
Article:
Fishwick, D., Carder, M., Iskandar, I. et al. (2023) Irritant asthma and work: cases from the UK SWORD reporting scheme from 1999 to 2018. Occupational and Environmental Medicine, 80. pp. 553-557. ISSN: 1351-0711

https://doi.org/10.1136/oemed-2023-108884

OPEN ACCESS

Original research

Irritant asthma and work: cases from the UK SWORD reporting scheme from 1999 to 2018

David Fishwick ,[1,2] Melanie Carder,[2] Ireny Iskandar ,[2] Beth Charlotte Fishwick,[3] Martie van Tongeren [2]

[1]Science Division, Health and Safety Executive Bootle Headquarters, Bootle, UK
[2]Centre for Occupational and Environmental Health, The University of Manchester, Manchester, UK
[3]The University of Manchester, Manchester, UK

Correspondence to
Professor David Fishwick, Science Division, Health and Safety Executive Bootle Headquarters, Bootle, Sefton, UK; d.fishwick@sheffield.ac.uk

Received 22 February 2023
Accepted 3 July 2023
Published Online First 28 September 2023

ABSTRACT

Background Acute irritant asthma is a preventable health consequence of a workplace exposure and has a number of adverse outcomes. While cases and case series are reported, little is known about the causes and incidence of this condition over prolonged periods of time.

Aims We aimed to estimate the reported incidence of irritant asthma referred to a national reporting scheme, and how this has changed over time.

Methods Cases of irritant asthma reported to SWORD, the UK-based Surveillance of Work-related Occupational Respiratory Diseases scheme, were grouped into four 5-year time periods from 1999 onwards. Likely causative exposures, job, work sector and incidence rates were analysed over time.

Results 307 actual cases equated to 1066 estimated cases; actual cases had a mean age of 46 years (SD 17.8); 70.7% were male. The annual incidence fell from 1.98 per million employed in the first 5-year period, to 0.56 in the most recent. Eleven occupational codes were associated with six or more attributed cases, and between them accounted for 38% of all cases. Thirteen exposure categories were associated with five or more cases. These were formaldehyde (n=5), cutting oils and coolants (n=6), isocyanates (n=6), pesticides and herbicides (n=6), welding fumes (n=7), paints (n=7), solder and colophony (n=7), solvents (n=9), fuel oil, diesel and ill-defined fumes (n=10), chlorine and hypochlorites (n=15), acids (n=23), smoke (n=25) and cleaning products and sterilising agents (n=39).

Conclusions While the incidence of irritant asthma may have fallen, cases are persistently attributed to well-described causes. A persistence of cases attributed to cleaning agents was seen.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Reactive airways dysfunction syndrome, or acute irritant induced asthma, is a well-described consequence of an acute inhalational injury, with a significant set of adverse consequences. Despite this, relatively little real-world data exist relating to their extent and causation.

⇒ Previous reviews have identified a general lack of information on relevant exposures and have suggested a structured approach to documenting relevant information on each case. Cases are most commonly attributed to chlorine or chlorine-releasing agents, toluene diisocyanate and paint fumes but other novel exposures and jobs are described.

WHAT THIS STUDY ADDS

⇒ This study shows that the incidence of this condition may be falling over 20-year period in the UK.

⇒ This study also confirms that based on real-world data, the above commonly reported exposures of cleaning products and sterilising agents are cited even in the most recent cases. In addition, acids, glues and adhesives, fuel oil, diesel, ill-defined fumes gases and welding fumes and certain food-related work tasks are recent attributed causes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Despite the suggestion that incidence may be falling over time, workplace interventions designed to reduce risks from these known inhalational hazards remain important to develop, implement and evaluate in order to prevent acute irritant-induced asthma.

INTRODUCTION

The UK-based Surveillance of Work-related and Occupational Respiratory Disease (SWORD)[1] collects data on new cases of occupational lung diseases. Data previously collected by SWORD have provided insight on a variety of occupational lung diseases[2 3] including most recently for occupational inhalational accidents.[4]

Acute irritant asthma, also termed reactive airways dysfunction syndrome (RADS), is a form of occupational asthma normally associated with (caused by) a single high exposure to an inhaled irritant. Its original definition was developed by Brooks *et al*,[5] although it is clear from recent reviews of the literature that many cases described do not conform to the original diagnostic framework. Work based on an assessment of the literature[6] up to and including 2004 concluded that only 63 of the 633 cases reported to that date in the literature had sufficient diagnostic information included to permit a diagnosis of RADS using the Brooks criteria. That review identified a wide variety of agents implicated in the causation of irritant asthma, with chlorine, toluene diisocyanate and paint fume as the most common reported inhaled exposures linked to reported cases. A more recent review,[7] building on

To cite: Fishwick D, Carder M, Iskandar I, *et al*. *Occup Environ Med* 2023;**80**:553–557.

the evidence since 2004, identified again a variety of potentially causative agents; chlorine or chlorine-releasing molecules were most frequently reported from the total of 752 cases assessed.

While, therefore, there are relatively good data on causation from published evidence, there are few studies that address these issues in the real world. This condition has merit for further work in certain domains, including developing a better understanding of causation and mechanisms of action of causative agents (and hence early intervention and treatment options) and heightening clinical awareness of this condition, given its likely under-reporting and developing preventative strategies. Furthermore, an established diagnosis is also known to be associated with a set of adverse personal consequences,[8] which importantly reinforces all these preventative approaches.

This paper consequently describes the real-world experience represented by reported cases of irritant asthma from a national UK-based occupational lung disease reporting scheme over a 20-year period.

METHODS

UK-based respiratory physicians report cases of occupational lung disease to SWORD. Core reporters submit their cases every month[3] and sample reporters submit their cases on one randomly selected month each year. Voluntary reporters represent all parts of the UK. Irritant asthma is one such category available for reporting of cases, separate from a category also available to report occupational inhalational accidents. All irritant asthma cases reported to the SWORD scheme between January 1999 and December 2018 were used in this analysis. This time period was chosen to be directly comparable with previous work on occupational inhalational accidents and also because the subsequent COVID-19 pandemic may have affected data from 2020 onwards. In addition to the actual reported cases, numbers of estimated cases were calculated and used for the incidence estimates. Estimated cases were calculated by multiplying the cases from sample reporters by 12 (as they report cases from only 1 month out of 12) and adding them to the core cases.

The two-digit Standard Industrial Codes (SIC 2003)[9] were used to categorise industry sector, and the four-digit level of the Standard Occupational Codes (SOC) 2000 system[10] was used to categorise occupation. The reported agent thought to have caused the case was allocated to 1 of 40 a priori defined categories based on its physical and chemical characteristics.

Data were grouped into four 5-year periods (1999–2003, 2004–2008, 2009–2013, 2014–2018), as previously used for a similar analysis of hypersensitivity pneumonitis[3] and occupational inhalation accidents.[4] For each 5-year period, the annual incidence of irritant asthma was estimated using time matched data from the working population of the UK.[11]

RESULTS

Over the study period between 1999 and 2018, 307 cases of irritant asthma were reported to the scheme, equivalent to 1066 estimated cases. The mean age of the reported cases was 46 years (SD 17.8), with a range of 17–83; 70.7% were male. The annual incidence of irritant asthma fell from 1.98 per million employed in the first 5-year period, to 0.56 in the most recent, although increased in the two middle 5-year time periods (table 1). The mean number of cases of irritant asthma per active reporter per year changed over the study period from 0.04 (1999–2003) to 0.03 (2014–2018).

Forty-six SIC codes were represented of a possible 99 SIC codes in total; 12 SIC codes were associated with five or more actual cases. SIC codes with the highest number of cases were in increasing order; manufacture of food products and beverages (n=15), manufacture of chemicals and chemical products (n=18), public administration and defence, compulsory social security (n=23), manufacture of motor vehicles, trailers and semitrailers (n=26) and medical work (n=36).

Eleven occupational codes were associated with six or more attributed cases, and between them accounted for 38% of all cases. These 11 SOC codes, in increasing level of frequency were: laboratory technicians (SOC 3111, n=6), fire service officers (SOC 3313, n=6), assemblers, vehicles and metal goods (SOC 8132, n=6), metal making and treating process operatives (SOC 8117, n=7), nurses (SOC 3211, n=10), Welding trades (SOC 5215, n=11), metal working production and maintenance fitters (SOC 5223, n=12), other goods handling and storage occupations (SOC 9149, n=12), chemical and related process operatives (SOC 8114, n=13), labourers in process and plant operations (SOC 9139, n=13) and cleaners, domestics (SOC 9233, n=20).

Most of the occupations associated with these cases (84.4% of all reported cases) were within the four major SOC2000 categories of process, plant and machine operatives (n=86), elementary occupations (n=63), skilled trades occupations (n=60) and associate professional and technical occupations (n=50).

Of the wide variety of potential causative agents reported by the physician for each case, certain agents were more commonly represented. Thirteen of the 40 predefined exposure categories were associated with five reported cases or more. These were formaldehyde (n=5), cutting oils and coolants (n=6), isocyanates (n=6), pesticides and herbicides (n=6), welding fumes (n=7), paints (n=7), solder and colophony (n=7), solvents (n=9), fuel oil, diesel and ill-defined fumes (n=10), chlorine and hypochlorites (n=15), acids (n=23), smoke (n=25) and cleaning products and sterilising agents (n=39).

Table 1 gives more detailed demographic, incidence, detailed occupational and exposure information for the reported cases by major 5-year periods of study. There are a heterogenous group of exposure types and individual agents attributed to cases of irritant asthma. It is also evident that numbers appear to be falling over time, but the role of cleaning agents appears to persist into the most recent 5-year period of study. The latter exposure has been identified as an important and persistent cause of occupational respiratory disease.[12 13]

DISCUSSION

This analysis has described one national reporting scheme's 20-year experience of irritant asthma linked with workplace exposures. The data offer insight into the typical jobs, industrial sectors and attributed exposures related to this condition, with a predominance of chemical and related process operatives, labourers in process and plant operations and cleaners and domestics affected. These data also suggest that the incidence of this condition is falling over time, although other factors contributing to this fall, such as changing referral practices and reduced reporting (as the numbers of cases per active reporter fell slightly over the four time periods of interest) and reduced numbers of workers in relevant work sectors should also be considered and cannot be excluded.

The strengths of these real-world data lie in their consistency with other published data, while also being derived from a national reporting source. The agents we identified as potentially causative for irritant asthma were broadly consistent with those described in the literature to date,[6 7] although additional

Table 1 Number and demographic factors associated with all actual cases of irritant asthma reported each year

Report years inclusive	Cases actual/estimated number/average cases per active reporter* per year	Average incidence rate (per million employed)	Mean age years (SD), % male	Most frequently reported occupations (SOC2000 codes) of cases in ascending frequency	The most common specified reported agent categories in ascending frequency
1999–2003	117/271/0.04	1.98	44.7 (10.7), 75.2	3312 Police Officers (n=3) 3313 Fire service officers (n=3) 8114 Chemical and related process operatives (n=3) 8131 Assemblers (electrical products) (n=3) 8135 Tyre, exhaust and windscreen fitters (n=3) 9223 Kitchen and catering assistants (n=3) 5223 Metal working production and maintenance fitters (n=4) 8116 Plastics process operatives (n=4) 9149 Other goods handling and storage occupations (n=4) 9233 Cleaners, domestics (n=4) 3211 Nurses (n=5) 5215 Welding trades (n=6) 9139 Labourers in process and plant operations (n=7) *(13 occupations with three or more cases)3 occupations with three or more cases*	Cutting oils and coolants (n=3) Formaldehyde (n=3) Welding fumes (n=3) Pesticides, herbicides and insecticides (n=4) Paints (n=4) Solder/colophony (n=4) Chlorine, hypochlorites (n=5) Solvents (n=6) Smoke (n=6) Cleaning products and sterilising agents (n=8) Acids (n=10) Fuel oil, diesel, ill-defined fumes gases (n=11) *(12 exposures with three or more cases)*
2004–2008	100/452/0.04	3.11	47.5 (10.8), 69	3111 Laboratory technicians (n=4) 3211 Nurses (n=4) 5223 Metal working production and maintenance fitters (n=4) 9149 Other goods handling and storage occupations (n=4) 8117 Metal making and treating process operatives (n=5) 9139 Labourers in process and plant operations (n=5) 9233 Cleaners, domestics (n=6) 8114 Chemical and related process operatives (n=7) *(eight occupations with more than four cases)*	Cutting oils and coolants (n=2) Paints (n=2) Solder/colophony (n=2) Acids (n=8) Chlorine, hypochlorites (n=8) Fuel oil, diesel, ill-defined fumes gases (n=11) Cleaning products and sterilising agents (n=12) *(seven exposures with two or more cases)*
2009–2013	45/254/0.02	1.75	44.3 (10.9), 53.3	6111 Nursing auxiliaries and assistants (n=2) 8111 Food, drink and tobacco process operatives (n=2) 8133 Routine inspectors and testers (n=2) 8211 Heavy goods vehicle drivers (n=2) 9233 Cleaners, domestics (n=6) *(five occupations with two or more cases)*	Chlorine, hypochlorites (n=2) Fuel oil, diesel, ill-defined fumes gases (n=2) Wood dusts (n=2) Acids (n=3) Isocyanates (n=3) Cleaning products and sterilising agents (n=10) *(six exposures with two or more cases)*
2014–2018	45/89/0.03	0.56	47.5 (9.8), 80	3422 Product, clothing and related designers (n=2) 5215 Welding trades (n=2) 5433 Fishmongers, poultry dressers (n=2) 5223 Metal working production and maintenance fitters (n=3) 8114 Chemical and related process operatives (n=3) 9149 Other goods handling and storage occupations (n=4) 9233 Cleaners, domestics (n=4) (seven occupations with two or more cases)	Acids (n=2) Glues and adhesives (n=2) Fuel oil, diesel, ill-defined fumes gases (n=2) Welding fumes (n=4) Cleaning products and sterilising agents (n=9) *(five exposures with two or more cases)*

*Active reporter=reporter in each calendar year of interest who reported a case or returned a 'no cases to report' communication

exposure types, often limited to single or small case numbers were seen. For example, cutting oils and coolants, welding fumes, pesticides, herbicides and insecticides, fuel oil, diesel, ill-defined fumes gases and glues and adhesives were also relatively commonly attributed causes.

There were also interestingly commonalities between job classifications seen in this analysis with those previously attributed specifically to occupational inhalational accidents,[4] with the latter being associated with work, in increasing frequency, with associate professional and technical occupations, elementary occupations, skilled trades occupations and process, plant and machine operatives. The current study identified these identical four major groupings as having the highest levels of irritant asthma also, with some ordering differences. This commonality

potentially suggests similar causative exposures causing these two conditions, or perhaps equally likely persisting difficulties in differentiating between these two diagnoses when reporting individual cases, and the likelihood of significant overlap between these conditions.

Additionally, and perhaps less commonly available in prior work, assessment of the job titles of the reported cases confirmed the wide array of work type associated with irritant asthma. While most jobs were intuitively linked with an exposure that might cause irritant asthma, various food-related tasks were of novel interest and worthy of mention; kitchen and catering assistants, food, drink and tobacco process operatives, fishmongers and poultry dressers were recorded as occupations in at least one case.

There are a significant set of weaknesses to our approach. Other important clinical data for each case, highlighted as diagnostically key by Walters *et al*,[7] were not available from the data collected from reporters. This includes lung function estimates (including reversible airways obstruction) and the presence of airway reactivity, integral to a more specific diagnosis of acute irritant-induced asthma. Similarly, the diagnostic criteria used by each reporting clinician will differ, as this is not specifically predefined, purposefully, within the current reporting system. It is likely that the reported cases described will be a mix of those that would meet a more strictly defined case of acute irritant asthma, and many that would not. In addition, certain cases may well have been reported where the clinician believed that repeated lower doses of irritant exposure (sometimes referred to as not so sudden or subacute irritant-induced asthma, rather than a high-level single exposure) may have caused asthma, although this former mechanism is still actively debated.[14] The SWORD case data do not permit further analysis of single versus multiple irritant exposure episodes. Additionally, misclassification of a case as an irritant-induced asthma, rather than due to sensitisation, is possible differentially across the reporter group; the latter will inevitably have varying experience of these cases.

There may also, as alluded to already, have been reporting overlap between irritant asthma and occupational inhalational accidents. In addition, it is highly likely that there is a significant under-reporting of cases, although previous work has been done in this area to estimate and limit these effects.[15] Differentiation by reporters between these diagnostic groups and inducible laryngeal obstruction[16] will also affect the numbers reported, although it is not possible to quantify this further with this study type.

Finally, while numbers appear to have dropped over the entire study period, this observation must be interpreted cautiously. The data do not permit a more comprehensive analysis of trend. Reporter numbers dropped through the study period, and other factors including change in referral practices and numbers of workers in relevant work sectors will all influence numbers of case reported. Previous work has specifically addressed trends in occupational asthma[2] from related data.

Further resolution of these significant weaknesses using these data alone is not possible. However, further work here could consider adaptation of the reporting process to include more comprehensive clinical characterisation and case definitions, lung function results and exposure information. This would permit further insight in relation to the exact nature, context and duration of each case, and also into the temporal relationships between the exposure and the clinical manifestations.

These future considerations must of course be balanced against the consistent requirements of the how these schemes run day to day, and in particular avoiding overly prescriptive reporting guidance for the reporters. Equally, as much is now known about the nature of the agents and work tasks linked to irritant asthma, it could be argued that developing and implementing workplace interventions to reduce the risks associated with these inhaled hazards is of equal or greater future priority.

In summary, this analysis has identified common occupations, work sectors and attributed exposures associated with irritant asthma. Incidence of this condition in the UK appears to be falling over the last 20 years, but many limitations in these data highlight the need to continue to develop research questions that fill evidence gaps. These should importantly include how to better characterise cases within such reporting schemes and also how best to develop and implement evidence based and practical interventions to reduce the workplace risks associated with a wide variety of well-characterised inhaled irritant hazards.

Twitter Ireny Iskandar @IrenyIskandar and Martie van Tongeren @martievt

Acknowledgements The authors wish to thank the entire THOR team based in Manchester.

Contributors All authors (DF, MC, II, BCF and MvT) contributed to the design, data collection, analysis and manuscript preparation; have seen and agreed the final manuscript. DF is responsible for the overall content as the guarantor.

Funding This report, and the work it describes, were funded by the Health and Safety Executive (HSE) of Great Britain.

Disclaimer Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval THOR (including SWORD) has National Health Service ethics approval given by the North West (Haydock) Research Ethics Committee (reference 17/NW/0129).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. There are currently no data available for sharing.

ORCID iDs
David Fishwick http://orcid.org/0000-0001-5941-090X
Ireny Iskandar http://orcid.org/0000-0002-8030-1908
Martie van Tongeren http://orcid.org/0000-0002-1205-1898

REFERENCES

1 SWORD (COEH - University of Manchester). SWORD - surveillance of work-related and occupational respiratory disease (SWORD) website; SWORD. n.d. Available: https://sites.manchester.ac.uk/thor/thor-uk-reporting-schemes/sword/
2 Seed MJ, Carder M, Gittins M, *et al*. Emerging trends in the UK incidence of occupational asthma: should we be worried. *Occup Environ Med* 2019;76:396–7.
3 Barber CM, Wiggans RE, Carder M, *et al*. Epidemiology of occupational hypersensitivity pneumonitis; reports from the SWORD scheme in the UK from 1996 to 2015. *Occup Environ Med* 2017;74:528–30.
4 Fishwick D, Carder M, Iskandar I, *et al*. Occupational inhalational accidents: analysis of cases from the UK SWORD reporting scheme from 1999 to 2018. *Occup Environ Med* 2022;79:628–30.
5 Brooks SM, Weiss MA, Bernstein IL. Reactive airways dysfunction syndrome (RADS). Persistent asthma syndrome after high level irritant exposures. *Chest* 1985;88:376–84.
6 Shakeri MS, Dick FD, Ayres JG. Which agents cause reactive airways dysfunction syndrome (RADS)? A systematic review. *Occup Med (Lond)* 2008;58:205–11.

7 Walters GI, Huntley CC. Updated review of reported cases of reactive airways dysfunction syndrome. *Occup Med (Lond)* 2020;70:490–5.
8 Malo JL, L'archevêque J, Castellanos L, *et al*. Long-term outcomes of acute irritant-induced asthma. *Am J Respir Crit Care Med* 2009;179:923–8.
9 SIC 2003 codes. Available: https://www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksicarchive [Accessed 25 Jan 2023].
10 Office for National Statistics. SOC2000 codes. SOC 2000. Available: ons.gov.uk [Accessed 25 Jan 2023].
11 Office for National Statistics. Time series: employment release date. 2016. Available: http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/mgrz [Accessed 5 Aug 2021].
12 Lucas D, Robin C, Vongmany N, *et al*. Main causal agents of occupational asthma in France, reported to the national network for occupational disease vigilance and prevention (Rnv3P) 2001-2018. *Ann Work Expo Health* 2023;67:297–302.
13 Carder M, Seed MJ, Money A, *et al*. Occupational and work-related respiratory disease attributed to cleaning products. *Occup Environ Med* 2019;76:530–6.
14 Lemiere C, Lavoie G, Doyen V, *et al*. Irritant-induced asthma. *J Allergy Clin Immunol Pract* 2022;10:2799–806.
15 Carder M, McNamee R, Turner S, *et al*. Improving estimates of specialist-diagnosed, work-related respiratory and skin disease. *Occupational Medicine* 2011;61:33–9.
16 Giraud L, Destors M, Clin R, *et al*. Diagnostic work-up of exercise-induced laryngeal obstruction. *Eur Arch Otorhinolaryngol* 2023;280:1273–81.