

OCCUPATIONAL ASTHMA IN A HIGHLY INDUSTRIALIZED REGION OF UK: REPORT FROM A LOCAL SURVEILLANCE SCHEME

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Summary

Estimates of the incidence of occupational asthma may be derived from surveillance schemes established in several countries. SHIELD is a voluntary surveillance scheme for occupational asthma in the West Midlands, a highly industrialized region of UK. The aim of this study was to estimate the general and specific incidence of occupational asthma in the West Midlands in 1990-97. The annual incidence was 41.2/million. There was a two fold difference in the incidence by sex (male 59.6/million/yr; female 27.4/million/yr). The highest annual incidence (53.2/million) was observed in the age group 45-64 yr (male) and 45-59 yr (female).

Spray painters were the occupation at the highest risk of developing occupational asthma, followed by electroplaters, rubber and plastic workers, bakery workers and moulders. Although the percentage of reported cases was low among healthcare workers, there was a raising trend. Isocyanates still remained the most common causative agents with 190 (17.3%) out of the total 1097 cases reported to the surveillance scheme in seven years. There was a decrease in the reported cases due to colophony (9.5% to 4.6%), flour & wheat (8.9% to 4.9%). There was an increase of reported cases due to latex (0.4% to 4.9%) and glutaraldehyde (1.3% to 5.6%).

The serial measurement of peak expiratory flow at and away from work was the most used method of diagnosis to confirm the occupational cause of asthma. Specific bronchial challenge test with the occupational agents were used when the serial measurement of peak expiratory flow was not able to confirm undoubtedly the diagnostic suspicion or when it was difficult to identify the possible causative agent due to multiple exposures in the workplace.

Following diagnosis, 24% of the patients were moved away from exposure within the same workplace in 1997, compared to 15.8% in the previous years. Those remaining exposed to the causative agent in the same workplace decreased from 28.3% to 17.7% between 1990-97.

The surveillance of occupational asthma through this voluntary scheme has allowed to monitor the incidence of the disease in the region and to identify clusters of cases, where control measures are a priority

Key-words: Occupational asthma; Incidence; Surveillance scheme

Occupational asthma is one of the most common occupational respiratory diseases in industrialized societies. It is a preventable disease and only an early diagnosis with prompt removal from further exposure to the causative agents is associated with a better prognosis.

Estimates of the incidence of occupational asthma may be derived from surveillance schemes established in several countries. Surveillance schemes based on a legally compulsory reporting of cases exist in countries such as Finland (1,2) and USA (3,4,5). An annual incidence of 175 million was found in Finland in 1990-95 (2) and of 29/million was found in Michigan (USA) in 1988-94 (5). Voluntary surveillance schemes

exist in countries such as UK (6,7), Sweden (8) and Canada (9,10). An annual incidence of 20/million was found in UK in 1989-90 (6) and of 80/million in Sweden in 1990-92 (8). Two studies carried out in Canada showed an annual incidence of 92/million in British Columbia in 1991 (9) and of 79/million (male)-42/million (female) in Quebec in 1992-93 (10). Epidemiological data on occupational asthma (prevalence, risk of disease attributable to occupational exposure) have also been derived from population surveys in Spain (11) and New Zealand (12).

SHIELD is an intensive and voluntary surveillance scheme for occupational asthma in the West Midlands region (UK) (13,14). The main functions of the scheme are to monitor the incidence of occupational asthma in the region and to identify clusters of cases, where control measures are a priority. From a previous study the annual incidence in the West Midlands was

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43/million in 1989-91 (14). The highest figure for specific occupational groups was among paint sprayers (1833/million/yr) and the most common causative agents were isocyanates.

The aims of this study were to estimate the general and specific incidence of occupational asthma in the West Midlands in 1990-97, to identify clusters of cases, to describe the most common causative agents associated with reported cases, to determine methods of diagnosis and the employment state of workers at diagnosis.

METHODS

SHIELD is part of the Midland Thoracic Society Rare Disease Reporting Scheme. All respiratory specialists report cases monthly. For the Shield scheme reports are also retrieved from members of the West Midlands Group of the Society of Occupational Medicine (SOM). The full details of the scheme are given by Gannon et al. (13).

The estimation of the annual incidence was done counting all cases by the year of report starting from 1990 until 1997 and cases who had residence outside the West Midlands were excluded from the study. Data from the Labour Force Survey (15) were used as denominators to calculate the annual incidence by sex, age and specific occupations. Specific occupations were coded according to the Standard Occupational Classification (16). Each occupation was distinguished at the most detailed level of classification with a three digit code.

Details about workplaces, causative agents, methods of diagnosis and employment state of workers at diagnosis were documented in the reporting forms by physicians participating in the scheme.

In May 1995 a postal questionnaire was sent to a sample of physicians taking part in the scheme to access the coverage of the scheme and the attitude toward the scheme from participants.

Diagnosis of occupational asthma was based firstly on a history describing worsening of symptoms on working days compared with weekends or holidays off work. Following the history and physical examination, spirometry pre- and post bronchodilator was assessed within 24 hours of typical workplace exposure or at a time when symptoms were present. If spirometry was normal, then a methacoline challenge was performed, also within 24 hours of typical workplace symptoms, to determine the presence or absence of non specific airway hyper-responsiveness. The relationship of asthma

with work relied mostly on peak expiratory flow (PEF) recordings at work and off work for at least 4-5 weeks. Specific occupational laboratory challenge tests were performed when the serial measurements of peak expiratory flow did not show undoubtedly a work related effect on their value and variability. When feasible, immunological tests like serum radio-allergosorbent (RAST) or enzyme-linked allergosorbent testing (ELISA), were used to identify specific IgE antibodies to a workplace allergen.

RESULTS

CASE REPORTING

Between 1990 and 1997, 948 occupational asthma cases were reported to the scheme and those coming from the West Midlands region were 697. Most cases (62.3%) were reported by the occupational lung disease unit at the Birmingham Chest Clinic. Fig. 1 shows the number of reported cases by year. In 1992-93-94 figures observed were lower than 1990. This was probably due to a high response at the beginning followed by a decrease of reporting, which may be attributed to many factors including: 1) physicians lack of awareness that aggravation of asthma from work exposures is a reportable condition, 2) physicians antipathy and fear of programme that is perceived to involve governmental or legal hassles, 3) physicians workload and demands on time for completing multiple records requirements. Then there was an increase of reported cases in 1995 probably due to the identification of previously unrecognised causes of occupational asthma. A consistent reduction of reported

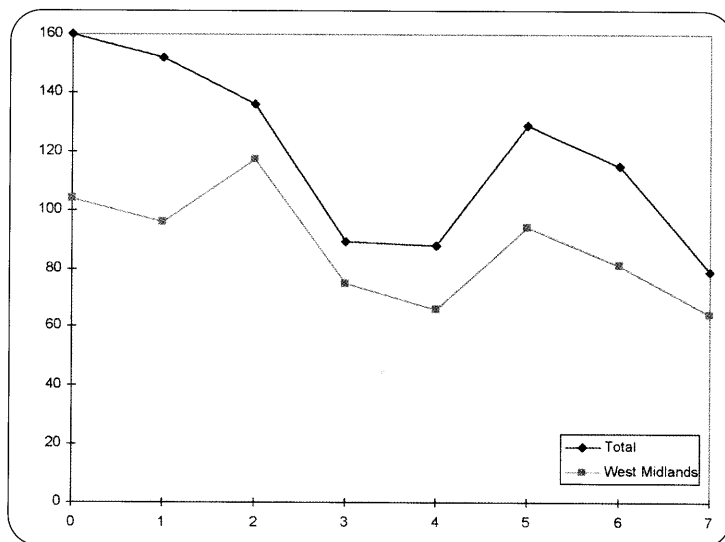


Fig 1 : Number of cases reported to SHIELD by year, from West Midlands and total (also outside this region).

cases was observed in 1997 compared with the previous years. This might have occurred, as we believe, because the data from the surveillance scheme were used for industrial hygiene follow up of workplaces with reported cases, allowing further prevention and control of the disease.

From the postal questionnaire sent to a sample of physicians in May 1995, resulted that the reporting rate was lower than expected. Out of 90 respondents, 31% had reported at least a case for the past 12 months and only 40% had reported every case previously diagnosed.

In several industries clusters of disease were common. Since the scheme was established in 1989, 103 workplaces with clusters of disease were identified. Multiple cases ranged from 2 to 13 (mean 3.98; median 3). Clusters decreased in 1997 compared with the previous years; only two cases were reported from the same workplace and 13 cases were reported from workplaces which had been previously notified to the scheme. In 1996 clusters were identified in 7 workplaces and 20 workplaces had already been reported in the previous years (the figures were respectively 17 and 22 workplaces in 1995, 15 and 12 workplaces in 1994, 18 and 15 workplaces in 1993, 20 and 9 workplaces in 1992, 14 and 5 workplaces in 1991 and 11 workplaces in 1990).

INCIDENCE (SEX, AGE, INDUSTRY, OCCUPATION)

Data from the Labour Force Survey (15) estimated a total number of employees in employment (including self-employed) of 2,087,000 persons in the region. The average annual incidence was 41.2 per million in 1990-97. Tab. 1 shows the incidence by sex and age group. The incidence figure in male (59.6/million) was a two fold greater than that in female (27.4/million). The highest incidence (53.2/million) was observed in the age group 45-64 years (male) and 45-59 years (female). The lowest figure (13.3/million) was amongst the age group 16-24 years.

Table 2 shows general and specific incidence figures calculated from reported cases. The considerable diversity in risk of developing occupational asthma by specific occupation was certainly reflected by their annual incidence rate. The highest annual incidence rates were observed among spray painters

(1135/million), electroplaters (625/million), rubber & plastic workers (528/million), bakers (486/million), and foundry core makers & moulders in the metal manufacture (354/million). An increasing number of cases were being reported in healthcare workers, although the annual incidence in this occupation remained still quite low. Healthcare workers were the most common occupation reported to SHIELD in 1996-97 with 10.8% of the total number of workers, followed by paint sprayers (8.8%), machine tool operatives such as drillers & grinders (7.2%), foundry & core makers (6.2%), electronic solderers & assemblers (5.1%).

CAUSATIVE AGENTS

The most common agents associated with cases of occupational asthma reported to SHIELD by the end of 1997 are showed in table 3. The top 5 causative agents were isocyanates (190 cases), followed by flour & wheat (84 cases), colophony (83 cases), coolants oils (67 cases) and wood dust (49 cases). Other common agents were glutaraldehyde (31 cases), epoxy resin (33 cases) and latex (23 cases). Among metals, a considerable number of cases (24) was due to chrome compounds. Isocyanates, flour & wheat, colophony and coolant oils, which were the original prescribed causative agents, decreased or remained stable in proportion. The new identified agents such as glutaraldehyde and latex were increasing in number.

The intensive surveillance implemented with the scheme made also possible the detection of unusual agents in peculiar circumstances. For example 4 occupational asthma cases due to triglycidyl isocyanurate (TGIC) were reported from one factory where gas fires are assembled. In 5 cases tall oil in a floor cleaner was the causative agent of occupational asthma.

Sex	actual cases	Total number of the population (x 1000)*	Annual incidence (per million)	95% CI
Male	488	1022	59.6	54.3-64.9
Female	209	952	27.4	23.7-31.1
Age group	actual cases	Total number of the population (x 1000)*	Annual incidence (per million)	95% CI
16-24 yr	53	495.2	13.3	10-17.5
25-44 yr	275	1281.6	26.8	23.6-29.9
45-64 yr (male)	344	807.6	53.2	47.6-58.8
45-59 yr (female)				
65+ (male)				
60+ (female)	25	63.6	49.1	31.8-72.5

Table 1 : Incidence of occupational asthma by sex and age group in the West Midlands from the SHIELD Surveillance Scheme (1990-1997).

* Source: Labour Force Survey, Employment Department.

DIAGNOSIS

The most used method of diagnosis was the serial measurements of peak expiratory flow (PEF) as confirmatory test of an history of asthma improving off work or on holiday. Between 1990-96 there were no statistical significant differences among method of diagnosis. In 1997 the serial measurements of PEF and the detection of specific IgE for occupational agents were more used than in the previous years as method of diagnosis of occupational asthma (tab. 4). The assessment of non specific airways responsiveness at work and away from work also increased significantly (tab.4).

EMPLOYMENT STATE

Between 1990-96 there were no statistical significant differences regarding the employment state of workers at diagnosis of occupational asthma. In 1997 approximately one-fifth of workers, increasing from the previous years, were moved away from exposure within the same workplace at diagnosis of occupational asthma (tab.5). Those remaining exposed to the causative agent in the same workplace decreased significantly in

1997 compared to the previous years. Although in 1997 the causative agents were replaced in more workplaces where cases of occupational asthma were identified, the difference was not statistically significant from the previous years. Change of job, early retirement and sick leave occurred also without any relevant difference. The unemployment status did not decrease in 1997 compared to the previous years.

DISCUSSION

The general annual incidence of 41.2 cases per million in 1990-97 was higher than that reported in the whole country by the national surveillance scheme named SWORD in 1989-90 (6). The latest figures from SWORD gave a total number of 1,136 new cases of occupational asthma reported in the UK in 1996 (7). Considering a total working population of 21,972000 as estimated by the Labour Force Survey, an incidence of 51.7/million can be derived.

The incidence in the West Midlands was higher than that reported in Michigan (USA) (5) and lower than

Occupational group (code)	Incidences per million workers (actual number of cases)								Mean incidence (total n. of cases)
	1990*	1991*	1992	1993	1994	1995	1996	1997	
GENERAL	47 (104)	44 (96)	56 (117)	36 (75)	32 (66)	45 (94)	39 (81)	31 (64)	41.2 (697)
Spray painters (596)	1250 (5)	1500 (6)	1500 (9)	500 (3)	1167 (7)	1000 (6)	1667 (10)	500 (3)	1135 (49)
Rubber and plastic workers (824, 825)	1167 (14)	830 (10)	308 (4)	615 (8)	154 (2)	231 (3)	615 (8)	308 (4)	528 (53)
Electroplaters (834)	1000 (3)	1000 (3)	1000 (4)	250 (1)	0	500 (2)	500 (2)	750 (3)	625 (18)
Foundry, core makers, moulders (911, 531)	400 (2)	1000 (5)	429 (3)	0	143 (1)	286 (2)	286 (2)	286 (2)	354 (17)
Bakery workers (580)	133 (2)	534 (8)	667 (6)	889 (8)	445 (4)	333 (3)	556 (5)	333 (3)	486 (39)
Chemical processing workers (820)	143 (1)	0	71 (1)	142 (2)	214 (3)	142 (2)	71 (1)	0	98 (10)
Machine tool operators (840)	140 (6)	117 (5)	158 (3)	53 (1)	53 (1)	105 (2)	0	105 (2)	91 (20)
Carpenters (570)	152 (7)	109 (5)	182 (4)	91 (2)	0	91 (2)	182 (4)	136 (3)	118 (27)
Welders, solderers (537)	177 (14)	80 (6)	276 (8)	207 (6)	276 (8)	345 (10)	172 (5)	103 (3)	205 (60)
Farmers (900)	49 (3)	16 (1)	80 (2)	0	40 (1)	40 (1)	80 (2)	80 (2)	48 (12)
Healthcare workers (340, 342)	12 (1)	25 (2)	56 (5)	45 (4)	67 (6)	89 (8)	100 (9)	67 (6)	58 (41)
Laboratory technicians (300)	143 (1)	285 (2)	0	167 (1)	0	333 (2)	167 (1)	500 (3)	199 (10)
Assemblers-electronic goods (850)	364 (4)	91 (1)	214 (3)	71 (1)	143 (2)	214 (3)	214 (3)	71 (1)	173 (18)
Hairdressers (660)	167 (2)	0	273 (3)	0	0	0	182 (2)	0	78 (7)
Cleaners (958)	14 (1)	27 (2)	16 (1)	32 (2)	16 (1)	0	16 (1)	48 (3)	21 (11)

Denominators derived from the Labour Force Survey, Employment Department.

* General and most specific incidences from the Shield surveillance scheme in 1990-91 reported by Gannon et al. in ref. 14.

Table 2 : General and specific occupational group incidences for occupational asthma in the West Midlands from the SHIELD surveillance scheme.

those reported from countries such as Finland (2), Canada in British Columbia (9) and in Quebec (10), and Sweden (8).

The incidence figures determined by the scheme are likely to underestimate the true incidence of occupational asthma in the region. Since the registry is voluntary, data are obviously biased by an incomplete reporting of cases. The low reporting rate and the difficulty to keep up the enthusiasm of participants after a while were the main problems encountered in running the scheme. Other authors expressed also the same limiting factors for a similar voluntary project in British Columbia, Canada (9). A low rate of physician participation was cited for the SENSOR project in United

States, despite reporting of cases was compulsory by law (17). In the SWORD project the response rates increased after the introduction of a sampling system (18). Moreover most cases reported to SHIELD (62.3%) were diagnosed by the occupational lung disease unit from the Birmingham Chest Clinic. The referral pattern to a clinic does not represent the overall pattern of disease in the general population.

The scheme has implemented an intensive surveillance in the West Midlands through the identification and monitoring of clusters of disease. Although SHIELD does not have its objective for direct action to a reported workplace like SENSOR (3), its local contacts with the relevant organisations or personnel have promoted awareness of occupational asthma in the singular workplaces and in the whole region, leading to timely preventive measures. Since the establishment of the scheme, clusters of disease common in several industries were terminated by control measures implemented through local contacts.

The two fold difference in the incidence by sex in the West Midlands reflected a greater number of men working in occupations associated with occupational asthma. The highest incidence in the age group more than 45 years old suggested that the risk of developing occupational asthma may become more relevant with age. The same age

Agents	1989-91	1992-94	1995-97	TOTAL
ORGANIC				
flour & wheat	41 (8.9%)	27 (8.6%)	16 (4.9%)	84 (7.6%)
colophony	44 (9.5%)	24 (7.7%)	15 (4.6%)	83 (7.5%)
latex	2 (0.4%)	5 (1.6%)	16 (4.9%)	23 (2.1%)
wood dust	24 (5.2%)	15 (4.8%)	10 (3.1%)	49 (4.5%)
farm animals	4 (0.9%)	3 (1.0%)	3 (0.9%)	10 (0.9%)
laboratory animals	6 (1.3%)	2 (0.6%)	6 (1.9%)	14 (1.3%)
humidifier contaminant	9 (1.9%)	3 (1.0%)	0	12 (1.1%)
proteolytic enzymes	2 (0.4%)	2 (0.6%)	4 (1.2%)	8 (0.7%)
CHEMICALS				
isocyanates	95 (20.6%)	51 (16.3%)	44 (13.6%)	190 (17.3%)
glutaraldehyde	6 (1.3%)	7 (2.2%)	18 (5.6%)	31 (2.8%)
formaldehyde	3 (0.6%)	6 (1.9%)	4 (1.2%)	13 (1.2%)
chlorine	3 (0.6%)	0	2 (0.6%)	5 (0.4%)
METALS				
aluminium	0	1 (0.3%)	3 (0.9%)	4 (0.3%)
cobalt	2 (0.4%)	0	3 (0.9%)	5 (0.4%)
chrome compounds	7 (1.5%)	11 (3.5%)	6 (1.9%)	24 (2.2%)
platinum salts	2 (0.4%)	3 (1.0%)	2 (0.6%)	7 (0.6%)
zinc compounds	2 (0.4%)	2 (0.6%)	5 (1.5%)	9 (0.8%)
nickel	3 (0.6%)	2 (0.6%)	5 (1.5%)	10 (0.9%)
MISCELLANEOUS				
glues	4 (0.9%)	2 (0.6%)	1 (0.3%)	7 (0.6%)
epoxy resins	15 (3.2%)	14 (4.5%)	4 (1.2%)	33 (3.0%)
welding fumes	10 (2.2%)	4 (1.3%)	5 (1.5%)	19 (1.7%)
paints	5 (1.1%)	2 (0.6%)	4 (1.2%)	11 (1.0%)
persulphates	1 (0.2%)	1 (0.3%)	2 (0.6%)	4 (0.3%)
coolant oils	28 (6.1%)	19 (6.1%)	20 (6.2%)	67 (6.1%)
cleaning products	7 (1.5%)	3 (1.0%)	5 (1.5%)	15 (1.4%)
acid anhydrides	3 (0.6%)	2 (0.6%)	4 (1.2%)	9 (0.8%)
inks and dyes	2 (0.4%)	1 (0.3%)	7 (2.2%)	10 (0.9%)
grain dust	3 (0.6%)	3 (1.0%)	2 (0.6%)	8 (0.7%)
others	97 (21%)	79 (25%)	86 (26%)	262 (23.9%)
unknown	31 (7.4%)	19 (6.1%)	21 (6.5%)	71 (6.5%)
TOTAL	461	313	323	1097

Table 3 : Agents associated with reported cases of occupational asthma to the SHIELD surveillance scheme.

Method	No. in 1997	No. in previous
Symptoms improving off work	82.3% (65/79)	85.6% (869/1011)
Symptoms improving on holiday	87.9% (69/79)	88.6% (892/1011)
Serial peak flow*	74.7% (59/79)	61.2% (632/1011)
Specific IgE*	51.9% (41/79)	38.5% (392/1011)
Specific challenge test	15.2% (12/79)	6.8% (69/1011)
Methacoline challenge test*	46.8% (37/79)	7.9% (108/1011)

Table 4 : Comparison of method of diagnosis between 1997 and previous years.
* P value < 0.05 (Chi-square test).

Method	No. in 1997	No. in previous
Moved away from exposure within the same workplace	24% (19/79)	15.8% (161/1011)
Still exposed to the causative agent*	17.7% (14/79)	28.3% (288/1011)
Agent has been replaced	7.6% (6/79)	3.8% (39/1011)
Changed job	16.5% (13/79)	14.1% (144/1011)
Sick leave	3.8% (3/79)	9.5% (97/1011)
Early retirement	12.7% (10/79)	8.4% (86/1011)
Unemployed	17.7% (14/79)	18.5% (188/1011)
others	0%	0.7% (15/1011)

Table 5 : Comparison of the employment state of workers at diagnosis of occupational asthma between 1997 and previous years.
* P value < 0.05 (Chi-square test).

distribution of reported cases was noticed in SWORD (6), although differences between age groups were much smaller. Certainly the longer duration of exposure to sensitizing agents predisposes to the onset of occupational asthma. However younger workers with work related respiratory symptoms may find it easier to change job or relocate themselves away from exposure carrying out a different task, without ever seeking medical advice. Also in other countries the majority of cases were male in the middle age group. On the contrary in Finland an increase in the incidence of occupational asthma was detected among women (2) and especially in young adults (1).

In the West Midlands high incidence rates were observed in workers employed in the manufacturing sector and caused by exposure to well-known agents in high risk occupations. Exposure to isocyanates was almost the only cause of occupational asthma in spray painters reported to SHIELD. Direct exposure to isocyanates was also found in many industrial processes such as in the production of paints, plastics, flexible polyurethane foam, surface covering materials, adhesives, rubber and fibres. Foundry core makers and moulders were also an high risk occupation associated with isocyanates exposure, as sand cores used for casting hollow metal objects are bound together with an isocyanate resin.

In the electroplating sector the harmful exposures were mainly due to nickel and chrome. Nickel electroplating is very efficient with minimal gas generation whereas chromium electroplating is inefficient with a consistent generation of potentially respirable aerosols of chromic acid. Bright et al. (19) showed that airways sensitivity to both agents was the cause of occupational asthma in some of the electroplating workers referred to the occupational lung disease unit at the Birmingham Chest Clinic.

The bakers and flour confectioners reported were almost all sensitised to high molecular weight allergens present in wheat or other flour, or they had specific IgE for fungal or cereal amylase. Few cases of food processors other than bakers and flour confectioners were also reported, mainly developing sensitisation to enzymes used as tenderizers.

Solderers employed in the electronic industry were exposed to colophony, which was also the causative agent for assemblers of electronic goods.

Machine tool operatives were occupationally exposed to oil mists which caused asthma predominantly when a microbiological contamination had occurred. Cases of occupational asthma due to oil mists were also identified in the absence of any microbiological contami-

nation, as asthma may be induced by the various constituents of unused (clean) oils.

Laboratory technicians also represented a high risk occupation, being exposed to highly sensitising organic agents such as urine proteins of rats and mice.

The annual incidence was low in healthcare workers compared with other occupations. However the increase of number of cases in nurses and medical radiographers should be considered as a cause for concern. In these occupations workers were exposed to agents such as latex and glutaraldehyde, which were emerging with an always increasing number of cases since the first years of the SHIELD scheme.

Incidence of occupational asthma varies considerably between countries, partly due to differences in type and size of industry, working practices and implementation of environmental protection in the workplace. In UK and USA those occupations associated with isocyanates exposure, such as spray painters and others in the manufacturing sector, had the highest risk of developing occupational asthma (6,7,5). Bakers were the highest risk occupation in Finland and Sweden (2,8). In Finland farmers also represented a high risk occupation with one half of the reported cases, mostly due to cow dander exposure (2). In British Columbia (Canada) wood industry was the industrial sector with the greatest proportion of cases with western red cedar as the most common causative agent (9). However some of the variation in the general and specific incidence of occupational asthma in different countries may be spurious because of an incomplete ascertainment and reporting of cases (20). Moreover estimates may be biased by different diagnostic criteria, coverage and selection when compensation statistics, surveillance schemes or self reported cases are used as sources of data.

With regard of methods of diagnosis used for cases reported to SHIELD, the serial measurements of PEF was certainly encouraged by a computer assisted diagnostic aid (21), which made easier the interpretation of records in a more general clinical and occupational setting. Specific antibody testing was more readily accessible not only for high molecular weight compounds (flour, grain, colophony, latex), but also for small molecular weight compounds (isocyanates, acid anhydrides, glutaraldehyde).

The diagnosis of occupational asthma may constitute a socioeconomic burden for workers, who may suffer adverse consequences. A good sign of improvement of the employment state in the West Midlands was the increasing number of workers being removed from

exposure in a different job at the same company and the reduction of workers still exposed to the causative agents in 1997 compared to the previous years. Gannon *et al.* in a previous study in the West Midlands (22) and other authors (23, 24, 25) found that approximately one-quarter of the patients are still exposed to the causative agent at the same job following diagnosis of occupational asthma. Workers should be acknowledged that delay in removal from exposure affects their prognosis and may cause a severe deterioration in lung function. It is common that workers with less severe and pharmacologically controlled symptoms do not collaborate with or even seek the advice of the relevant occupational health authorities, as they may consider their actual health condition not severe enough to justify eventual transfers which could impair their livelihood. In 1997, 16.5% of reported cases to SHIELD changed their job compared to 32% of the patients in the London study (23). In addition, 17.7% of the patients from the scheme were unemployed compared to 36% in Ontario, Canada (24), 29% and 25% respectively from the London (23) and Paris (25) studies. Unemployment remained approximately stable in the West Midlands and was slightly lower than the figure reported in the previous study done in the region by Gannon *et al.* (22).

In conclusion the SHIELD surveillance scheme has provided a detailed epidemiological insight on the frequency and distribution of occupational asthma in the West Midlands. The scheme has detected epidemics of cases and helped participants to identify suspected causative agents, being in communication with the workplace of patients. A participation lower than expected and therefore potential for bias in the estimate of disease incidence, might be considered inevitable for a voluntary project. Besides the need to improve recognition of the disease, efforts must be made to enhance the coverage of new reported cases.

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