Reported incidence of occupational asthma in the United Kingdom, 1989–97

J C McDonald, H L Keynes, S K Meredith

Abstract

***Objectives*—To examine trends in estimated population based incidence of occupational asthma by age, sex, occupation, geographical region, and causal agents based on 9 years of the Surveillance of Work Related and Occupational Respiratory Disease (SWORD) data.**

***Methods*—In January 1989 the SWORD scheme for the surveillance of occupational respiratory disease was established in the United Kingdom to make good the lack of epidemiological information on the incidence of these diseases in the United Kingdom. Between 80% and 90% of chest and occupational physicians report voluntarily all new cases they see, on a monthly or random sampling basis. During the 9 years 1989–97, an estimated 25 674 new cases of occupational respiratory disease, including 7387 of occupational asthma, were reported. Suspected causal agents were classified into 44 categories and estimated annual incidences of asthma were calculated with denominators from the labour force survey.**

***Results*—Overall, a third of the suspected causes of asthma were organic, a third chemical, 6% metallic, and the rest miscellaneous, or in 8%, unknown. There was evidence of an increase since 1989 in cases due to latex, and possibly glutaraldehyde, and an apparent drop since 1991 in the proportion of cases attributed to isocyanates. Incidences were higher in men than women and the disparity was especially marked in the population aged 45 years or more in which rates for men were at least twice those for women. Average annual rates per million workers for 1992–7 ranged from 7 (95% confidence interval (95% CI) 5 to 9) for the lowest risk group of professional, clerical, and service workers to 1464 (95% CI 968 to 2173) for coach and other spray painters. Except for laboratory technicians, all other occupations with rates over 100 were concerned with manufacturing and processing that used chemicals, metals, and organic materials. Incidences were two to three times higher in the north and midlands than in East Anglia and the south. The introduction of a sampling scheme in 1992 doubled estimates of reported incidence of occupational asthma, but there was little evidence of other temporal changes.**

***Conclusions*—The SWORD scheme has produced consistent estimates of the causes and incidence of occupational asthma as seen by chest and occupational physicians. It has allowed the epidemiology of occupational asthma in the population to be studied and high risk occupations to be identified. There is certainly more occupational asthma in the population than that which reaches specialists in occupational and chest medicine; therefore the incidence rates presented here are underestimates, but by how much remains unknown.**

(*Occup Environ Med* 2000;**57**:823–829)

Keywords: occupational asthma; incidence; regional differences

Department of Occupational and Environmental Medicine, National Heart and Lung Institute, Imperial College of Science, Technology and Medicine, Dovehouse Street, London SW3 6LY, UK
J C McDonald
H L Keynes

Department of Preventive Medicine, School of Medicine, Vanderbilt University, Nashville, TN 37232–2637, USA
S K Meredith

Correspondence to:
Dr J C McDonald
c.mcdonald@ic.ac.uk

Accepted 25 July 2000

The SWORD project was established in January 1989[1] as both an information system by and for chest and occupational physicians, and has become a national surveillance scheme for occupational respiratory disease. Surveillance has been defined as "ongoing scrutiny generally using methods distinguished by their practicability, uniformity, and often their rapidity, rather than by complete accuracy. Its main purpose is to detect changes in trend or distribution in order to initiate investigation or control measures."[2] Its source of information is specialists in occupational and respiratory medicine who report new cases of suspected occupational respiratory disease. In return, participants receive monthly and quarterly analyses, including descriptions of cases of special interest, intended to further the understanding of occupational respiratory diseases and to assist in clinical diagnosis and management. As a surveillance scheme SWORD serves increasingly as a guide to the Health and Safety Executive (HSE) and others concerned with prevention.

This paper is concerned only with occupational asthma, which has consistently been the single disease reported most often, accounting for over 25% of the total number of new cases recorded each year. Information on their distribution by age, sex, agent, and occupation has been presented in regular publications,[3–9] but with analyses of population based incidence rates only for the first 2 years of the scheme, 1989–90.[10] That analysis, based on 1085 cases, showed that rates overall were twice as high in men as in women, although similar within occupational groups, and increased with age in men. There was great variation between occupations, with highest annual rates per million (sexes combined) observed in spray painters (658), chemical processors (364), plastics workers (337), and bakers (334), compared with an overall average of 20 per million. Regional differences were also considerable, explained in part by the distribu-

tion of industry and perhaps also by uneven levels of reporting. Of the 1085 cases of occupational asthma described in the 1989–90 analysis, only 554 (51%) were attributed to any of the 14 agents officially prescribed for compensation at that time.

Since 1990, there have been important changes in both SWORD reporting procedures and in the National Industrial Injuries Scheme. The regulations for the recognised causes of occupational asthma were made more flexible in 1990,[11] and nine additional specific agents were recommended for prescription; these could have accounted for a further 59 (5%) of the 1085 cases reported in the first 2 years of SWORD.

In January 1992, a new system was introduced for reporting cases to SWORD by chest physicians. A small core group of some 24 chest physicians were identified from those who had reported the most cases and they were asked to continue to report every month. This group consisted mainly of doctors with a special interest in occupational lung disease, to whom possible cases would often have been referred. The rest, comprising most of the roughly 450 chest physicians in the United Kingdom, were allocated each year by random sampling to one particular month, and were asked to report only for that month. The effect of this change was to increase greatly the estimated total number of new cases of occupational respiratory disease diagnosed annually by participants, from some 2000 to almost 4000, but with little change in the distribution of cases by diagnosis or suspected agent. Whereas the number of cases reported annually by core members has remained roughly constant, the estimated numbers obtained from non-core participants sampled for 1 month each year were much greater than those reported for an entire year before sampling.

Over the same period, considerable changes have also been made in the participation of occupational physicians in the surveillance of work related disease more generally. This culminated in January 1996 with the establishment of the Occupational Physicians Reporting Activity (OPRA), which covers occupational diseases of all types, including respiratory, and which has adopted a sampling strategy from the start. Occupational physicians report all cases to OPRA and those which are respiratory are passed on to the SWORD team. There is little evidence that this has greatly affected the contribution of occupational physicians to SWORD, especially for asthma, no doubt because those with responsibility for industries with potentially important exposures reported to one or other of the schemes from the outset.

Given the passage of time and the various changes which have taken place, we think that a further analysis of population based incidence would now be useful both for the 3 years 1989–91 before sampling in the SWORD scheme, and for the 6 years 1992–97 since it was introduced. The purpose of these analyses is to provide estimates of risk of developing occupational asthma in the United Kingdom during the 9 year period by age, sex, occupation, and region, together with information on the agents thought to have been responsible.

Methods

REPORTING PROCEDURES

The reporting procedures are simple, and the information requested kept to a minimum, as illustrated by the reporting card (figure), which has remained almost unchanged since 1989. Instructions on diagnosis, occupation, and suspected agent were kept brief, as our aim was to obtain the professional judgement of specialist physicians on each reported case. Precise criteria and definitions were not imposed. This was a deliberate policy in recognition of the wide variations that exist both in clinical opinion and in the availability of evidence for causation. Participants were asked to report newly diagnosed cases of asthma that they thought were caused by an exposure at work. This does not include cases aggravated, but not initiated, by work exposure—a difficult but important distinction in occupational asthma. Information from two follow up surveys suggests that in very few cases had the patient had asthma previously.[12 13]

DATA ANALYSIS

In preparation for analysis, occupation, region of residence, and suspected agent for each reported case were coded. Geographical analyses were based on standard administrative regions. The information given on suspected agents was not always precise and classification often required some judgement, which introduces the possibility of misclassification. For cases reported before 1992, occupations were coded in accordance with the classification of occupations 1980[14] and thereafter with the 1990 standard occupational classification (SOC).[15] The Office for Population and Census Surveys (OPCS) converter[16] was used to ensure comparability. Groups of occupations were aggregated into 16 orders as defined in the 1980 classification system. They were also aggregated into 20 occupational sets, as in the method previously devised by Meredith[10] to prevent misclassification and to facilitate more detailed analysis. An occupational set covers all possible codes for the same job irrespective of the occupational order grouping. For example, a laboratory worker with asthma could be coded as either a laboratory assistant or a technician; these two occupations are in different orders, but in the same occupational set. The miscellaneous labouring occupations included in Order 16 were reclassified into the appropriate occupational set according to type of industry.

Annual incidence rates by age group, sex, standard administrative region, occupational order, and occupational set were calculated per million employed people with population estimates from the Labour Force Survey. The Labour Force Survey data for 1989 and 1990 were used as denominators for cases reported in 1989–91, and data for Spring 1994 and Winter 1996 for calculation of rates for 1992–7. The Labour Force Survey is a sample

SWORD

Please report the number of NEW cases first diagnosed in
as a disease or illness caused by occupational exposure (month/year)

A	Asthma		G	Mesothelioma	
B	Inhalation accidents		H	Lung cancer - *partly or wholly work-related*	
C	Allergic alveolitis		I	Pneumoconiosis	
D	Bronchitis/emphysema		J	Other - *eg. rhinitis, byssinosis etc.*	
E	Infectious disease *- eg. omithosis, Q fever, TB, legionella*			*1* *2*	
F	Non-maligant pleural disease				

I have no case to report ☐

Date _____ Initials _____

Please give details of all cases listed above on the back of the card.

Details of all cases

Group (A–J)	Identifying number	Sex	D. o. B.	Initials	Postcode (first half) eg. SW3	Industry	Job	Suspected agent

Include below any cases of special interest first diagnosed before the start of the month, including those due to unusual agents:

SWORD reporting card.

survey, therefore population estimates are subject to sampling variation. As recommended, population estimates of less than 10 000 (95% confidence interval (95% CI) ±4000) were not used in this analysis.

Confidence intervals (95%) for incidence rates were calculated based on the Poisson distribution.[17] To take account of sampling, a two stage process was used. Firstly, upper and lower values for the observed numbers of cases from the sample were calculated and these were multiplied by 12 (the sampling fraction) and added to the cases from the participants who reported every month, thus providing upper and lower estimates of the numbers of cases. Secondly, based on these figures and the relevant population data, high and low estimated rates were calculated, as well as 95% CIs for each. The 95% CIs quoted are the upper 95% CI for the rate based on the high estimate

Table 1 Distribution of agents (n (%)) reported as causing occupational asthma, 1989–97

Agent	*1989–91*	*1992–94*	*1995–97*
Organic:			
Flour or grain	102 (7)	231 (8)	280 (9)
Laboratory animals	87 (6)	131 (5)	117 (4)
Solder or colophony	85 (6)	102 (4)	131 (4)
Wood dust	62 (4)	119 (4)	186 (6)
Crustaceans and fish	34 (2)	20 (1)	82 (3)
Proteolytic enzymes	9 (1)	33 (1)	32 (1)
Soya	2 (<1)	1 (<1)	0 —
Green coffee beans	1 (<1)	0 —	1 (<1)
Ispaghula	0 —	0 —	14 (<1)
Microbial antigens or fungi	22 (1)	25 (1)	40 (1)
Latex	3 (<1)	14 (<1)	86 (3)
Tea	0 —	3 (<1)	4 (<1)
Other plants	34 (2)	39 (1)	107 (4)
Other animals	29 (2)	78 (3)	86 (3)
Subtotal	470 (31)	796 (28)	1166 (39)
Chemical:			
Isocyanates	336 (22)	437 (15)	410 (14)
Glutaraldehyde	30 (2)	128 (4)	133 (4)
Azodicarbonamide	17 (1)	11 (<1)	2 (<1)
Antibiotics	17 (1)	44 (2)	25 (1)
Formaldehyde	18 (1)	26 (1)	30 (1)
Pesticides	12 (1)	5 (<1)	6 (<1)
Chlorine	9 (1)	15 (1)	19 (1)
Ammonia	8 (1)	16 (1)	3 (<1)
Sulphur dioxide	8 (1)	41 (1)	2 (<1)
Other	77 (5)	230 (8)	221 (7)
Subtotal	532 (35)	953 (33)	851 (28)
Metallic:			
Platinum salts	9 (1)	10 (<1)	5 (<1)
Aluminium potroom emissions	17 (1)	9 (<1)	6 (<1)
Stainless steel welding fume	4 (<1)	2 (<1)	20 (1)
Other welding fume	33 (2)	74 (3)	44 (1)
Cobalt	9 (1)	4 (<1)	5 (<1)
Nickel	6 (<1)	3 (<1)	5 (<1)
Chrome compounds	9 (1)	40 (1)	7 (<1)
Zinc compounds	0 —	16 (1)	2 (<1)
Other	6 (<1)	45 (2)	49 (2)
Subtotal	93 (6)	203 (7)	143 (5)
Miscellaneous:			
Hardening agents	44 (3)	142 (5)	67 (2)
Other glues and resins	50 (3)	95 (3)	91 (3)
Paints	33 (2)	46 (2)	39 (1)
Cutting oils	22 (1)	63 (2)	71 (2)
Cleaning products	22 (1)	28 (1)	45 (1)
Hair products	22 (1)	8 (<1)	13 (<1)
Inks	14 (1)	45 (2)	33 (1)
Reactive dyes	7 (<1)	15 (1)	4 (<1)
Other	98 (6)	206 (7)	277 (9)
Subtotal	312 (20)	648 (23)	640 (21)
Unknown or not stated	121 (8)	257 (9)	202 (7)
Total	1528	2857	3002

and the lower 95% CI for the rate based on the low estimate.

Results

REPORTED CASES

During the 9 years 1989–97, 13 732 new cases of occupational respiratory disease were reported to SWORD, of which 3966 (29%) were of occupational asthma. After application of the sampling fraction, the estimated totals were 25 674 and 7387 (29%) respectively. Among the 3966 cases, 1195 (30%) were reported by occupational physicians; after allowance for sampling, of the 7387 total estimated cases, 1866 (25%) were derived from occupational physician reports. Our analyses are based on the total estimated number of cases of asthma (7387).

SUSPECTED AGENTS

Table 1 shows the frequency distribution of agents suspected by the reporting physicians as having been responsible for their patients' asthma. In the first period, 1989–91, before the introduction of participant sampling, the numbers of cases shown are those that were actually reported; thereafter the numbers were estimated with allowance for the sampling fraction. In all three periods, chemical and organic agents were about equally responsible for two thirds of the cases, metals and their compounds for very few, and a miscellaneous group of products, fumes and dusts for about 20%. In the remaining cases (<10%), the agent was unknown or not stated. It is noteworthy that over the 9 year period, there were few examples of any change in the frequency distribution of these four main categories or in the constituent agents. There is evidence, based on small numbers, of a proportional increase of latex, and possibly of glutaraldehyde, and an apparent fall since 1991 in the proportion of cases attributed to isocyanates. Conceivably this decline was related in some way to the introduction of sampling in 1992, although no similar change was found with any of the other agents listed. In support of this being a reflection of a real reduction, there was also a drop in the number of awards of disablement benefit for asthma due to isocyanates between 1992 and 1997.[18] Despite the decline, isocyanates remained easily the single cause of occupational asthma most often reported throughout the 9 year period.

Of the 22 groups of specific agents prescribed for compensation, only 19 were mentioned in reports to SWORD. No case was attributed to three agents (castor bean, cimetidine, and ipecacuanha) and very few to some of the other 19—such as soya and green coffee bean. The SWORD estimate of the number of cases due to these agents for 1992–7 (n=2963) was 40% higher than the number of new cases of occupational asthma with assessed disablement in the same years (n=2095), but the distribution by agent was similar.[18] However, almost half the cases reported to SWORD were attributed to agents not on the official list. This was probably due, at least in part, to the unknown composition of some products in the miscellaneous category, but there were four times as many cases attributed to other agents (n=2896) than there were in the "open" category of the disablement statistics (n=696).

AGE AND SEX

The distribution of the estimated 7387 cases by age and sex, less 592 for which the information was unknown, is presented in table 2 in the three successive periods, each of 3 years together with mean annual incidence rates per million employed people. In all three periods, and overall, there was a fairly clear increase with age in men, but little evidence of anything similar in women. In all three periods, and overall, the incidence was about twice as high in men as in women, and the difference most marked over the age of 44. Although the rates after 1991 were almost double those for 1989–91, the distribution by age and sex remained constant over the 9 years.

OCCUPATION

The main results of analyses of incidence relative to occupation are summarised in table 3. Once again, the rates presented are based on the actual figures for 1989–91, and estimated to take

*Table 2 Average annual incidence of occupational asthma per million people employed by age and sex, 1989–97**

	1989–91		*1992–4*		*1995–7*		*1992–7*	
Age (y)	*Cases (n)*	*Incidence (95% CI)*	*Cases (n)*	*Incidence*	*Cases (n)*	*Incidence*	*Cases (n)*	*Incidence (95% CI)*
Women:								
16–29	136	11 (10 to 13)	214	21	242	25	456	23 (16 to 32)
30–44	139	11 (10 to 13)	309	24	340	25	649	25 (18 to 33)
⩾45	141	14 (12 to 16)	252	22	300	25	552	23 (17 to 32)
All	416	12 (11 to 13)	775	23	882	25	1657	24 (20 to 28)
Men:								
16–29	221	15 (13 to 17)	367	30	350	30	717	30 (22 to 40)
30–44	366	23 (21 to 25)	625	40	757	45	1382	43 (35 to 52)
⩾45	418	29 (26 to 32)	851	56	767	57	1618	53 (44 to 64)
All	1005	22 (21 to 24)	1843	45	1874	43	3717	44 (39 to 50)

*For 1989–91, the cases shown were the numbers reported; thereafter the cases shown were estimated, taking account of the sampling fraction.
Sex or age missing in 107 (7%) cases for 1989–91 and 485 (8%) cases for 1992–97.

account of the sampling fraction in the later years. The potential for sampling error is considerable, especially when the number of observed cases in any category is small; nevertheless, certain general conclusions are clear. Firstly, the annual mean rates per million during the 6 year period, 1992–7, ranged from seven for the lowest risk group of professional, clerical, and service workers to 1464 for coach and other spray painters. Secondly, with the exception of laboratory technicians and assistants in orders 1–10, all the other occupations with rates over 100 were in orders 11, 12, and 13, and were concerned with manufacture and processing, of chemicals, metals, or organic materials—such as foodstuffs and wood. Thirdly, there is little consistent evidence of an increase or decrease in incidence in any of the 20

Table 3 Estimated average annual incidence rates by occupational set, 1989–97

		*Average annual incidence (million/y)**					
Order	*Set*	*1989–91*	*(95% CI)*	*1992–94*	*1995–97*	*1992–97*	*(95% CI)*
1–10	Professional, clerical, and service:						
	Laboratory technicians and assistants	235	(177 to 271)	198	216	207	(150 to 297)
	Cleaners	9	(6 to 14)	9	28	18	(8 to 39)
	Nurses	17	(12 to 24)	52	74	62	(40 to 96)
	Farmers and farm hands	34	(2 to 46)	64	73	68	(34 to 123)
	Hairdressers	81	(51 to 120)	17	32	24	(5 to 106)
	Remainder	3	(3 to 4)	4	9	7	(5 to 9)
11	Material processors (excluding metal and electrical):						
	Wood workers	45	(35 to 58)	110	171	139	(82 to 221)
	Food processors (excluding bakers)	121	(92 to 156)	151	423	280	(171 to 441)
	Bakers	285	(220 to 364)	1048	857	951	(618 to 1415)
	Plastics workers	387	(307 to 481)	613	158	380	(220 to 635)
	Chemical processors	346	(273 to 433)	640	511	573	(357 to 898)
	Remainder	53	(45 to 62)	119	127	123	(83 to 176)
12	Metal and electrical processing and makers:						
	Welding, soldering, and electronic assembly	158	(130 to 191)	265	266	266	(181 to 389)
	Metal treatment	211	(157 to 278)	691	454	567	(345 to 907)
	Remainder	26	(22 to 30)	63	55	59	(44 to 78)
13	Painting, assembly, and packing:						
	Painters (excluding spray painters)	53	(37 to 75)	78	45	61	(19 to 167)
	Coach and other spray painters	729	(598 to 880)	1350	1586	1464	(968 to 2173)
	Remainder	33	(25 to 43)	63	85	74	(44 to 122)
14	Construction and mining	11	(8 to 16)	46	35	41	(22 to 71)
15	Transport and storage	7	(5 to 10)	17	9	13	(7 to 26)
1–15	All occupations	19	(18 to 20)	37	38	38	(34 to 41)

*Rates for 1992–7 are based on estimated case numbers.

*Table 4 Main occupations associated with the seven agents cited most often 1992–7**

Agent	*Occupational set*	*n*	*%*
Isocyanates	Spray painter	286	34
	Other metal or electrical processor, maker or repairer (mainly vehicle manufacture and mechanics)	161	19
	Plastics worker	87	10
Flour and grain	Baker	317	62
	Other food processor	56	11
	Farmer or farm worker	45	9
Wood	Woodworker	251	82
Glutaraldehyde	Nurse	189	72
	Other non-metal or electrical processors (mainly darkroom technicians)	28	11
	Other professional, clerical, and service occupations (mainly radiographers)	26	10
Laboratory animals	Laboratory technicians, scientists, and assistants	184	74
	Other professional, clerical, and service occupations (mainly medical or pharmacological research)	61	25
Solder or colophony	Welder, solderer, or electronic assembler	161	69
	Other metal or electrical processor, maker, or repairer	57	24
Hardening agents	Metal and electrical processor, maker, or repairer	81	39
	Construction and mining	36	17
	Other non-metal or electrical processor, maker, or repairer	30	14
	Chemical processor	24	11

*The percentages shown are based on the number of cases recorded in table 1 for each of the seven listed agents.

Table 5 Average annual incidence rates of occupational asthma per million employed people by geographical region, 1992–7 and 1989–91

	1992–7		1989–91	
Rates	*Estimated cases (n)*	*Incidence rates (95% CI)*	*Reported cases (n)*	*Incidence rates (95% CI)*
High:				
West Midlands	912	65 (52 to 77)	301	41 (37 to 46)
Yorkshire and Humberside	753	58 (42 to 72)	94	14 (12 to 18)
Northern Ireland	202	56 (30 to 86)	27	15 (10 to 22)
East Midlands	595	53 (37 to 69)	84	15 (11 to 18)
North	401	53 (37 to 69)	124	32 (27 to 38)
Moderate:				
Scotland	566	42 (30 to 53)	183	27 (24 to 32)
North west	648	40 (29 to 51)	184	22 (19 to 25)
Wales	263	37 (23 to 53)	72	20 (15 to 25)
Low:				
East Anglia	181	30 (18 to 46)	51	17 (13 to 22)
South west	324	25 (17 to 33)	114	17 (14 to 21)
South east	1041	21 (17 to 25)	297	12 (10 to 13)
All United Kingdom	5859	38 (34 to 41)	1528	19 (18 to 20)

occupational sets shown, apart from hairdressers in whom the incidence seems to have fallen. Despite the possibilities of sampling error, the rates are remarkably stable. Inspection of the annual mean incidence rates for 1992–7 compared with 1989–91, together with their 95% CIs (table 3), suggests a possible increase over and above the overall doubling of rates, among nurses, construction and mine workers, and perhaps bakers, but a decrease among hairdressers, and perhaps also laboratory technicians. However, sampling error and the change from the 1980 to 1990 occupational classification system could explain these differences.

The association between occupation and agent is shown in table 4 for the seven causes of occupational asthma cited most often. The seven agents selected each accounted for over 3% of cases (table 1). There will be few surprises, as all seven agents are immediately identifiable with a particular occupational group. However, it is worth noting that isocyanates were associated with asthma not only among spray painters but also among metal, electrical, and plastics workers; that flour and grain affected not only bakers, but other food processors and farm workers; that glutaraldehyde affected various medical workers; and hardening agents affected various metal, electrical, and construction trades, and even mining.

REGION

For a geographical analysis the United Kingdom was divided into Scotland, Wales, Northern Ireland, and the eight English administrative regions—that is, 11 in all. Table 5 shows, in descending order, the regional average annual incidence rates for 1992–7, together with comparable data for 1989–91. For 1992–7 the rates fall into three categories: five regions mainly in the north with rates above 50 per million, three in the south and south east with rates of 30 or less, and an intermediate group comprising Scotland, Wales, and the north west.

Discussion

SWORD was the first, and is the largest, national voluntary reporting scheme for occupational respiratory disease. With sampling, estimates of incidence of occupational asthma based on SWORD data are similar to those for the West Midlands reported to SHIELD[19] and somewhat lower than those derived from two comparable pilot schemes in Quebec[20] and British Columbia.[21] More recently established projects in France and South Africa have yet to report their findings in sufficient detail for comparisons to be made. The many cases reported to SWORD permit more stable incidence estimates by occupation, region, sex, and age group to be calculated than is possible elsewhere. Even the Finnish Register,[22] which is both older and likely to be much more complete than SWORD, lacks the numbers of cases for robust estimates of incidence. Because SWORD is limited to reports by specialists in occupational and chest medicine, who only see a fraction of all patients with occupational asthma, the estimates of incidence presented here reflect relative, rather than absolute, risks.

The introduction of sampling in 1992 doubled our estimates of reported incidence of occupational asthma, but had little impact on the distribution of cases by suspected agent or on the relative risk by occupational set, age group, or sex which have remained almost unchanged throughout the 9 year period. Except for three regions in the high incidence category (Yorkshire and Humberside, Northern Ireland, and the East Midlands), the ranking of regions before and after the introduction of sampling in 1992 has also remained broadly similar. In the analysis for 1989–90,[10] the reported incidence in these three regions was found to be much lower than would be expected from the distribution of occupations, especially for the two English regions. This was thought to be due to low ascertainment, perhaps resulting from relatively fewer participating chest clinics in these regions. The higher rates for these regions in 1992–7 are likely to be due to the introduction of sampling, which gave more complete coverage by physicians, as indicated by a high proportion of reported cases from the sample—over 20% in these three regions, compared with an average of 13%. We therefore think that the estimates based on participant sampling provide a better reflection of incidence of occupational asthma than was previously available, although variation in sampling inevitably renders the estimates less precise.

Although the data presented in this paper are useful both for clinical and epidemiological purposes and are extensively used by the HSE, certain important limitations should still be recognised. Firstly, reporting is voluntary and despite a high level of participation, about 80%, is certainly incomplete. Secondly, each report represents a specialist's uncorroborated opinion, likely to be good on diagnosis, for which they are well qualified, and perhaps on occupation, obtainable by direct questions, but rather less than perfect on attribution of the causal agent. This is particularly a problem for chest physicians, who seldom have access to the workplace. Also, the calculation of meaningful rates is impeded by the lack of wholly appropriate denominators. The Labour Force Survey provides very useful information, but

the size of the sample interviewed is too small for detailed annual analyses of occupational subgroups or geographical regions, and quantative data on populations exposed to various causal agents listed in table 1 are completely lacking. Apparent changes in trend, such as that noted in asthma due to isocyanate in the early 1990s, or between 1992–4 and 1995–7 in the incidence rates for certain occupations, cannot therefore be evaluated reliably.

Overall, the incidence of occupational asthma seems to reflect the general distribution of heavy industry in the United Kingdom. It was thought that the pattern might be primarily due to the higher risk occupations, but a detailed analysis (not tabulated here) showed that in fact the rates for lower risk jobs correlated better with the geographical ranking than the rates for higher risk jobs. Presumably this is because regional incidence is determined less by level of risk than by the number of exposed employees at risk. The elucidation of this interesting question would require more detailed information than is available from the Labour Force Survey, and is beyond the scope of this paper.

Cases of occupational asthma reported to SWORD have made possible several detailed investigations, dependent on the availability of a large nationally representative series and the willing collaboration of reporting physicians. As the reported cases are anonymous and the information supplied in strict confidence, such collaboration is essential. One such investigation was concerned with clinical outcome and subsequent employment, and another with the contribution of accidental inhalation of irritants to the causation of asthma. The first of these studies,[13] based on the follow up in 1994 of over 1300 patients reported in 1989–92, found that of patients reported by occupational physicians, 45% had recovered, compared with only 14% of those reported by chest physicians (excluding medicolegal cases). This study, which also provided information on their subsequent employment, showed that the initial clinical diagnoses were based on one or more laboratory tests in 74% of cases and on work related symptoms only in 25%. Very similar proportions were found in an earlier follow up of reported asthma in chemical, pharmaceutical, and plastics workers.[12]

In a follow up in 1996 of all inhalation accidents reported to SWORD,[23] it was found that in 11 (3%) of 403 cases reported by occupational physicians and in 39 (18%) of 217 cases reported by chest physicians, the patients had proceeded to develop asthma-like symptoms. A subsequent inquiry 1 year later about these 50 patients[24] found that 34 were considered by the reporting physicians to have developed persistent asthma as a direct consequence of the inhalation accident. Other ongoing investigations based on SWORD asthma reports are of case-control design, with the object of assessing risk relative to level and duration of exposure.

Conclusion

The SWORD scheme has provided useful information not otherwise available on the occurrence of occupational asthma in the United Kingdom. Although incidence is undoubtedly underestimated from SWORD data, and certainly excludes the unknown number of patients seen only by general practitioners, analysis of reported cases has produced consistent estimates of the relative importance of the various possible agents, and identified the demographic characteristics and occupations at increased risk. It has also provided a valuable source of cases for studies of aetiology and outcome. However, the essential validity of the SWORD data has been tested systematically only to a very limited extent. This needs to be done, but will be neither a simple nor easy task.

We are indebted to chest and occupational physicians throughout the United Kingdom for their continuing voluntary participation over a 10 year period in the SWORD scheme, which has been supported in part by grants from the Health and Safety Executive.

1 Meredith SK, Taylor VM, McDonald JC. Occupational respiratory disease in the UK 1989: a report by the SWORD project group. *Br J Ind Med* 1991;**48**:292–8.
2 Last JM, ed. *A dictionary of epidemiology, 2nd edition*. Oxford, Oxford University Press, 1988:125.
3 Meredith SK, McDonald JC. Work-related respiratory disease in the UK, 1989–92: report on the SWORD project. *Occup Med* 1994;**44**:183–9.
4 Sallie BA, Meredith SK, Ross DJ, *et al*. SWORD '93: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1994;**44**:177–82.
5 Ross DJ, Sallie BA, McDonald JC. SWORD '94: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1995;**45**:175–178.
6 Keynes HL, Ross DJ, McDonald JC. SWORD '95: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1996;**46**:379–81.
7 Ross DJ, Keynes HL, McDonald JC. SWORD '96: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1997;**47**:377–81.
8 Ross DJ, Keynes HL, McDonald JC. SWORD '97: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1998;**48**:481–5.
9 Meyer JD, Holt DL, Cherry NM, *et al*. SWORD '98: surveillance of work-related and occupational respiratory disease in the UK. *Occup Med* 1999;**49**:485–9.
10 Meredith SK. Reported incidence of occupational asthma in the UK, 1989–90. *J Epidemiol Community Health* 1993;**47**: 459–63.
11 Department of Social Security. *Social Security Act 1975—Occupational Asthma*. London: The Stationery Office, 1990.
12 Meredith SK, McDonald JC. Occupational asthma in chemical, pharmaceutical and plastics processors and manufacturers in the UK, 1989–90. *Ann Occup Hyg* 1994; **38**(suppl 1):833–7.
13 Ross DJ, McDonald JC. Health and employment after a diagnosis of occupational asthma: a descriptive study. *Occup Med* 1998;**48**:219–25.
14 Office of Population Censuses and Surveys. *Classification of occupations, 1980*. London, The Stationery Office, 1980.
15 Office of Population Censuses and Surveys. *Standard occupational classification*. London, The Stationery Office, 1990.
16 Office for National Statistics. *Occupational support service user guide: 2.1*. Fareham, Hampshire: Occupational Information Unit, ONS, 1998.
17 Gardner MJ, Altman DG. *Statistics with confidence*. London: BMJ, 1989.
18 Health and Safety Commission. *Health and safety statistics 1997–8*. Norwich: HSE Books, 1998.
19 Gannon PFG, Burge PS. The SHIELD scheme in the West Midlands region, United Kingdom. *Br J Ind Med* 1993;**50**: 791–6.
20 Provencher S, Labrèche FP, de Guire L. Physician based surveillance system for occupational respiratory diseases: the experience of PROPULSE, Québec, Canada. *Occup Environ Med* 1997;**54**:272–6.
21 Contreras GR, Rousseau R, Chan-Yeung M. Occupational respiratory diseases in British Columbia, Canada in 1991. *Occup Environ Med* 1994;**51**:710–12.
22 Karjalainen A, Keskinen H, Nordman H, *et al*. Incidence of reported occupational asthma in Finland 1990–5. In: Chiyotani K, Hosoda Y, Aizawa Y, eds. *Advances in the prevention of occupational respiratory diseases*. Amsterdam: Elsevier, 1998:434–8.
23 Sallie BA, McDonald JC. Inhalation accidents reported to the SWORD surveillance project 1990–3. *Ann Occup Hyg* 1996;**40**:211–21.
24 Ross DJ, McDonald JC. Asthma following inhalation accidents reported to the SWORD project. *Ann Occup Hyg* 1996;**40**:645–05.