

ORIGINAL ARTICLE

12-year data on dermatologic cases in the Finnish Register of Occupational Diseases I: Distribution of different diagnoses and main causes of allergic contact dermatitis

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Abstract

Background: Skin diseases are among the most common occupational diseases, but detailed analyses on their epidemiology, diagnoses, and causes are relatively scarce.

Objectives: To analyze data on skin disease in the Finnish Register of Occupational Diseases (FROD) for (1) different diagnoses and (2) main causes of allergic contact dermatitis (ACD).

Methods: We retrieved data on recognized cases with occupational skin disease (OSD) in the FROD from a 12-year-period 2005–2016 and used national official labor force data of the year 2012.

Results: We analyzed a total of 5265 cases, of which 42% had irritant contact dermatitis (ICD), 35% ACD, 11% contact urticaria/protein contact dermatitis (CU/PCD), and 9% skin infections. The incidence rate of OSD in the total labor force was 18.8 cases/100 000 person years. Skin infections concerned mainly scabies in health care personnel. Twenty-nine per cent of the ACD cases were caused by plastics/resins-related allergens, mainly epoxy chemicals. Other important causes for ACD were rubber, preservatives, metals, acrylates, and hairdressing chemicals. Cases of occupational ACD due to isothiazolinones reached a peak in 2014.

Conclusion: Our analysis confirms that epoxy products are gaining importance as causes of OSD and the isothiazolinone contact allergy epidemic has started to wane.

KEYWORDS

contact urticaria, epoxy chemicals, incidence, irritant contact dermatitis, isothiazolinones, occupational contact dermatitis, occupational skin infections, protein contact dermatitis

1 | INTRODUCTION

Skin diseases are among the most common occupational diseases. In Finland, they comprise about 20% of all recognized occupational diseases. In many countries, occupational diseases are recorded and some data are published on a regular basis, but the information is very general. Detailed analyses on epidemiology, diagnoses, and causes of occupational skin disease (OSD) are published infrequently.¹

In Finland, all employees are insured for occupational disease, and insurance companies provide data on occupational diseases to the Finnish Register of Occupational Diseases (FROD). In this study, we

describe general characteristics of a 12-year material of the FROD covering the years 2005–2016 with a focus on the distribution of different diagnoses and causes of allergic contact dermatitis (ACD). We analyze risk occupations and causes of contact urticaria/protein contact dermatitis (CU/PCD) in detail in two other studies.

2 | MATERIALS AND METHODS

The Finnish Institute of Occupational Health (FIOH) maintains the Finnish Register of Occupational Diseases (or FROD). The data are provided

by a coordinator of the Finnish insurance institutions, Finnish Workers' Compensation Center, that collects data from private insurance companies and the Farmers Social Insurance Institution; farmers are covered by a special legislation that obliges them to insure themselves in their own social insurance institution. Other entrepreneurs can, if they want, insure themselves in private insurance companies where employees are insured. Employers must insure all their employees, but they can freely choose an insurance company. The FROD also receives copies of physicians' short reports on occupational diseases to Regional State Administrative Agencies. Although statutory, these reports cover only a minority of cases and provide some complementary information.

The register contains both recognized and suspected cases of occupational diseases determined by private insurance institutions and the Farmers Social Insurance Institution. The register comprises data, for example, on occupation, branch of industry, up to three causes of occupational disease, and the respective diagnoses. One case can have up to three different skin diagnoses, for example, ACD, irritant contact dermatitis (ICD), and contact urticaria (CU). Since 2005, we have been able to identify cases that have been recognized as occupational diseases by the insurance company. We restricted the present study to the recognized cases.

Branches of industry were coded according to the Standard Industrial Classification TOL 2008² since 2009. This national classification is equal to European industry standard classification system, NACE (Nomenclature des Activités Économiques dans la Communauté Européenne) revision 2. The preceding 2002 version of the national classification³ was used in 2005–2008. We restricted analyses on branches of industry to an 8-year period covering years 2009–2016 when the later classification was used. Statistics of Finland provided labor force data at section level (level 1).⁴

3 | RESULTS

3.1 | Demographic data

During the 12-year period, 2005–2016, the FROD comprised a total of 5265 newly recognized cases of occupational skin disease. In 2012, the size of the total employed labor force was 2 339 904. Based on that, the incidence rate of recognized occupational skin disease was 18.75 per

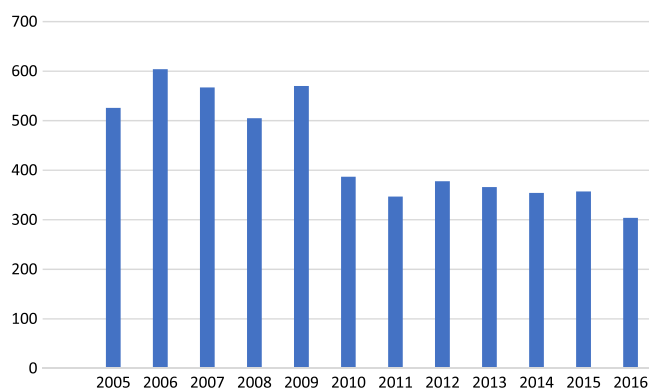


FIGURE 1 Annual numbers of recognized occupational skin diseases in 2005–2016 (according to the year of recognition)

100 000 person years during the 12-year period (95% confidence interval: 18.25–19.26). In 2005–2009, the annual case numbers exceeded 500, but thereafter they have varied between 300 and 400 (Figure 1).

A clear majority, 61%, of all the cases were female, but almost half of ACD cases were male (49%; Table 1). The mean age was 39.9 years in the whole material. That of skin infection cases was somewhat higher, at 43.5 years. Mean ages in different types of contact dermatitis were within a small range (Table 1).

3.2 | Branches of industry

This part of the analysis covered 3063 cases in years 2009–2016. Of the sections in the Standard Industrial Classification TOL 2008, "Human health and social work activities" comprised a quarter of the skin-related cases in the FROD. Manufacturing comprised one fifth. Incidences in these two sectors were about the same: 25.0 and 24.2 cases/100 000 person years, respectively (Table 2). The number of skin infections in "Human health and social work activities" was 255 (33%). If infections were excluded, the incidence of other skin diseases, that is, mainly different types of contact dermatitis, was 16.7/100 000 person years in this section. "Agriculture, forestry and fishing" was the third largest section, comprising 11% of the cases. Other large groups were "Wholesale and retail trade; Repair of motor vehicles and motorcycles"; "Other service activities"; "Construction"; and "Accommodation and food service activities." Their share of all the cases was about the same at 7%–8%. "Other service activities" include, for example, hairdressers and beauticians. "Wholesale and retail trade" also comprises many hairdressers and beauticians as well as bakers, cooks, and related workers in large department stores and markets. The incidence of OSD was highest in "Agriculture, forestry and fishing" (53.6), followed by "Other service activities" (40.9) and "Accommodation and food service activities" (31.4).

3.3 | Diagnoses

Among the 5265 cases, five individuals had as many as three different diagnoses: ACD, ICD, and CU or protein contact dermatitis (PCD), and 187 cases had two different diagnoses, most often both ICD and ACD (130 cases).

TABLE 1 Gender and mean age in the whole material and in groups with different types of contact dermatitis and skin infections as the first diagnosis

First diagnosis	Gender male/total; N (%)	Mean age; years
All	2039/5265 (38.7)	39.94
Allergic contact dermatitis	902/1832 (49.2)	40.09
Irritant contact dermatitis	737/2067 (35.7)	39.39
Contact urticaria/protein contact dermatitis	195/556 (35.1)	38.98
Other	159/359 (44.3)	39.44
Skin infection	46/451 (10.1)	43.43

TABLE 2 Seven sections in the Standard Industrial Classification TOL 2008 with the largest numbers of cases in 2009–2016

Section	Letter code	Codes at 2-digit level	No of cases (infections excluded)	Share of all 3063 cases (infections excluded)	Labor force in 2012	Incidence (95% CI), cases per 100 000 person year [infections excluded]
Human health and social work activities	Q	(86–88)	768 (513)	25% (17%)	383 605	25.0 (23.3–26.8) [16.7 (15.3–18.2)]
Manufacturing	C	(10–33)	622 (620)	20%	321 182	24.2 (22.4–26.2) [24.1 (22.3–26.1)]
Agriculture, forestry, and fishing	A	(01–03)	343 (333)	11%	80 058	53.6 (48.1–59.5) [52.0 (46.6–57.8)]
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	(45–47)	239 (238)	7.8%	282 438	10.6 (9.3–12.0) [10.5 (9.3–11.9)]
Other service activities	S	(94–96)	226 (222)	7.4% (7.2%)	69 005	40.9 (35.9–46.5) [40.2 (35.2–45.8)]
Construction	F	(41–43)	220 (220)	7.2%	154 184	17.8 (15.6–20.3)
Accommodation and food service activities	I	(55–56)	213 (213)	7.0%	84 688	31.4 (27.4–35.9)
Total work force			3063 (2757)		2 339 904	16.4 (15.8–17.0) [14.7 (14.2–15.3)]

Note: During this 8-year-period, the total number of cases with recognized occupational skin disease was 3063. Incidence rates and size of the labor force are given for these seven sections.

TABLE 3 Case numbers of diagnoses

Diagnosis	As first diagnosis		As secondary diagnosis (N)	Total number of cases with the diagnosis	
	N	Fraction of all cases		N	Fraction of all cases
Irritant contact dermatitis	2067	39.3%	148	2215	42.1%
Allergic contact dermatitis	1832	34.8%	31	1863	35.4%
Contact urticaria/protein contact dermatitis	556	10.6%	14	570	10.8%
Skin infection	451	8.6%	1	452	8.6%
Paronychia	9	0.17%		9	0.17%
Acne	1	0.019%		1	0.019%
Unclear	349	6.6%		349	6.6%
Total	5265				

TABLE 4 Main causes of irritant contact dermatitis (ICD) in cases with ICD as the first diagnosis

Cause	Cases	Fraction of all 2067 cases
Wet work	722	35%
Detergents	230	11%
Dirty work	170	8%
Cutting fluids and oils	112	5%

Table 3 shows that the most common diagnoses were ICD (in 42% of all the cases) and ACD (in 35% of all the cases). In the FROD, we are not able to make a clear distinction between cases with CU, PCD, or both. These two diagnoses formed the third largest group, comprising about 11% of all the cases. Skin infections were also a relatively large group, comprising 452 cases (8.6% of all). These were mostly scabies infections in health care workers. Occupational acne, in turn, was a very

rare disease: One sole case was an oil-induced acne in a motor vehicle assembler. Paronychia was also a rare diagnosis: only nine cases in occupations such as cooks and nurses were recorded. The diagnosis was unclear in 349 cases (6.6%). These mostly comprised unspecified dermatitis (L30.9 in International Classification of Diseases, Tenth Revision [ICD-10]), atopic dermatitis, or other types of dermatitis. Although the annual number of all OSD decreased during the study period (Figure 1), the fraction of ACD increased at the same time: in 2005–2010 it varied between 27% and 34% and in 2011–2016 between 36% and 45%.

3.4 | Main causes of ICD

ICD was the first diagnosis in 2067 cases and a secondary diagnosis in 148 (Table 3). Table 4 shows the most commonly mentioned causes of ICD (secondary diagnoses not included). About 150 different

causes were mentioned, many of which were closely related, for example, "wet work" and "hairdresser's work."

3.5 | Main causes of ACD

ACD was the first diagnosis in 1832 cases and a secondary diagnosis in 31; thus the total number of ACD cases was 1863. A total of 2210 causes were declared for ACD. One thousand five hundred eighty cases had only one cause, 219 cases had two causes, and 64 cases had three different causes for their ACD. The most common causes are presented in Table 5.

3.5.1 | Plastics and resins

Some plastic or synthetic resin was among the causes of ACD in a total of 541 cases (29.0%), epoxy chemicals and products being the most common group with 302 cases. Acrylates were mentioned in 116 cases and isocyanates or polyurethanes in 48 cases. These data included 35 ACD cases due to phenol formaldehyde resins (including "plywood glues"), 3 cases due to melamine formaldehyde resin, 2 cases due to *p*-tert-butylphenol formaldehyde resin, 21 cases due to polyvinyl chloride plastics, 4 cases due to polyester resins, and single cases due to polyethylene resin and silicone resins. It was not uncommon that ACD was caused by several resin types in one patient.

During the 12-year period, the relative importance of epoxy compounds as causes of ACD has increased, especially in the most recent years (Figure 2). We saw no increase in absolute case numbers, because annual numbers of all OSD cases declined during the same period. The largest occupational groups with epoxy ACD were plumbers and pipe fitters (41 cases) and painters (37 cases). The first group probably comprised mainly sewage pipe reliners.

Among the diisocyanates, diphenylmethane di-isocyanate (MDI) or diaminodiphenylmethane (MDA) was reported in 23 cases, hexamethylene di-isocyanate (HDI) in 6 cases, toluene di-isocyanate (TDI) in 5 cases, and isophorone di-isocyanate (IPDI) in one case. We interpreted MDA as a polyurethane-related allergen.

3.5.2 | Rubber

With a total of 312 cases, rubber-related cases formed the largest group, 16.7% of all ACD cases. During the study period, there was a steady slow decrease in annual numbers of rubber-related ACD, but the fraction of all ACD cases remained about the same.

3.5.3 | Preservatives

Isothiazolinones were the largest preservative group comprising a total of 172 ACD cases in the register. Benzisothiazolinone (BIT) was among

TABLE 5 Most common causes of allergic contact dermatitis (ACD)

Allergen group	Number of cases	Fraction of all 1863 ACD cases (%)
Plastics/resins; at least one type	541	29.0
Epoxy chemicals	302	16.2
Acrylates	116	6.2
Polyurethane-related (including isocyanates, MDA)	48	2.6
Other plastics and synthetic resins	111	6.0
Rubber/rubber chemicals	312	16.7
Preservatives; at least one type	299	16.0
Isothiazolinones	172	9.2
Formaldehyde and releasers	102	5.5
Other preservatives and disinfectants	49	2.6
Metals	220	11.8
Hairdressers' chemicals (dyes, bleaches, perms)	91	4.9
Colophonium	59	3.2
Plants	56	3.0
Fragrances	40	2.1
Coco fatty acid derivatives	29	1.6
Ethanolamines	28	1.5
Drug ingredients	17	0.9

Abbreviations: MDA, diaminodiphenylmethane.

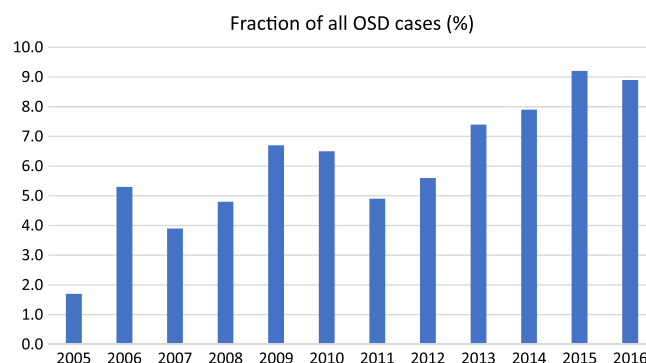


FIGURE 2 Allergic contact dermatitis due to epoxy products: Fraction of all cases of occupational skin diseases in 2005–2016. No clear change was seen in absolute numbers (10, 32, 20, 27, 36, 23, 21, 22, 24, 27, 34, and 23)

the causes in 20 cases, and octylisothiazolinone (OIT) in 12 cases. In 37 cases, methylisothiazolinone (MI) was the sole isothiazolinone declared. Methylchloroisothiazolinone/methylisothiazolinone (MCI/MI) or both its components were mentioned in 103 cases, and in 6 cases the

exact isothiazolinone was not declared. Figure 3 shows annual cases of isothiazolinone ACD. In the FROD, the isothiazolinone contact allergy epidemic reached its peak in 2014 and has clearly started to wane.

Formaldehyde or its liberators were mentioned in 102 cases, glutaraldehyde in 8 cases, and glyoxal in 4 cases of ACD. Parabens were among the causes in five cases, methylidibromo glutaronitrile in six cases, and iodopropynyl butylcarbamate (IPBC) in two cases. ACD due to polyaminopropyl biguanide (PHMB) was found in four cases, and sodium omadine and chlorhexidine in one case each.

3.5.4 | Metals

In a total of 220 cases, at least one metal was declared as a cause of ACD. Nickel was a cause in 92 cases, cobalt in 58 cases, and chrome in 88 cases. Gold was the cause in one case, zinc in one case, and mercury in two cases. Many individuals were allergic to several metals.

3.5.5 | Others

Concerning hairdressers' chemicals, hair dyes were declared in 65 cases, hair bleaches in 36 cases, and permanent chemicals in 6 cases. Quite many cases had several causes for their ACD within this category, for example, both hair dyes and persulfates.

In the group of coco fatty acid derivatives, cocamidopropyl betaine (CAPB)-related allergies, mainly dimethylaminopropylamine (DMAPA) and cocamidopropyl dimethylamine,⁵ were declared in 14 cases, cocamide diethanolamine (CDEA) in 9 cases, and sodium cocoamphopropionate was the cause of ACD in 6 cases.

In the group of ethanolamines, mono-ethanolamine (MEA) was the most common cause in 25 cases. Diethanolamine (DEA) was declared in five cases and triethanolamine in only one case. Among these patients, three cases had two causes, namely MEA and DEA. In 76 cases (4.1%), the cause of ACD were unspecified "other chemical factors."

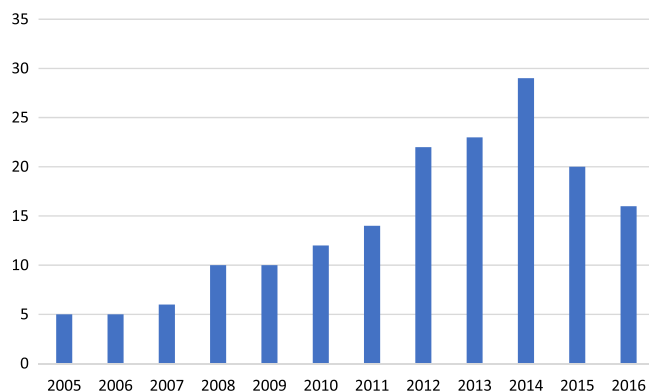


FIGURE 3 Isothiazolinone contact allergy epidemics: Annual numbers of cases of allergic contact dermatitis due to isothiazolinones

3.6 | CU/PCD

Contact urticaria and/or protein contact dermatitis was the first diagnosis in 556 cases. Of these, 322 (58%) were due to animal-derived materials, 184 (33%) from plant-derived materials, and 24 (4%) from chemicals.

4 | DISCUSSION

This study reports diagnoses and main causes of a total of 5265 recognized cases of occupational skin disease in Finland during a 12-year period from 2005–2016. As an estimate of the annual incidence rate during the whole period, we calculated 18.8 cases per 100 000 workers. That is within the range of two estimates from the UK: In 2002–2005, dermatologists provided an incidence rate of 9.1/100 000 and occupational physicians of 37/100 000.⁶ The incidence reported from Northern Bavaria in 1993–1999, 49 cases per 100 000 workers per year, was considerably higher.⁷ In Denmark, all recognized occupational skin diseases in year 2010 were reported in detail: In a country of about the same population as Finland, there were a total of 1504 cases, almost a fourfold figure compared with that of Finland, 391 cases in 2010. Underdiagnosing and underreporting in Finland are possible explanations; furthermore, there are probably differences in definitions of OSDs. In Finland, active atopic dermatitis in adult age usually excludes the diagnosis of occupational ICD. In the Danish material, there were 18 ICD cases due to "paper and cardboard" in office, postal, and sales workers. Such cases would probably not be recognized as an OSD in Finland. The share of ACD was 25% in Denmark, clearly lower than in our material, 35%. The criteria for an OSD are probably stricter in Finland, especially for ICD.

The annual number of recognized occupational skin diseases has clearly decreased during the 12-year period. There was a change to a lower level in 2010. This timing might be related to the recession that followed the international financial crisis. When companies are cutting personnel, those still at work do not seek medical investigations for bearable conditions such as mild or medium-grade hand dermatitis, and those already unemployed do not develop new occupational skin diseases. During the study period, Finland has met the same changes as most developed countries: Between 2007 and 2016, the size of the labor force in the manufacturing sector decreased from 397 000 to 288 000 (–27%), and that of "farming, forestry and fishing" from 93 000 to 67 000 (–28%). These changes might have had some impact on the total figures of OSD. In addition, the size of the total labor force was 3.9% smaller in 2016 than in 2007.

In about 6% of the recognized cases, the diagnosis was unclear, for example, unspecified dermatitis (L30.9) or atopic dermatitis. These should not be recognized or reimbursed, if the diagnoses were correct. We assume that the unclear data probably derived to a large extent from earlier stages of the process, when investigations had not yet been performed, and they not necessarily represent the final recognized diagnoses.

Causes of occupational skin disease are recorded in the FROD as they are reported, and this leads to a large variety of causes with different grades of specificity. The largest number of possible causes is three, and this also limits the possibilities to analyze all allergen groups in detail. For example, cases due to epoxy products often have contact allergies to many allergens: resins, hardeners, reactive diluents, and epoxy acrylates. When reporting cases to the FROD, it is not always easy to decide which three allergens are the most important actual causes. Instead of naming individual allergens, it is possible to use group-level reporting, for example, "epoxy compounds." For above-mentioned reasons, FROD data cannot be used to analyze, for example, frequencies of individual epoxy-related allergens, acrylates, or rubber allergens. Plants and fragrances were so often reported at group level that we decided not to give any numbers for individual allergens. Causes of ICD in the register are even more difficult to analyze, as they reflect physicians' opinions and varying traditions in naming them.

Regarding causes of ACD, the largest allergen groups in the FROD were rubber, epoxy chemicals, preservatives (biocides), and metals, in this order. In the above-mentioned Danish paper, the four largest allergen groups were the same.⁸ In the FROD, not only epoxy chemicals but also other plastics and resin allergen were so prominent that if grouped together, they formed by far the largest allergen group. "Hairdressing chemicals" were also a large allergen group both in the FROD and in the Danish material. When major allergens of occupational ACD in 2001–2010 were analyzed in France, "metals" was the largest group followed by "hairdressing products," "biocides," "resin/glue," and "rubber additives."⁹ Thus, the five largest groups in France were the same as in the FROD, although the comparison was not as straightforward as between the FROD and the Danish material.

Regarding time trends of individual allergen groups in the FROD, epoxy chemicals clearly gained relative importance during the study period (Figure 2). In France, there was an increase in absolute numbers of ACD due to epoxy resins in the period of 2001–2010.⁹ Also in China, an increasing rate of sensitivity to epoxy resin was observed between 2001 and 2006.¹⁰ The FROD material unsurprisingly reflected the worldwide epidemic of isothiazolinone contact allergy: There was first a more than fivefold increase in annual case numbers with a peak in 2014, and then declining numbers in line with recent papers.^{11,12}

5 | CONCLUSIONS

This analysis of OSD cases in Finland in the 12-year period from 2005–2016 provides a picture of OSD that is largely similar to previous reports from other European countries, especially with respect to

the causes of occupational ACD. There are some differences in overall incidences that may reflect national definitions of OSDs.

CONFLICTS OF INTEREST

No conflicts of interest.

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REFERENCES

1. Uter W. Surveillance in occupational contact dermatitis. In: John SM, Johansen JD, Rustemeyer T, Elsner P, Maibach HI, eds. *Kanerva's Occupational Dermatology*. Cham, Switzerland: Springer; 2018.
2. Standard Industrial Classification TOL 2008 http://www.stat.fi/meta/luokitukset/toimiala/001-2008/index_en.html. Accessed February 18, 2020.
3. Standard Industrial Classification 2002 http://www.stat.fi/meta/luokitukset/toimiala/001-2002/index_en.html. Accessed February 18, 2020.
4. https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin_vrm_tyokay/statfin_tyokay_pxt_115m.px/. Accessed August 7, 2019
5. Suuronen K, Pesonen M, Aalto-Korte K. Occupational contact allergy to cocamidopropyl betaine and its impurities. *Contact Dermatitis*. 2012;66(5):286–292.
6. Turner S, Carder M, van Tongeren M, et al. The incidence of occupational skin disease as reported to the health and occupation reporting (THOR) network between 2002 and 2005. *Br J Dermatol*. 2007;157(4):713–722.
7. Dickel H, Kuss O, Blesius CR, Schmidt A, Diepgen TL. Occupational skin diseases in northern Bavaria between 1990 and 1999: a population-based study. *Br J Dermatol*. 2001;145(3):453–462.
8. Carøe TK, Ebbeløh N, Agner T. A survey of exposures related to recognized occupational contact dermatitis in Denmark in 2010. *Contact Dermatitis*. 2014;70(1):56–62.
9. Bensefa-Colas L, Telle-Lamberton M, Paris C, Faye S, et al. French National Network of occupational disease vigilance P, Momas I. occupational allergic contact dermatitis and major allergens in France: temporal trends for the period 2001–2010. *Br J Dermatol*. 2014;171(6):1375–1385.
10. Cheng S, Cao M, Zhang Y, et al. Time trends of contact allergy to a modified European baseline series in Beijing between 2001 and 2006. *Contact Dermatitis*. 2011;65(1):22–27.
11. Flury U, Palmer A, Nixon R. The methylisothiazolinone contact allergy epidemic in Australia. *Contact Dermatitis*. 2018;79(1):189–191.
12. Urwin R, Craig S, Latheef F, Wilkinson M. Methylisothiazolinone: the epidemic is declining - but not gone. *Contact Dermatitis*. 2017;76(5):301–302.

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