



Worldwide trends in incidence in occupational allergy and asthma

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Purpose of review

Recent improvements in the methods for analyzing trends in occupational health surveillance and the prospect of future improvements in the collecting and sharing of electronic data alongside increasing availability of linked datasets make this a good time to review the existing literature on trends in occupational allergy and asthma (OAA).

Recent findings

There is a notable lack of reports of recent trends in OAA in the academic literature and much of the published work comes from European countries. The incidence of OAA appears to be declining based on physician-reporting or recognized compensation claims for the countries with published data. However, we need to be cautious in interpreting this as a decline in the 'true' incidence of OAA. Few of the studies adjusted appropriately for changes in the population at risk and one of the most robust study designs showed no change in the incidence of allergic contact dermatitis in contrast to the other studies.

Summary

Many existing datasets have the potential to be used to examine trends, and studies from Canada show the potential of using linked databases for surveillance. We hope that this review will encourage improvements in the analysis, and more dissemination, of trends.

Keywords

asthma, contact dermatitis, contact urticaria, occupational allergic disease, occupational or work-related, trends in incidence

INTRODUCTION

Occupational health surveillance is a continuous and systematic process of collecting, interpreting, analyzing and disseminating descriptive information for monitoring occupational diseases. Monitoring trends is a major objective of most surveillance systems; changes in incidence can be used to identify new and emerging risks, evaluate national or regional-level interventions and identify individuals in need of treatment, prevention or education [1]. Some occupational health surveillance systems may be useful to estimate the incidence or prevalence of an occupational disease, but other study designs may be more suitable for this aim [2]. Given the differences in industries, occupations and occupational health surveillance systems between countries, cross-country comparisons of the incidence of occupational disease may be problematic but measures of change in incidence over time within countries, that is trends, may be more meaningful [3]. For example, a common problem in occupational health surveillance

systems is under-reporting, which is less of a problem when measuring trends rather than incidence (unless the level of under-reporting also changes with time). Occupational allergies and asthma (OAA) are particularly amenable to surveillance because of the availability of diagnostic tests and methods to identify the causal agent and confirm the work-relatedness, for example patch or specific inhalation challenge tests, compared with, for

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KEY POINTS

- The incidence of occupational asthma, allergic contact dermatitis and contact urticaria appears to be declining across many countries based on nationally representative physician-reporting or recognized compensation claims.
- French and UK data suggest declining trends in occupational asthma attributed to wood, flour, aldehydes, isocyanates and latex.
- French data suggest increasing trends in occupational allergic contact dermatitis attributed to quaternary ammonium, isothiazolinones, fragrances, epoxy resins, acrylic resins, hair bleaching products, biocides and cosmetics and no change for rubber additives that is consistent with trends reported in the United Kingdom and Germany.
- There are few reports of recent trends in OAA in the academic literature and much of the published work comes from Europe, yet the regression models discussed in this review could be applied to existing datasets worldwide.
- More use of linked datasets, better knowledge of the population denominators and improving the quality of recording of occupational exposures and diseases in health records would allow better estimates of trends in OAA and potentially lead to more evaluations of national-level interventions.

example, musculoskeletal disorders or mental health. Furthermore, the ability to identify the causal agent allows trends in exposures to be compared with trends in OAA [4[•]].

SCOPE OF THE REVIEW

The aim of this review is to summarize the published work potentially reflecting nationally representative recent trends in OAA. We have included reports of trends in the incidence of OAA from academic journals or published online by nationally representative bodies. As the time period covered by the trend was judged a better indicator of the current situation than the date of publication, reports that included at least 5 years of data and at least five measurements after the year 2000 were considered. Any diagnosis of OAA or type of data was considered, but most reports addressed trends in occupational asthma, allergic contact dermatitis (OACD) or contact urticaria (OCU) using physician-reported data or recognized compensation claims. Only articles written in English were considered, which could bias the review, for example, an article about a contact allergy

surveillance network in the Triveneto region of Italy was published in Italian only [5]. Also, some articles were not easily available, for example an article about the trends in prevalence of occupational disease in Bulgaria [6]. Often, potentially informative data are collected and analyzed by public bodies for their own use and not published in academic journals [7–9]. We have tried to describe some of this information but, again, it is likely to be incomplete.

STATISTICAL METHODS USED TO ESTIMATE TRENDS IN OCCUPATIONAL DISEASE

In 2008, McNamee *et al.* [10] published a method to analyze trends in occupational disease using count data obtained from the Health and Occupation Research Network (THOR), a UK-based voluntary physician-reporting scheme. This multilevel version of the Poisson regression model made some important methodological advances in analyzing data reported to physician-reporting schemes made up of multiple reporting centers. An important aspect of this model is the inclusion of the reporting center as ‘random effect’ meaning that the estimates are not affected by changes over time in the number of centers themselves. Furthermore, by allowing between-center variation in incidence, the model produces more accurate *P* values and confidence intervals than the simple Poisson model. Another feature of the model is the inclusion of population estimates as an ‘offset’ to take account of simultaneous change over time in the size of the population covered. A simpler version of this Poisson model (as there were not multiple reporting centers) was used to estimate trends in recognized compensation claims for occupational asthma in Belgium [11]. In France, a similar approach, albeit with some important differences, was taken by Ngatchou-Wandji and Paris [12] using a zero-inflated count model for estimating trends in occupational asthma reported to Le Réseau national de vigilance et de prévention des pathologies professionnelles (RNV3P) by occupational physicians in 32 occupational disease centers. This model includes the reporting center as a covariate rather than as a random effect and considers the situation in which reporter reports zero cases when in fact a case should have been reported. This can happen in voluntary reporting schemes for a variety of reasons such as holidays or if a reporter is too busy to file the report or after a decreasing enthusiasm for reporting after a long membership time (sometimes called reporter fatigue).

TRENDS IN OCCUPATIONAL ALLERGY AND ASTHMA ACROSS ALL EXPOSURES

In this review, we will first consider the trends in OAA over all exposures combined and then examine trends in OAA attributed to specific exposures, for example epoxy resins [13], or occupational sectors, for example hairdressers [14].

EUROPE

European Occupational Diseases Statistics have not been collected by Eurostat (the statistical office of the European Union) since 2009 [3[•]]. Despite this, much of the published work on trends in OAA comes from European countries. In the United Kingdom, there have been long-term declining trends in occupational asthma, OACD and OCU reported to THOR from 1996 to 2013 [15[•]]. Analysis of more recent trends (2006–2013) showed a decline of 2.8% per year in the incidence of occupational asthma and a decline of 5.5% per year for OACD. Another UK-based surveillance scheme based on reporting by respiratory and occupational physicians in the West Midlands (SHIELD) also observed a significant declining trend for occupational asthma of 5.5% per year from 1991 to 2011 [16[•]]. When the authors took into account the possibility of reporter fatigue, the incidence of occupational asthma was declining by 3.9% per year. The authors also pointed out that the overall declining trend was similar to the declining trend in occupational asthma attributed to flour that may reflect diminishing interest in some agents as there is no evidence for decline in exposure to flour. In France, there was a significantly decreasing trend in occupational asthma [17] and allergic rhinitis [12] reported to RNV3P from 2001 to 2009. There was very little change in the incidence of OACD [12,18], but a significant decline in the incidence of OCU of 6% per year from 2001 to 2010 [19[•]]. In Belgium, compensation claims with a definite, probable or possible diagnosis of occupational asthma were declining in incidence by an average of 2.9% per year between 1991 and 2003 [11], and in the Czech Republic there was a decline in recognized compensation claims for OACD from 1998 to 2009 [20]. Reporting by Dutch dermatologists showed a declining trend for occupational contact dermatitis (OCD) and OCU from 2001 to 2005 [21].

Building on this work, a European collaboration (MODERNET) used the method developed by McNamée *et al.* [10] to descriptively compare trends in OCD, OACD and occupational asthma between Belgium, the Czech Republic, Finland, France, Italy, the Netherlands, Norway, Spain, Switzerland and the United Kingdom [3[•]]. There was a declining trend for occupational asthma and OCD in both

recognized compensation claims and physician-reported cases in most countries (Table 1) [3[•]]. Three different types of French data were analyzed for trends. These were *Maladies à Caractère Professionnel* (MCP) [22] based on a periodic survey of workers and other visits to occupational health services, RNV3P and recognized compensation claims. There were declining trends for OCD observed in MCP and recognized compensation claims, but no change in incidence reported to RNV3P [3[•]]. Only THOR (UK) and RNV3P (France) have reported OACD separately from OCD as described above [15[•],18]. Analyzing the RNV3P data with the multilevel model showed a small but significant increasing trend in OACD (Table 1) [3[•]], but the analysis using reporting odds ratios found no significant change [18].

Other European data sources, besides those contributing to MODERNET described earlier, also show declining trends on OAA. In Poland, recognized claims for occupational asthma have significantly declined by around 20 cases per year from 1998 to 2011 (reducing from 2.7 to 0.5 cases per 100 000 employees) [23]. German compensation data show a declining trend in recognized allergic respiratory disease from 1995 to 2014 [24,25] and an increase in notifications for extrinsic allergic alveolitis over the same time period, but few were recognized [24]. The Norwegian Labour Inspectorate Registry for work-related diseases observed a steep decline in reports of suspected or confirmed work-related skin disease (of which 94% was OCD) from 2000 to 2013 [26].

NORTH AMERICA

In Ontario, there has been a decline in the incidence of accepted compensation claims for occupational asthma since the 1980s that seems to plateau between 2003 and 2007, although no statistical estimates of trends were made [27,28]. In Alberta and British Columbia, linkage between health records and employer-paid health premium codes allowed estimates of new adult-onset asthma by industry of employment [29,30]. The data linkage approach used in Alberta and British Columbia provides an alternative to reporting schemes for population surveillance [30], and in future changes in the work-attributable fraction of occupational asthma could be used to estimate trends. Also in British Columbia, the use of linked records to study asthma rates by industry showed an increasing trend in all industries from 1999 to 2003 [31]. The US Bureau of Labor Statistics publishes data on nonfatal workplace illnesses from the Survey of Occupational Injuries and Illnesses [32], and there are other US datasets [33] that appear to be suitable for estimating

Table 1. Estimated annual percentage change in incidence for physician reported and recognized compensation claims for occupational allergy and asthma in some European countries from 2001 to 2010 [3[¶]]

Country	Contact dermatitis	Allergic contact dermatitis	Asthma
Physician-reported annual % change 95% confidence intervals			
Italy	-8.4 -10.5, -6.4	-	-3.7 -6.0, -1.3
Netherlands (clinical specialist)	-10.8 -13.3, -8.3	-	-9.1 -19.0, 2.1
Netherlands (occupational physician)	-0.3 -2.4, 1.8	-	-0.8 -5.6, 4.3
UK (clinical specialist)	-3.0 -4.0, -1.8	-6.3 -7.9, -4.7	-9.1 -11.2, -5.9
UK (occupational physician)	-6.7 -9.9, -3.5	-	-11.9 -17.6, -5.8
France (RNV3P) ^a	0.1 -0.9, 1.1	1.8 0.6, 3.0	-14.8 -16.1, -13.5
France 2007–2012 ^b (MCP) ^c	-7.5 -11.9, -2.9		-2.6 -12.3, 8.2
Recognized compensation claims annual % change 95% confidence intervals			
Czech Republic	-4.8 -8.0, -1.5	-8.1 -10.1, -6.0	-1.7 -5.6, 2.4
Italy	-10.5 -11.6, -9.4	-	-3.8 -6.1, -1.5
Spain	-	-	-3.1 -9.5, 3.7
Switzerland	-6.0 -6.7, -5.3	-6.1 -7.5, -4.7	-3.2 -5.1, -1.3
Great Britain (UK data n/a)	-12.5 -15.2, -9.8	-	-3.7 -7.4, 0.3
Finland 2005–2011 ^b	-9.8 -12.1, -7.4	-9.3 -11.9, -6.6	-7.7 -17.0, 2.7
France 2004–2012 ^b	-6.9 -8.0, -6.2	-6.9 -7.8, -6.0	-6.8 -8.4, -5.1

^aLe Réseau national de vigilance et de prévention des pathologies professionnelles.

^bData not available for 2001 to 2010 – not directly comparable with other countries.

^cMaladies à Caractère Professionnel.

trends, for example Washington State's work-related asthma surveillance programme [34], but trends analyses do not seem to have been published.

ASIA AND AUSTRALIA

In Korea, compensated (cases recognized for medical care) occupational asthma appears to have declined from 2000 to 2006, whereas surveillance data did not seem to change but no tests of statistical significance were reported [35]. In Australia, there was an overall decline of around 50% in compensation claims for OCD from 2000 to 2011 and a more modest decline in occupational asthma claims [36].

TRENDS IN OCCUPATIONAL ALLERGY AND ASTHMA BY EXPOSURE OR OCCUPATION

The French RNV3P network [17,18,19[¶]] and the SHIELD database based in the West Midlands of the United Kingdom [16[¶]] have analyzed trends by occupation or industry and causal agents in a systematic way with statistical tests for trend. In RNV3P, there was a significant declining trend for occupational asthma attributed to wood, flour, aldehydes, isocyanates and latex. The SHIELD database reported a significantly declining trend for occupational asthma attributed to adhesives, colophony, flour/amylase, isocyanates, laboratory

animals, metalworking fluids, wood dusts and nonsignificantly declining trends for latex and glutaraldehyde. The only significant increasing trends reported were for quaternary ammonium products in RNV3P and cleaning products in SHIELD. It is likely that these reflect similar exposures as quaternary ammonium products were analyzed separately from cleaning products in RNV3P but not in SHIELD. The UK THOR database reported a declining trend in occupational asthma attributed to latex and glutaraldehyde in healthcare workers [37] and isocyanates in all workers [4[■]] in agreement with RNV3P and SHIELD (however, some of the cases reported to SHIELD may also be reported to THOR).

RNV3P reported significantly increasing trends for OACD attributed to quaternary ammonium, isothiazolinones, fragrances, epoxy resins, acrylic resins, hair bleaching products, biocides and cosmetics from 2001 to 2010 [18]. This is consistent with the German Information Network of Departments of Dermatology reporting a significantly increasing trend in positive patch tests for OACD caused by isothiazolinones [38] and the UK THOR database reporting a significantly increasing trend for OACD attributed to acrylates in beauticians [37,39]. Both RNV3P and THOR reported no significant trend in the incidence of OACD attributed to rubber additives [18,40] and significantly decreasing trends for OCU attributed to latex [19[■],40].

Apart from these more rigorous trend estimates for different causal agents described above, there are also some reports of observed changes in incidence without formal statistical tests. These include Dutch dermatologists reporting of the incidence of OAD and OCU between 2001 and 2005 by occupation and causal agent [41]. In Germany, changes in recognized compensation claims for occupational obstructive airway diseases (OADs) were reported by causal agents from 1970 to 2005 [25]. Another German study [14] of confirmed compensation cases of OAD from 1998 to 2007 observed a decline in latex-induced OAD in healthcare workers and in allergen-induced OAD in hairdressers from 2003. In an occupational dermatology clinic database Victoria, Australia, there was an increase in incidence for OACD in hairdressers from 1999 to 2004 followed by a decline from 2009, but no change in compensation claims over the same period [42]. In agreement with the above reports [4[■],17], accepted compensation claims in Ontario for occupational asthma attributed to di-isocyanates declined from 1998 to 2007 [28]. There was a significant decline in asthma among the US military population on active duty from 2001 to 2013, but this was not specified as occupational [43].

Although there is a variety in type of data and rigor of analysis among these reports of different causal agents, there are few conflicting directions of trend or substantial disagreements. Many of these studies would be considered weak individually, but this re-enforcement of each other's findings makes the overall picture a little more convincing.

USING TRENDS ANALYSES TO EXAMINE THE IMPACT OF INTERVENTIONS

Once a reliable method to estimate national-level trends in OAA is established, it is relatively straightforward to apply the method to examining the impact of national-level interventions on the incidence of OAA [44] or explain trends in terms of changes in market forces or legislation [37]. As long as potential confounding is considered appropriately, temporal changes in incidence can provide circumstantial evidence of the impact of an intervention, but if simultaneous trends in exposure are also known there is stronger evidence for a causal relationship. Comparing trends in isocyanate exposure in UK motor vehicle repair workers with trends in occupational asthma showed a simultaneous decline [4[■]], and a decline in occupational asthma attributed to natural rubber latex occurred alongside declining the use of powdered latex gloves in Belgium and Ontario [45,46].

REASONS FOR CAUTION IN INTERPRETING THE ESTIMATED TRENDS IN OCCUPATIONAL ALLERGY AND ASTHMA

Across many reports in several countries, there seems to be declining trends in OAA. However, we need to be cautious in interpreting this as a decline in 'true' incidence of OAA. First, there is a notable absence of reports of recent trends in OAA in the academic literature. Also, there is one important exception to this observation in that the incidence of OACD reported by the French RNV3P network remains temporarily stable [18] or shows a modest increasing trend (Table 1) [3[■]] depending on the precise method of analysis. As RNV3P is one of the most robust study designs in the review, it should heighten the caution with which we view the downward trends in OACD. It could be, however, a ceiling effect whereby the French occupational disease centers are at full capacity and therefore are not sensitive to reduced referrals, although declining trends in occupational asthma and OCU were detected [17,19[■]]. In addition, only one of these reviewed studies adjusted for changes in the working population at risk and only one of the

datasets analyzed was adjusted for the change in working population within each sector covered by the scheme (French MCP data) [3^o]. For the other datasets, population adjustments used the whole working population or the population covered by the worker's insurance [3^o]. A decline in the population at risk without the appropriate adjustment will bias the trend toward a decline. Apart from this, a decreasing trend could indicate a reduction in worker's health surveillance or access to healthcare, a reduction in case ascertainment, workers choosing not to seek advice because of poor job security or reporter fatigue (reporting zero cases when cases have occurred) as well as a genuine reduction in incidence. Furthermore, a decreasing trend is not always indicative of improvements in workers' health; we would expect to see an increase in following improvements in legislation to protect workers who require improved health surveillance or campaigns to draw attention to OAA. Changes in knowledge and opinions about OAA among physicians and patients over time can impact on trends in either direction.

CONCLUSION

Much of the published work comes from European countries, but articles from Canada show progress in the use of linked databases. Many existing nationally representative datasets have the potential to estimate trends [7–9,47], and we hope that this review will encourage improvements in the analysis and dissemination of trends. Despite the clear potential of occupational health surveillance, it has not achieved the same status as infectious disease surveillance. Possibly, this is because the diverse combinations of exposures, events and disease underlying occupational ill-health make the interpretation of trends complex, but another factor could be that burden of gathering information for occupational health surveillance has been placed on those providing the data, often volunteer reporters. This burden might be reduced in future through improvements in collecting and sharing of electronic data and increasing availability of linked datasets.

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Conflicts of interest

There are no conflicts of interest.

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