



Work-related asthma in a sample of subjects with established asthma



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ABSTRACT

Objective: To assess the impact of occupational exposure to irritants or sensitizers on the occurrence, recrudescence and worsening of asthma and to identify unrecognized cases of work related asthma (WRA) including Work-Exacerbated Asthma (WEA) and Occupational Asthma (OA), in a general asthma clinic population sample.

Setting, design and participants: The study was a population-based cross sectional survey. 1289 asthmatic subjects (from 15 to 46 yrs old) living in a vast district of Tuscany (Italy) were identified from the Medical Reimbursement Register of the National Health System. 893 subjects agreed to take part in the study. Subjects who were currently working or had worked in past were classified in different categories of occupational risk exposure (No, Low or High) according to the Italian standard classification for industries and job titles, associated with the judgment of occupational hygiene experts.

Results: 41% of subjects worked in industries and in job titles at risk for exposure to airway irritants and/or sensitizers, 48.6% reported an occupational exposure to gases, dust and fumes, more males than females. Prevalence of WEA and OA was higher in subjects who worked at higher risk exposure; these subjects reported a higher prevalence of markers of asthma severity (asthma control, level of treatment, FEV1) than subjects without WRA. Risk of WEA was significantly associated to female gender, older age, and self-reported exposure, while risk of OA was associated to job title with higher exposure risk to occupational asthmogens.

Conclusions: Our study shows a high prevalence of WRA (especially WEA) associated with employment in industries and job titles at risk for airways sensitizers and/or irritants; data also support a role for occupational exposure in determining a poor asthma control and a higher level of asthma severity.

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1. Introduction

Asthma is common among adults in Europe, and its prevalence (about 7%) has markedly increased in recent decades [1], thus posing now a major public health problem and a frequent cause of disability at work. It is therefore of paramount importance to identify modifiable risk factors for this disorder. Epidemiologic evidence suggests that most variations in the prevalence of asthma

are due to environmental more than to genetic factors. Approximately 5–20% of cases of adult asthma are attributable to occupational factors, which is consistent with a role for work in initiating asthma [2,3].

The associations between occupational exposure and asthma is probably underestimated because the prevalence of work related asthma (WRA) – which includes occupational asthma (OA) specifically caused by occupational sensitizers or irritants, and work-exacerbated asthma (WEA), in which pre-existing asthma is made worse by work – has not been well defined, due in part to variable definitions, diagnostic criteria, and work settings, as well as incomplete surveillance data. The awareness of magnitude and

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management of WRA nevertheless highlights a significant potential for the primary prevention of new cases and the secondary and tertiary prevention of disease progression and disability [4].

Large population-based studies could provide deeper insight into the extent and the characteristics of WRA. To date surveillance systems usually underestimate these features and only a few population-based studies have previously estimated occupation-specific risks of asthma [3,5–7], showing large discrepancies in the prevalence of work-related asthma.

The aim of this study was to assess the impact of occupational exposure on the occurrence, recrudescence and worsening of asthma, and to identify unrecognized cases of WRA in a general asthma population sample. As opposed to previous study protocols [8–10], we enrolled subjects with a clinically well-established diagnosis of asthma, as derived from the national health service record of patients with medication reimbursement for asthma. This record includes all patients with a diagnosis of asthma performed by a pulmonary specialist according to standard criteria (GINA report, update 2011), in order to have free access to asthma evaluation over time and treatment, as appropriate. For this purpose, we investigated in this group of young asthmatic subjects the potential influence of the work exposure on asthma symptoms and severity.

2. Subjects and methods

2.1. Study population

The study was a population-based cross sectional survey. During the year 2008, 1289 asthmatic subjects (from 15 to 46 yrs old) living in a vast district of Tuscany (Italy) of about 400.000 inhabitants, were contacted by telephone and invited to a medical examination. The cases were identified from the Medical Reimbursement Register of the National Health System and all those who had received the special reimbursement right for asthma investigations and medications at the end of 2007 and were alive were selected.

Eight hundred ninety three subjects agreed to take part in the study. Six hundred eighty four respondents (76.6%) were currently in full time employment, 82 (9.1%) had retired and 127 (14.2%) were unemployed. The analyses of this paper were restricted to the 684 subjects who were currently in full-time employment.

The data reported are related to the investigations performed in the medical examination in the Occupational Health Clinic. This included a detailed questionnaire exploring asthma and work characteristics, spirometry, level of pharmacologic treatment and asthma control.

2.2. Questionnaire

A trained survey investigator administered to all subjects a standardized computer assisted questionnaire, which collected informations on the demographic characteristics, smoking history, global health status, asthma severity, pharmacologic therapy, work history and current work status [11,12]. The questionnaire was specifically developed for this study and was based on existing instruments [13–15]. The questionnaire required 15–20 min to complete.

Specific sections addressed asthma management, symptoms timing and severity, career choice and history, and demographic and socioeconomic data. Asthma history and management-related variables included identification of asthma care providers, allergies, rhinitis and/or eczema, asthma triggers, smoking history, medication use and the perceived impact of asthma on daily life. Asthma

control assessment was based on GINA criteria [16], and included frequency of weekly nocturnal awakening due to asthma, day-time asthma symptoms, activity limitation related to asthma, short-acting bronchodilator use, and number of exacerbations in the previous 12 months.

Respondents were asked about the occurrence and the frequency of asthma symptoms caused or worsened by work, whether in the current job or in the past. Occupational specific variables included knowledge of occupational factors that may aggravate asthma and the impact of asthma in occupational career. Current and past occupations of the respondents was coded in two different ways: 1) according to the 2007 “ATECO” statistical classification (Nomenclature “Attività ECONomiche”) of the Italian National Institute of Statistic (ISTAT), national version of european statistical classification of economic activities “Nace Rev. 2”, to categorize economic sectors; 2) according to 2001 Italian ISFOL (Istituto per lo Sviluppo della Formazione Occupazionale dei Lavoratori, which means Institute for the Development of Vocational Training of Workers) classification, based on the International Standard Classification of Occupations (ISCO) used by the European Community, to categorize job titles. In addition, a subjective assessment of the type and severity of current occupational exposure to gas, fumes and dusts (GFD) was asked.

Using national classifications of industry and job titles, occupational exposure to possible asthma triggers/sensitizers (asthmogens) of each referred industry and job titles was thereafter classified as None, Low or High, according to the opinion of 3 experts familiar with both local and national exposures at work (Appendix 1). Self reported exposure to dusts, gases, and fumes in the current occupation was estimated by the response to the following question: “Are you exposed to dusts, gases, or chemical fumes ?” (presence/absence).

2.3. Assessment of work-related asthma (WRA), work exacerbated asthma (WEA) and occupational asthma (OA)

According to the American College of Chest Physicians Consensus Statement (4), Work-related asthma (WRA) includes occupational asthma (OA) and Work-exacerbated asthma (WEA). OA refers to asthma caused by occupational exposure to specific sensitizers or irritants. WEA, unlike OA, is not initially brought about by occupational exposures, and is defined as pre-existing or concurrent asthma that is worsened by workplace conditions [15].

Subjects answering “Yes” to at least one of the 7 questions in Appendix 2 were categorized as having WRA. Subjects with suspected OA (according to age of onset of asthma symptoms, occupational exposure to well-known sensitizers, and positive response to item questions no. 4 and/or no. 5 of Appendix 2) underwent further investigations (full history collection, methacholine challenge test, specific challenge test when available, PEF monitoring in and out of work), and defined as affected by OA on the basis of the final judgment of a panel of experts (new diagnoses of OA). In addition, subjects with a previous diagnosis of OA already accepted by the Italian National Work Insurance Institute on the basis of specific examinations performed in a specialized asthma clinic, and subjects with a history suggestive of OA in relation to an earlier work and who have lost their previous job due to asthma (question no. 6 of the Appendix) were also placed in OA category (established diagnoses of OA).

2.4. Pulmonary function tests

Spirometry with assessment of forced expiratory volume in 1 s

(FEV₁) and slow vital capacity (VC) was carried out according to published standards [17] using a computerised water-sealed spirometer (Biomedin, Padova, Italy) using predicted values approved by the European Respiratory Society. In subjects with airflow obstruction (FEV₁/VC < 88/89% of predicted), a reversibility test was carried out with salbutamol administration. A significant bronchodilator response was considered when FEV₁ improved > 12% and >200 mL compared with baseline after salbutamol administration [17]. Reference values were derived from Pistelli et al. [18].

2.5. Statistical analyses

Data analysis was performed using a statistical software package the Statistical Package for Social Sciences (SPSS), rel. 13.0. Used routines were frequency distribution, cross tabulations, and logistic regression.

Prevalence of respiratory symptoms are reported as percentages. FEV₁ is expressed as mean (SD). Statistical significance of the unadjusted differences in prevalence of symptoms between groups in contingency tables was assessed by chi² analysis, while the comparison among continuous variables was assessed by unpaired t-Student test. A p value < 0.05 was considered significant, and a p value between 0.1 and 0.05 was considered suggestive of a trend.

Logistic regression was used to analyse the effects of potential factors (independent variables: sex, age, smoking habit, risk exposure) on the dependent variables (WEA and OA). The results are given in terms of odds ratios (ORs) with 95% confidence intervals (95% CI). Dependent and independent categorical variables were binary (0 = absence, 1 = presence of the condition); then, reference categories were: male for gender, non-smoker or ex-smoker for smoking habit, no or low risk for exposure categories. The only continuous variable (age) was transformed into a categorical variable with the quartile distribution, with the highest quartile being associated with the presence of the condition.

3. Results

Table 1 shows demographic and asthma characteristics of the 684 asthmatic with a full-time employment. At the time of the examination, the mean age of these subjects was 34.5 ± 7.2 years. In 40% about of subjects, the onset of asthma was before 16 years of age (which is the usual age of beginning of apprenticeship in Italy); this percentage was greater for males than females. In more than ¾ of the examined subjects, asthma resulted in a good or partial control; asthma control was significantly poorer among females, despite a higher level of asthma treatment (particularly oral corticosteroid use). There was no difference in pulmonary function between male and female subjects, except for a higher number of subjects with lower FEV₁/VC in males than females.

As regards work exposure, 41% of subjects worked in industries and in job titles at risk for exposure to airway irritants and/or sensitizers, and 48.6% reported an occupational exposure to gases, dusts and fumes. As expected, more males than females worked in industries and in job titles at higher risk (Table 2). Subdividing subjects by occupational risk exposure, most subjects were occupied in no risk work activities. The subjective assessment of GFD presence at work was reported by 50% about of the examined subjects. No differences were found among groups with different risk level as for age, smoking habits, level of asthma control and level of antiasthma treatment. Subjects with FEV₁ < 80% predicted

Table 1

Demographic and asthma characteristics of the 684 asthmatic with a full-time employment who participated to the study. Data are reported as absolute number (%) or as mean ± standard deviation (M±SD).

	Total	Males	Females	
Subjects n.	684	334 (48.8)	350 (51.2)	
Age (M±SD)	34.5 ± 7.2	33.8 ± 7.4	35.1 ± 6.9	
BMI	24.8 ± 4.9	25.0 ± 4.0	24.5 ± 5.5	
Current Smokers	145 (21.3)	76 (22.8)	69 (19.9)	
Ex Smokers	135 (19.8)	65 (19.5)	70 (20.2)	
Onset of asthma				
<16 yrs	280 (40.9)	162 (48.5)	118 (33.7)	*
Current therapy				**
No therapy	181 (26.5)	93 (27.8)	88 (25.1)	
SABA prn	108 (15.8)	59 (17.7)	49 (14.0)	
ICS or LTRA	102 (14.9)	52 (15.6)	50 (14.3)	
ICS/LABA or ICS/LTRA	261 (38.2)	122 (36.5)	139 (39.9)	
Oral GC	32 (4.7)	8 (2.4)	24 (6.9)	
FEV ₁				
L (M±SD)	3.44 ± 0.82	3.97 ± 0.69	2.93 ± 0.58	
% pred (M±SD)	97.97 ± 16.30	98.17 ± 16.52	97.78 ± 16.11	
FEV ₁ <80%	71 (11.5)	35 (11.6)	36 (11.4)	
FEV ₁ /VC < 88/89%pred	103 (16.5)	79 (25.7)	24 (7.5)	**
BD responders	79 (15.2)	42 (15.9)	37 (14.5)	
Level of control (GINA)				**
Well controlled	157 (24.2)	85 (27.1)	72 (21.5)	
Partly controlled	341 (52.5)	173 (55.1)	168 (50.1)	
Uncontrolled	151 (23.3)	56 (17.8)	95 (28.4)	

BMI: body mass index.

SABA: short-acting beta2-agonists.

ICS: inhaled corticosteroids.

LABA: inhaled long-acting beta2-agonist.

LTRA: leukotriene receptor antagonists.

FEV₁: forced expiratory volume in the first second; FVC: forced vital capacity.

BD: bronchodilator.

*p < 0.05 **p < 0.01 between male and female.

were more represented in the groups with low or high risk industries and with low or high risk job titles in comparison with subjects with no occupational risk. This was not observed when the subjective assessment of GFD exposure was considered. A positive bronchodilator test was observed more frequently (although not statistically significant) in subjects with higher level of occupational risk.

Considering the prevalence of WRA, WEA and OA within the three categories of occupational risk according to industry, job title risk classification and self-reported occupational risk exposure (Fig. 1), the prevalence of WEA and OA was higher in subjects who worked at higher risk exposure, mainly if industry classification or job title risk classification were considered (chi square test: 19.5, p < 0.001 and 31.3, p < 0.001, respectively in ATECO and ISFOL classifications). In the self-reported occupational risk exposure, only WEA was more prevalent in subjects who reported a positive risk (chi square test: 18.2, p < 0.001).

Occupational asthma was diagnosed in 49 subjects: in 30 of them, the disease had been already diagnosed at the time of our study (see methods) (by diisocyanates in 15 subjects, by wood dusts in 3, by persulphate salts in 4, by azyridine in 1, by latex in 2, and by flour dust in 5). Thirteen subjects reported to have developed asthma symptoms at the beginning of a new job, having left job for that (flour dust in 4, wood dust in 2, diisocyanates in 4, and hair-dressing materials in 3), while 6 subjects were diagnosed as affected by occupational asthma at the time of our study (latex in 1, flour dust in 1, diisocyanates in 3, and azyridine in 1).

Subdividing subjects in those with OA, WEA or without WRA (Table 3), adult onset asthma tended to be more prevalent in

Table 2
Demographic and asthma characteristics of the 684 subjects with asthma currently employed full time subdivided by their actual exposure of occupational risk factors (according to industry, job title risk classification and to self reported occupational risk exposure).

	ATECO			ISFOL			GFD	
	No risk	Low risk	High Risk	No Risk	Low Risk	High Risk	Absence	Presence
N.	403 (58.9)	191 (27.9)	90 (13.2)	413 (60.4)	140 (20.5)	131* (19.1)	338 (49.4)	320 (46.8)
Sex (M/F)	186/217	94/97	54/36	191/222	65/75	78/53*	160/178	165/155
Age (M + SD)	34.3 + 7.36	34.6 + 7.01	35.4 + 6.9	34.08 + 7.14	34.95 + 7.33	35.53 + 7.21	34.39 + 6.96	35.0 + 7.25
Smoking habit Curr.smokers (%)	19.4	25.0	22.2	18.5	22.9	28.5	19.6	23.2
Ex smokers (%)	19.6	20.2	20	18.7	20.7	22.3	19.0	20.7
Asthma control (%)								
Well contr.	24.6	23.3	24.1	26.0	20.6	22.4	26.5	22.6
Part. contr.	52.1	55.6	48.3	53.6	52.9	48.8	55.1	48.7
Uncontr.	23.3	21.1	27.6	20.4	26.5	28.8	18.4	28.7
Therapy (%)								
None	27.0	27.2	22.2	28.8	23.6	22.1	26.3	24.4
SABA	17.1	15.7	10.0	17.7	15.0	10.7	16.6	15.0
ICS or LTRA	13.6	15.2	20.0	14.5	15.0	16.0	13.6	17.2
ICS/LABA	37.5	37.7	42.2	36.6	40.0	41.2	38.5	39.1
Oral CS	4.7	4.2	5.6	2.4	6.4	9.9	5.0	4.4
FEV1<80%	8.6	16.1	15.6*	8.6	16.1	15.6*	10.7	12.2
FEV1/VC	15.4	17.5	18.7	15.4	17.5	18.7	14.4	19.1
< 88/89%p								
BD responders	12.1	19.5	19.6	12.1	19.5	19.6	13.4	16.1

\$ missing data for 26 subjects.

SABA: short-acting beta2-agonists.

ICS: inhaled corticosteroids.

LABA: inhaled long-acting beta2-agonist.

LTRA: leukotriene receptor antagonists.

FEV1: forced expiratory volume in the first second.

FVC: forced vital capacity.

BD: bronchodilator.

*: $p < 0.05$.

subjects with OA and WEA; these subjects had also a higher level of asthma therapy. Subjects with WEA or OA reported a higher prevalence of poor asthma control than subjects without WRA; furthermore, they reported a greater use of step 4–5 treatments for asthma. FEV1 was lower in OA with respect to other subjects.

We analyzed by logistic regression analysis the risk of WEA and OA by age, sex, smoking habit and self reported or expert evaluated occupational exposure in current job. Data showed that risk of WEA was significantly associated to female gender, greater age group, and self-reported exposure to GFD presence, while the risk of OA was associated to job title with a higher exposure risk to occupational asthmogens (Table 4).

4. Discussion

Our study document a high prevalence of WRA (especially WEA) associated with employment in industries and job titles at risk for airways sensitizers and/or irritants, among young adults with asthma certified by pulmonary specialists, especially those with adult-onset asthma. Self reported or expert-evaluated exposure to dusts and chemicals significantly explained the occurrence and the worsening of WRA. Subjects with WEA and OA had a poorer asthma control according to GINA, which in turn was associated to a higher functional impairment and level of asthma treatment.

The subjects included in our study are an unselected sample of young patients with a diagnosis of asthma, according to the Medical Reimbursement Register of the National Health System. All levels of asthma control and severity were included. The poor level of asthma control observed in our sample is in agreement with several previous real-life observations, showing that in subjects selected from the general population and not from patients attending to

asthma clinics, the asthma control is really poor in Italy [19,20]. It is not unusual also to observe in these unselected population that regular use of oral corticosteroids is often recommended before the optimization of the treatment with inhaled drugs (high dose ICS, LABA and/or LAMA). The reasons for this poor implementation of Asthma Guidelines in general practise are several, in part due to poor attention of the General Practitioners to the measurement of the level of asthma control [21] and in part due to a poor perception of the patients to their symptoms.

The prevalence of WRA has not been well defined due in part to variable definitions, diagnostic criteria, and work settings, as well as unsatisfactory surveillance criteria. The incidence of OA has been difficult to measure with accuracy, and OA surveillance data vary widely in case capture, underestimating the true extent of the issue. As much as 25% of adult asthmatic patients are estimated to have WRA, which would include WEA as well as OA [22,23]. In other studies of patients in whom WRA has been diagnosed, the proportion of patients with WEA widely ranged from 10 to 50%. Our data obtained in a large group of young asthmatic subjects show a high prevalence of WRA (48%); this is probably due to the demographic characteristics of the population under study, since only young subjects of working age were enrolled.

The large majority of our subjects with WRA were defined as affected by WEA, while only a minority of them could be considered as having OA. The distinction between WEA and OA is difficult in an epidemiological setting, because the diagnostic criteria for occupational asthma may be different in clinical practice. A limitation of our study concern the diagnosis of OA. In effect we included in the definition of OA different groups of subjects: a) subjects who, following the study visit, underwent more detailed investigations (full history collection, methacholine

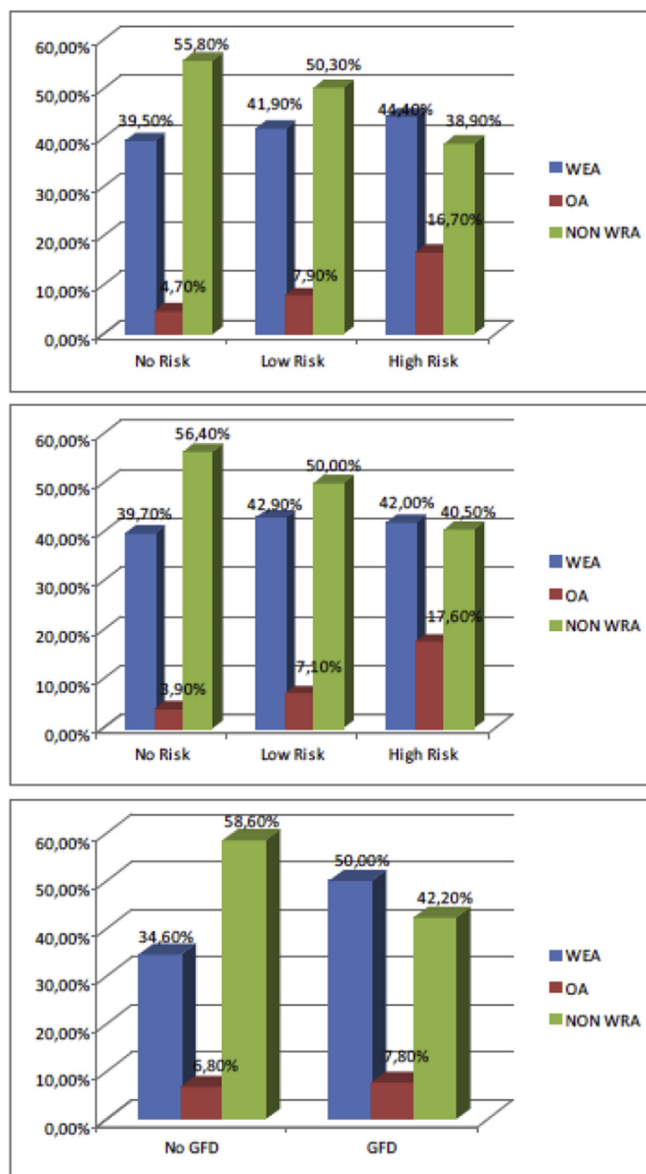


Fig. 1. Prevalence of WRA (WEA and OA) and non WRA within the three categories of occupational risk according to industry (a), job title risk classification (b) and self-reported occupational risk exposure (c).

challenge test, specific challenge test when available, PEF monitoring in and out of work) (new diagnoses of OA); b) subjects with a previous diagnosis of OA already accepted by the Italian National Work Insurance Institute on the basis of specific examinations performed in a specialized asthma clinic, and subjects with a history suggestive of OA in relation to an earlier work and who have lost their previous job due to asthma (established diagnoses of OA). This last situation was reported mainly by young patients who developed asthma symptoms for the first time during the apprenticeship. These criteria are obviously different in terms of diagnostic accuracy, and it is possible that some of the asthma cases defined as WEA had been caused by specific work-related factors. This might suggest that prevalence of OA estimates from this cohort is likely to be conservative, but it was not too much

Table 3

Main clinical and functional characteristics of subjects according to the definition of WRA (WEA and OA) or not.

	No WRA	WEA	OA	P
Subjects	356 (52.0)	279 (40.8)	49 (7.2)	
Age	33.371 ± 7.50	35.71 ± 6.75	36.36 ± 6.24	0.001
Smoking Habit				0.582
Current smokers	22.0	21.6	14.6	
Ex smokers	18.9	21.6	16.7	
Onset of asthma				0.052
<16 yrs	159 (44.7)	107 (38.4)	14 (28.6)	
>16 yrs	197 (55.3)	172 (61.6)	35 (71.4)	
Level of control (GINA) (%)				0.001
Well Controll	34.5	17.0	14.3	
Partly controlled	56.1	51.1	36.7	
Uncontrolled	12.4	31.9	49.0	
Asthma therapy (%)				0.001
No therapy	33.4	18.3	22.4	
Short-acting b2-agonist	15.7	16.8	10.2	
ICS or LTRA	13.2	17.6	12.2	
ICS/LABA or ICS + antileuk.	34.8	40.1	51.0	
Oral GC	2.8	7.2	4.1	
FEV1, L (M±SD)	3.50 ± 0.78	3.35 ± 0.83	3.14 ± 0.77	0.001
FEV1, %p (M±SD)	99.5 ± 16.1	97.6 ± 16.2	89.8 ± 15.6	0.001
FEV1 <80% p	8.5	13.3	21.7	0.015
FEV1/VC < 88/89%p	16.1	16.0	21.7	
BD responders	14.9	14.2	22.5	

Table 4

Logistic regression analysis of risk of WEA and OA by age, sex, smoking habit and self reported or expert evaluated occupational exposure in the current job.

	WEA		p	OA		p
	OR	IC		OR	IC	
Sex	1.4*	(1.1–2.0)	0.038	1.4	(0.7–2.7)	0.354
Age	2.3*	(1.3–3.8)	0.002	2.6	(0.8–8.4)	0.119
Smoking habit	1.2	(0.8–1.6)	0.490	0.5	(0.2–1.3)	0.175
Risk exposure						
by industry	1.3	(0.8–2.4)	0.299	2.0	(0.7–5.4)	0.185
by job title	1.2	(0.7–2.0)	0.503	6.8*	(2.5–18.6)	0.001
by GFD	2.0*	(1.4–2.8)	0.001	1.2	(0.6–2.3)	0.662

*: $p < 0.05$.

different to the prevalence calculated in other cross sectional studies with similar occupational asthma definition [24]. However, the significant increase in the percentage of subjects with OA in the categories with higher risk exposure seems to support the validity of our classification.

Epidemiological studies conducted in general populations indicate that WEA occurs in a substantial proportion of adults with asthma, with a median prevalence of 21.5% (ranging from 13% to 58%) [15]. Nevertheless, few studies have been conducted on the symptoms of asthmatics at work, and the comparison among these studies is difficult because they differ in the definitions of asthma, inclusion/exclusion criteria and concepts of the work-relatedness of asthma. Studies have usually been more focused on the aetiological factors inducing asthma [8,25,26], while few authors [9,27] investigated the role of workplace exposure both in the induction of OA and in aggravating the symptoms of underlying asthma. These studies show a lower prevalence of WEA respect to our survey, but our population and our methods of assessment (e.g. the questionnaire) were different with respect to Tarlo and Saarinen studies. Tarlo studied a clinic population (without an age limit) during a 19-year period, and it is likely that these patients represented a more severe subgroup of asthmatic subjects [9]. On the contrary,

Saarinén carried out a population-based cross-sectional survey of asthmatic subjects (aged 20–65 yrs) and the respondents were asked about the average frequency of work-related asthma symptoms during the last month; these two aspects of the study might have reduced the rate of perception of the work exposure effect [27].

The assessment of work exposure is an important step of our study. In the analyses, the effect of occupational exposure on the aggravation of asthma symptoms at work was assessed according to both self-reported and expert evaluated exposure. Other authors [13,27] used the same self reported estimate of exposure but few authors assessed occupational exposure by experts coding of standard classification of the occupations referred by the asthmatic subjects [28,29]. We demonstrated a significant increase in some markers of asthma severity (asthma control, level of treatment, FEV1) with increasing the risk of exposure to sensitizers and/or irritants in the workplace. As reported in Fig. 1 and demonstrated also by the logistic regression, the expert evaluated exposure was more related to the definition of OA, while the self-reported exposure to GFD was more related to the definition of WEA.

As regards the assessment of work exposure, we defined the level of the risk exposure (no, low or high) without indication of specific occupational compounds, but this was done by a panel of experts according to the knowledge of the specific occupational exposure in our geographic area. This is not different from what has been performed by other authors [28,29]. Furthermore, our expert evaluated exposure was concordant with the self-reported occupational exposure to gas, fumes and dust, therefore reinforcing the accuracy of our evaluation of the exposure.

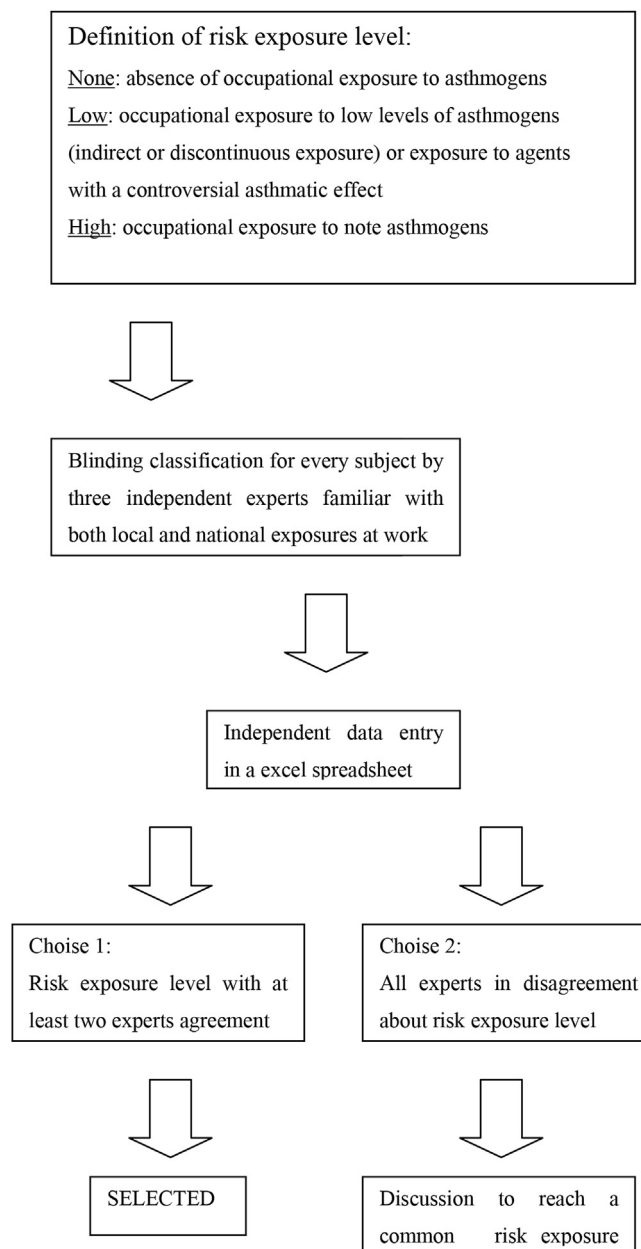
Subjects with WRA showed a greater asthma severity in comparison with subjects without any suggestion of work-related asthma. This fact may be interpreted in different ways: a) occupational exposure may represent significant triggers for asthma symptoms and exacerbations; b) patients with more severe asthma might have an enhanced perception of the adverse effects of the environmental exposure in the workplace. The first hypothesis is in agreement with previous reports showing the impact of occupational exposure on asthma control [26–30], but we cannot exclude also a different attitude of more severe asthmatics towards a greater perception of the effect of the occupational exposure on their asthma symptoms.

When assessing patients of working age who have asthma, the occupational history should be carefully considered, in particular job duties held when the asthma first became manifest. Medical surveillance in high-risk worksites can play an important role in secondary worker-oriented prevention by identifying early cases of WEA. Exposure control policies, such as those of corporate or governmental organizations, can also lead to a reduction in exposures that exacerbated asthma. Intervention studies are required to evaluate the effectiveness of different preventive and management approaches on the development and outcomes of WEA, including such measures as pre-employment advice or career counselling, interventions to reduce work exposures, and strategies to optimize asthma care.

In conclusion, our study performed in a large unselected group of asthmatic subjects shows a high prevalence of WRA (especially WEA) associated with employment in industries and job titles at risk for airways sensitizers and/or irritants, and further support a role of the occupational exposure in determining a poor asthma control and a higher level of asthma severity. This may be useful in order to promote pre-employment advice in asthmatic patients attending to occupational exposure and interventions to reduce work exposures, and to optimize asthma care in these patients.

Appendix 1

Risk exposure classification



Appendix 2

Questions to categorize as having WRA

- 1) Was your asthma ever defined as “work induced asthma”?
- 2) In your opinion, does your current work environment induce a worsening of asthmatic symptoms?
- 3) Do your respiratory conditions improve off work or during your holidays?

- 4) In your opinion, can your current work have an important role in the exacerbations as well as the onset of asthma?
- 5) Can you correlate your symptoms with a specific task, a job title or a section of your current work?
- 6) Did you ever change your job because of asthma?
- 7) Did you ever modify your job in the current company because of asthma?

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