoms was associated with atopy and smoking habit. *Conclusions:* Respiratory symptoms slightly increase over

1 year occupational exposure to sensitizers or irritants. The loss at the follow-up of subjects with higher smoking habit suggests a small “health worker effect” and could underestimate the effect of occupational exposure in apprentices.

Keywords Occupational asthma · Respiratory symptoms · Respiratory irritants or sensitizers · Apprentices · Longitudinal study

Introduction

Many studies have suggested that the prevalence of diagnosed asthma and wheezing in young subjects is increasing (European Community Respiratory Health Survey 1996). Epidemiologic studies suggest that most differences in the prevalence of asthma are due to environmental and not genetic factors (Peat 1994; Von Mutius 2000; Burrows and Martinez 1989); among environmental factors, occupational exposure can play a relevant role in the development of airway sensitization and bronchial asthma (Kogevinas et al. 1996). The contribution of occupational exposure to the prevalence of asthma is unknown. Estimates of the incidence of occupational asthma from surveillance of occupational physicians’ reports and workers’ compensation data are lower than expected from community-based cross-sectional studies, and some authors suggest that the incidence of asthma attributable to occupational exposures is significantly higher than previously reported (Milton et al. 1998; Smith and Patton 1999).

Previous studies reported that underdiagnosed asthma was frequent in young subjects (Peat et al. 1994; Nish and Schweitz 1992). Symptoms of asthma can occur frequently in young subjects exposed to occupational sensitizers, and frequently workers enter a job with undiagnosed asthma which can be triggered by the occupational exposure (Katz et al. 1999). Atopy, smoking habit, level and duration of exposure to sensitizers in the workplace are important risk factors for the

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development of asthma in subjects exposed to occupational sensitizers (Dosman et al. 1991; Niven and Pickering 1999; Malo et al. 1992). Apprentices represent a good model to investigate the early effect of occupational exposure on asthma occurrence and its role on recrudescence of asthma in subjects with previous disease. Some studies reported the early changes in respiratory symptoms, skin sensitization and bronchial hyperresponsiveness in selected groups of workers newly exposed to specific sensitizers, like animal derivatives (Gautrin et al. 2002), flour dusts (De Zotti and Bovenzi 2000) and metalworking fluids (Kennedy et al. 1999). All these studies showed that in the first 1–2 years of exposure a significant number of subjects developed skin sensitization to occupational allergens or bronchial hyperresponsiveness, despite a lower increase in the prevalence of asthma symptoms in the same subjects during the follow-up. This discrepancy can be due to a self-selection of affected workers.

The purpose of the study was to evaluate the effects of occupational exposure to a large variety of irritants and/or sensitizers on the incidence of respiratory symptoms and pulmonary function impairment in a group of young apprentices during the first year of work exposure, and to determine the prevalence of asthma-like symptoms and the role of different risk factors (gender, smoking habit, atopy and occupational exposure) in this young population.

Subjects and methods

Subjects

The study involved three Occupational Health Units at the Tuscany coast near Pisa during an 18-month period (from January 1996 to July 1997). All new apprentices attending the pre-employment evaluation for many jobs which exposes them to respiratory irritants or sensitizers (shoe makers, furniture workers, bakers, carpenters, welders, hair dressers, etc.) were examined at the time of the first pre-employment evaluation.

Study protocol

All subjects completed a standardized questionnaire administered by trained interviewers, in order to collect respiratory symptoms and diseases, smoking habit, occupational and non-occupational exposure, as well as present and past personal and family history of pulmonary diseases (Viegi et al. 1988). The following symptoms were recorded: any cough (or phlegm), defined as persistent cough (or phlegm) apart from common colds, chronic cough (or phlegm), defined as cough (or phlegm) for as much as 3 months of the year for at least 2 years; wheeze, defined as wheeze apart from the common cold; dyspnea, defined as shortness of breath (grade ≥ 1); shortness of breath with wheeze (SOBWHZ), defined as

any attack of shortness of breath with wheeze, apart from the common cold; allergic rhinitis, defined as hay fever or any allergy making the nose runny or stuffy, apart from the common cold; asthma, defined as previous asthma (with affirmative answer to the question “Have you ever had asthma”) and/or current asthma (with affirmative answer to the question “Do you currently have asthma”).

Spirometry was carried out using a computerized bell spirometer (Biomedin, Padova, Italy). Forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) were obtained in each subject after performing at least three reproducible forced expiratory manoeuvres as recommended (American Thoracic Society 1987). The data were expressed as percentages of the predicted values (Paoletti et al. 1986).

Skin prick tests were performed with 11 common allergens, positive and negative control (Lofarma Allergeni, Milano, Italy). Atopy was defined as the presence of a positive skin reaction (mean wheal diameter ≥ 3 mm) to at least one of the common allergens.

Follow-up examination

After the first survey, all subjects were asked to contact our center after 1 year of work as apprentices, in order to identify any possible change in respiratory symptoms and pulmonary function. At that time, they repeated all the evaluations performed at the first survey, except for skin prick tests. Both baseline and follow-up examinations were performed in the same season. Identical testing procedures and equipments were used for baseline and follow-up studies. Subjects who did not attend the follow-up examination were contacted by telephone, up to a maximum of two times, and invited to attend our laboratory. Only subjects who had referred at the follow-up examination a > 6 -month occupational exposure in the previous year were considered. At the follow-up, subjects were subdivided in groups according to the type of the occupational exposure they had in the previous year (e.g. spray painters, bakers, hair dressers, shoe makers, carpenters, welders, etc.). At the follow-up, qualitative information on the type of occupational exposure during the first year of apprenticeship, and on the use of personal protective devices were collected.

Statistical analysis

Prevalence of respiratory symptoms and diseases are reported as percentages. FVC and FEV1 (in percentage of the predicted value) are expressed as arithmetic mean $\pm$ standard deviation.

Statistical significance of the unadjusted differences in prevalence of symptoms between groups in contingency tables was assessed by chi square analysis. The difference in FVC and FEV1 (in percentage of the predicted value) among different groups of exposure was tested by

analysis of variance (ANOVA). A P value of <0.05 was considered significant.

Logistic regression was used to analyze the influence of some risk factors (gender, age, smoking habit, atopy, past personal or family history of pulmonary diseases) on the prevalence of respiratory symptoms at the first examination, and on the incidence of respiratory symptoms at the follow-up. The results are given in terms of odds ratio (ORs) with 95% confidence intervals (95% CIs). Binary-dependent and independent variables were categorized as 0=absence, or 1=presence of the condition. For gender, female was the reference group. Continuous variables (like age and FEV1) were transformed into categorical variables with the quartile distribution obtained from all subjects.

Changes in respiratory symptoms in the 1 year of follow-up were reported as remittent cases (subjects with respiratory symptoms only at the first observation but not at the second evaluation) and incident cases (cases with respiratory symptoms only at the second observation). The comparison between remittent and incident cases was performed by binomial chi-square with Fisher's test.

Results

Four-hundred and forty-eight apprentices (248 males and 200 females) were enrolled in the first survey. The comparison between male and female apprentices showed that males had significantly higher prevalence of attacks of SOBWHZ, diagnosis of asthma, smoking habit and atopy, than females (Table 1). FEV1 (% pred.) was lower and FVC (% pred.) was higher in females than in males, possibly due to a different growth rate between genders in the population examined in comparison with the reference population, and to the different BMI.

Apprentices with atopy had higher prevalence rates of wheezing (20.2 vs 11.6%, $P<0.05$), shortness of breath with wheeze (15.1 vs 1.9%, $P<0.05$), rhinitis (26 vs 2.6%, $P<0.05$) and asthma (16 vs 3.2%, $P<0.05$) than apprentices without atopy. Smokers showed higher prevalence rates for chronic cough and chronic phlegm than non-smokers.

In all subjects who attended the first examination, logistic regression showed that among different individual risk factors the prevalence of respiratory symptoms and diseases, and functional abnormalities was positively related to gender (higher in males), atopy, smoking habit, and past personal history, while age and family history of allergic diseases were not significantly associated with respiratory symptoms (Table 2). In this analysis, the lowest quartile of age was associated with the absence of the condition, and no significant relationship was observed.

One year after the beginning of work, 244 out of 448 subjects (54%) repeated the questionnaire and spirometry. The remaining 204 subjects were excluded from the

Table 1 Comparison of respiratory symptoms and functional abnormalities prevalence between males and females at the first survey

	Males	Females	P
Number	248	200	
Age (years, M $\pm$ SD)	16.8 $\pm$ 1.6	17.1 $\pm$ 1.6	0.07
BMI (M $\pm$ SD)	22.4 $\pm$ 2.7	21.4 $\pm$ 3.2	<0.001
Any cough	2.4(6)	3.5(7)	0.5
Chronic cough	2(5)	2(4)	0.8
Any phlegm	2(5)	2(4)	1
Chronic phlegm	0.8(2)	1.5(3)	0.6
Wheezing	14.7(36)	12.4(25)	0.5
SOBWHZ	9.2(22)	1.5(3)	<0.001
Rhinitis	11.8(29)	6.5(13)	0.053
Asthma			
Current	4.6(11)	1(2)	0.018
Previous	5.9(14)	1.1(5)	
Never	89.5(213)	96.4(190)	
Dyspnea	0	1(2)	0.1
Smoking habit			
Regular	32.9(81)	20.8(42)	0.01
Ex	2.4(6)	1.5(3)	
No	64.6(159)	77.7(157)	
FVC (% pred, M $\pm$ SD)	104 $\pm$ 10.7	106 $\pm$ 11.2	0.04
FEV1 (% pred, M $\pm$ SD)	120 $\pm$ 13.5	109 $\pm$ 11.5	<0.001
Atopy	36.1(75)	23.5(44)	0.008

Data are reported as percentages (absolute numbers in parenthesis) or as mean $\pm$ standard deviation (M $\pm$ SD)

follow-up examination because of early removal (<6 months) from the specific job ($N=54$) or because of unattendance to the follow-up examination ($N=150$). There was no difference between these two groups with regards to most baseline findings. Subjects lost to follow-up were slightly older and with higher prevalence of smoking habit, and male gender than subjects who attended the follow-up examination (Table 3). In the sample of subjects who attended the first and the second examination, logistic regression also confirmed the role of the same risk factors in the occurrence of respiratory symptoms in this subgroup (data not shown).

There was no significant increase in the prevalence of respiratory symptoms between the first survey and the follow-up examination, and pulmonary function tests also did not significantly change (Table 4). Pulmonary function follow-up showed an increase in FEV1 (change in FEV1 between the first examination and follow-up: 0.17 ± 0.28 l for male and 0.01 ± 0.18 l for female) different than changes expected by age (0.10 ± 0.21 for male and 0.05 ± 0.10 for female, respectively). There was no significant difference in the prevalence of respiratory symptoms between the first and the second survey, also when subjects or groups with different smoking habit, atopy, or type of jobs were considered (data not shown).

Analysis of the occupational exposure during the year of follow-up showed a very skewed distribution of the type of the exposure; the only trend we observed was an increase in the prevalence of asthma-like symptoms in shoe makers between first observation and follow-up (from 17.2 to 19.8% for wheezing, from 4.7 to 5.9% for

Table 2 Estimated odds ratios (and confidence intervals) for the prevalence of respiratory symptoms and functional abnormalities by smoking habit, gender, age, atopy, family history, and personal history of allergic or respiratory diseases

	Smoking ^a	Gender	Age	Atopy	Family history	Personal history
Any cough	6.2(1.7–22.5) <i>P</i> = 0.05	0.5(0.1–1.8) <i>P</i> = 0.3	1.6(0.4–5.8) <i>P</i> = 0.5	1.9(0.5–6.8) <i>P</i> = 0.3	0.3(0.1–1.2) <i>P</i> = 0.09	0.2(0.06–0.7) <i>P</i> = 0.015
Any phlegm	5.9(1.4–26) <i>P</i> = 0.02	0.6(0.1–2.6) <i>P</i> = 0.5	0.9(0.2–3.6) <i>P</i> = 0.8	2.6(0.6–11.3) <i>P</i> = 0.2	0.4(0.1–1.7) <i>P</i> = 0.2	0.2(0.04–0.7) <i>P</i> = 0.02
Wheezing	1.5(0.7–2.9) <i>P</i> = 0.2	0.99(0.5–1.9) <i>P</i> = 0.9	0.7(0.4–1.3) <i>P</i> = 0.3	1.7(0.9–3.2) <i>P</i> = 0.09	1.0(0.5–1.9) <i>P</i> = 0.9	0.1(0.1–0.3) <i>P</i> < 0.001
SOBWHZ	0.8(0.2–3.0) <i>P</i> = 0.8	6.3(1.4–27.3) <i>P</i> = 0.013	2.5(0.8–8.0) <i>P</i> = 0.12	8.0(2.4–26.2) <i>P</i> = 0.001	0.4(0.1–1.2) <i>P</i> = 0.13	0.03(0.01–0.1) <i>P</i> = 0.001
Rhinitis	0.6(0.2–1.5) <i>P</i> = 0.3	1.7(0.7–3.8) <i>P</i> = 0.2	2.0(0.9–4.5) <i>P</i> = 0.08	12.5(5.2–30.2) <i>P</i> < 0.001	0.6(0.3–1.3) <i>P</i> = 0.2	0.5(0.2–1.1) <i>P</i> = 0.08
Dyspnea	6.9(0.3–161) <i>P</i> = 0.2	0 <i>P</i> = 0.9	3.0 (0.3–89) <i>P</i> = 0.9	1.8(0.08–43.9) <i>P</i> = 0.6	0 <i>P</i> = 0.9	0.1(0.05–3.0) <i>P</i> = 0.2
Asthma ^b	1.6(0.4–5.7) <i>P</i> = 0.5	3.1(0.8–11.6) <i>P</i> = 0.09	0.5(0.1–1.8) <i>P</i> = 0.3	12.7(3.1–51.8) <i>P</i> < 0.001	0.4(0.1–1.5) <i>P</i> = 0.2	0 <i>P</i> = 0.7
FEV1(LQ)	0.7(0.4–1.4) <i>P</i> = 0.4	0.2(0.1–0.3) <i>P</i> < 0.001	0.7(0.4–1.1) <i>P</i> = 0.2	1.3(0.7–2.3) <i>P</i> = 0.3	1.4(0.8–2.4) <i>P</i> = 0.2	0.9(0.4–1.7) <i>P</i> = 0.7

Reference groups: non smokers, female, lowest quartile of age distribution, non atopic, no family/personal history

LQ Lowest quartile

^aCurrent + ex smokers

^bcurrent + previous

SOBWHZ, and from 3.9 to 6.0% for asthma, *N* = 128, all *P* < 0.1). The other groups of risk factors were much too heterogeneous and included small number of subjects. The analysis of the reported occupational exposures to dusts, chemicals or fumes showed that males

were equally exposed to dusts and chemicals/fumes, while females were mainly exposed to chemicals/fumes (Table 5). Very few subjects (< 5%) had used personal protective devices.

When the prevalence of respiratory symptoms in both surveys was considered, incident cases were more frequent than corresponding remittent cases for most respiratory symptoms (Table 6), although a significant difference was obtained only for phlegm and a trend for SOBWHZ and asthma. When different risk factors for the incidence of respiratory symptoms were considered in a logistic regression analysis, incident cases for cough (*P* = 0.07), phlegm (*P* = 0.07) and SOBWHZ (*P* = 0.02) were associated with atopy, while incident cases for wheezing (*P* = 0.004) were significantly associated with the smoking habit.

Table 3 Comparison of respiratory symptoms and functional abnormalities prevalence between drop-outs subjects (DO) and subjects examined at follow-up (FU), after 1 year occupational exposure

	DO	FU	P
Number	204	244	
Age (years, M ± SD)	17.3 ± 1.7	16.5 ± 1.4	0.001
Gender			
Males	64.7 (132)	46.7 (114)	0.001
Females	35.3 (72)	53.3 (130)	
BMI (M ± SD)	22.2 ± 2.9	21.7 ± 3.1	0.1
Any cough	2 (4)	3.7 (9)	0.4
Chr. Cough	1 (2)	2 (5)	0.5
Any phlegm	1.8 (4)	2.1 (5)	0.6
Chr. phlegm	1 (2)	1.2 (3)	0.9
Wheeze	12.3 (25)	14.8 (36)	0.5
SOBWHZ	6 (12)	5.5 (13)	0.8
Rhinitis	10.3 (21)	8.7 (21)	0.6
Asthma			
Current	2.5 (5)	8 (3.4)	0.8
Previous	5 (10)	3.8 (9)	
Never	92.5 (184)	92.8 (219)	
Dyspnea	0.5 (1)	0.4 (1)	0.7
Smoking habit			
Current	34.8 (71)	21.3 (52)	0.001
Ex	3.4 (7)	0.8 (2)	
No	61.8 (126)	77.9 (190)	
FVC (% pred, M ± SD)	105.5 ± 11	104.8 ± 10.9	0.5
FEV1 (% pred, M ± SD)	116.8 ± 14.4	114.3 ± 13.1	0.08
Atopy	27.6 (43)	31.8 (76)	0.4

Data are reported as percentages (absolute numbers in parenthesis) or as mean ± standard deviations (M ± SD)

Discussion

This study shows that in young apprentices the prevalence of asthma-like symptoms, smoking habit and atopy are higher in males than in females. Respiratory symptoms slightly increased during the first year of occupational exposure to irritants or sensitizers, with a significant higher number of incident cases for phlegm than remittent cases. This trend was not associated with a particular occupational exposure, also due to the heterogeneity of the occupational exposure and to the high rate of dropout.

Many epidemiological studies in the last few years have provided data on the prevalence of respiratory symptoms and diseases, and recently particular attention has been given to the increased frequency of asthma, especially in children and in subjects aged less than 25 years (Viegi et al. 1991). Compared with another young population studied with the same technique

Table 4 Comparison of respiratory symptoms and functional abnormalities prevalence between male and female apprentices at the first (I) and the second (II) survey, after 1 year occupational exposure

	Males		<i>P</i>	Females		<i>P</i>
	I° survey	II° survey		I° survey	II° survey	
Number	114	114		130	130	
Age (years, M ± SD)	16.4 ± 1.6	17.6 ± 1.5		16.6 ± 1.3	18.0 ± 1.5	
BMI (M ± SD)	22.2 ± 2.9	22.3 ± 3.5	0.8	21.2 ± 3.2	21.4 ± 3.4	0.5
Any cough	3.5 (4)	5.3 (6)	0.4	3.8 (5)	5.4 (7)	0.4
Chronic cough	1.8 (2)	2.7 (3)	0.8	2.3 (3)	3.1 (4)	0.8
Phlegm	1.8 (2)	5.3 (6)	0.1	2.3 (3)	4.6 (6)	0.2
Chronic phlegm	—	0.9 (1)	0.2	2.3 (3)	2.3 (3)	0.2
Wheeze	17.5 (20)	21.2 (21)	0.3	12.3 (16)	12.3 (16)	0.6
SOBWHZ	11.0 (12)	14.3 (16)	0.3	0.8 (1)	1.6 (2)	0.5
Rhinitis	12.4 (14)	15.9 (18)	0.3	5.4 (7)	8.5 (11)	0.2
Asthma						
Current	6.4 (7)	4.5 (5)		0.8 (1)	1.7 (2)	
Previous	5.5 (6)	10.8 (12)	0.3	2.4 (3)	1.7 (2)	0.7
Never	88.1 (96)	84.7 (94)		96.9 (123)	96.7 (117)	
Dyspnea	—	0.9 (1)	0.5	0.8 (1)	2.3 (3)	0.4
Smoking habit						
Current	24.6 (28)	40.4 (46)		18.5 (24)	26.2 (34)	
Ex	—	4.4 (5)	0.02	1.5 (2)	4.6 (6)	0.09
No	75.4 (86)	55.3 (63)		80.0 (104)	69.2 (90)	
FVC (% pred, M ± SD)	102.6 ± 0.10	102.0 ± 0.1	0.7	106.8 ± 0.1	106.2 ± 0.2	0.4
FEV1(% pred, M ± SD)	118.9 ± 0.13	120.0 ± 0.11	0.2	110.2 ± 0.11	108.0 ± 0.11	0.2
Atopy	40.9 (45)			24.0 (31)		

Data are reported as percentages (absolute numbers in parenthesis) or as mean ± standard deviations (M ± SD). Missing data for some answers to the questionnaire are not reported

during an epidemiological survey conducted in the same area (Viegi et al. 1999), in the present study, young apprentices showed a lower prevalence of most respiratory symptoms, suggesting an early health-related selection during apprenticeship (Tarlo 2000). Another explanation for the relatively low prevalence of respiratory symptoms in this population can be the possibility for subjects to hide respiratory symptoms at the pre-employment examination in order to avoid exclusion from work. Similarly, an overestimation of the reported respiratory symptoms at follow-up was unlikely in our population, which did not know the final aim of the study and which was dependent on the second medical examination for retaining the job.

As in the previous studies (Viegi et al. 1999; Laor et al. 1993; Anderson et al. 1992) evaluating the distribution of symptoms by gender in groups with different age, asthma-like symptoms were significantly higher in young males compared to young females. In accordance with other findings (European Community Respiratory Health Survey 1996), our data show that atopy and smoking habit were related to higher prevalence of respiratory symptoms; in particular atopy was associated with symptoms of asthma, whereas smoking was significantly associated with chronic cough, chronic phlegm, and wheeze.

During the follow-up there was no significant change in the prevalence of respiratory symptoms, even though there was a trend to increase the prevalence of almost all the respiratory symptoms as well as the smoking habit. The increase in asthma-like symptoms did not show any

significant correlation with the type of occupational exposure, except in shoe-makers. The possible explanation for this finding includes an incorrect definition of occupational respiratory hazards, the high number of

Table 5 Frequencies of the reported exposures to occupational agents during the first year of apprenticeship, among apprentices subdivided in males and females

	Males		Females	
	(N)	(%)	(N)	(%)
Dusts	81	41.3 ^a	19	10.2 ^a
Silice	1	1.0 ^b	2	1.8 ^b
Asbestos	5	5.1	2	1.8
Glass fibers	11	11.2	—	—
Wool	2	2.0	—	—
Wood dusts	2	2.0	—	—
Iron dusts	4	4.1	—	—
Berillium	4	4.1	—	—
Talc	1	1.0	—	—
Zinc dusts	23	23.5	—	—
Graphite	26	26.5	—	—
Other dusts	2	2.0	15	13.6
Chemicals/fumes	70	35.7	82	44.1
Gas	29	29.4	4	3.6
Solvents	35	35.7	66	60.0
Acids	4	4.1	12	10.9
Insecticides	2	2.0	—	—
Others	45	22.3	85	45.7
Total exposure ^c	196	100	186	100

^aPercentage on all exposures

^bPercentage on each group of exposure

^cAll exposures reported by subjects at follow-up

Table 6 Comparison between remittent and incident cases at the follow up

	Cough	Phlegm	Wheezing	SOBWHZ	Asthma
Remittent cases	(5) 2	(2) 0.8	(14) 6	(2) 0.8	(2) 0.8
Incident cases	(9) 3.8	(9) 3.8	(18) 7.9	(7) 3.1	(7) 3
<i>P</i>	0.2	0.03	0.3	0.09	0.09

Data are reported as percentages (absolute numbers in parenthesis) or as mean $\pm$ standard deviations (M $\pm$ SD)

workers who dropped out and the short period of follow-up. In fact the occupational risk was assessed on the basis of the type of job referred to by the subject, without any measurement of the level of exposure to different compounds in the workplace. The heterogeneity of occupational exposure in our sample (in comparison with results obtained by other authors who have considered homogeneous and well-selected populations) (Renstrom et al. 1995; Archambault et al. 2001; Gautrin et al. 2002) could have reduced the effectiveness of the study. A high number of dropouts in our study can justify the lack of significant increase in respiratory symptoms during follow-up. We can speculate that a higher number of subjects with occupational-induced increase in respiratory symptoms (particularly subjects exposed to sensitizers) could be represented as apprentices lost at follow-up (Zhong et al. 2002). On the other hand, Monso' et al. (2000) suggested that health-related self-selection during an apprenticeship with exposure to high-molecular-weight agents is likely to occur and to cause a bias. Finally, 1 year is a short period of time to develop occupationally induced respiratory symptoms, and a longer follow-up might have obtained better results.

There are some follow-up studies in subjects exposed to respiratory sensitizers. Some of these studies are conducted among a small section of apprentices examined and the subjects are frequently exposed to an homogeneous hazard (De Zotti and Bovenzi 2000; Kennedy et al. 1999; Monsò et al. 2000); in these cases the authors observed an increased skin reactivity to occupational agents but a slight or no change in the prevalence of respiratory symptoms, as observed in our study. More recently, other studies have evaluated the incidence of respiratory symptoms and allergic sensitivity in large samples of apprentices exposed to laboratory animals (Gautrin et al. 2002) or to latex (Zhong et al. 2002), showing a moderately high incidence of specific allergic sensitization or respiratory symptoms in these subjects exposed to well-selected occupational allergens. The lower prevalence of incident cases in our study could be due to the heterogeneity of occupational exposure, in comparison with the exposure to well-known and selected occupational sensitizers.

Results from analysis of incident cases indicate that, for some respiratory symptoms (e.g. phlegm and asthma), symptoms were higher than remittent cases. This fact is unlikely to be ascribed to the different age of the subjects between two observations, because many epidemiological

studies have reported a decrease in asthma prevalence in this range of age, prevalence of asthma being higher between 10 and 14 years and decreasing in the following age groups (Dodge and Burrows 1980). Thus, this mild increase in respiratory symptoms could be related to the beginning of occupational exposure. With the limit of the small number of incident cases, statistical analysis has shown that incidence of some respiratory symptoms in the first year of occupational exposure is related with atopy and smoking habit.

The surveillance programs have greatly improved our understanding of early occupational injuries. Little is known, however, about the extent to which apprentices experience acute or chronic illness as a result of work-related exposures. The potential of greater susceptibility among young workers, the effects of age at first exposure, and the combined effects of multiple exposures over a working lifetime raises the important issue of implementation of policy considerations about the acceptable health risks for working youth people. Pre-employment screening can be an important medical surveillance but also a useful source of medical information and also provides an opportunity for counseling.

In conclusion, respiratory symptoms slightly increase in young apprentices over 1 year of exposure to occupational irritants or sensitizers, suggesting a negative effect of occupational exposure on the airways. The loss at the follow-up of subjects with higher smoking habit suggests a small "health-worker effect" and could underestimate the effect of occupational exposure in apprentices.

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