Contact urticaria and protein contact dermatitis in the Finnish Register of Occupational Diseases in a period of 12 years

Maria Pesonen | Kirsi Koskela | Kristiina Aalto-Korte

Abstract

Background: Although occupational contact urticaria (CU) and protein contact dermatitis (PCD) are considered frequent among workers with exposure to proteinaceous materials, data on occupations at risk and the main causes of these occupational skin diseases are relatively limited.

Objectives: To report the causative agents and risk occupations for CU and PCD in the Finnish Register of Occupational Diseases (FROD).

Methods: We retrieved from the FROD all recognized cases of CU/PCD in the years 2005–2016.

Results: With 570 cases, CU and PCD constituted 11% of all recognized cases of occupational skin diseases in the study period. Occupations with the highest incidence of CU/PCD included bakers, chefs and cooks, farmers and farm workers, veterinarians, gardeners, and hairdressers. The most common causative agents were cow dander and flour and grain, followed by natural rubber latex (NRL) and other food. In food-related occupations, wheat and other flours were by far the most common cause of CU/PCD, with 76 cases, whereas fish and other animal-derived food caused 33 and other plant-derived food caused 23 cases.

Conclusions: Apart from the Finnish peculiarity of cow dander allergy, a striking finding was a large share of CU/PCD caused by flours in food handlers as compared to other food.

Keywords

bakers, contact dermatitis, farmers, immediate allergy, incidence, occupational skin disease

1 | INTRODUCTION

Contact urticaria (CU) is defined as a wheal and flare reaction of the skin after contact with an eliciting substance, which appears immediately and usually clears within a few hours.1,2 Protein contact dermatitis (PCD) is a slightly controversial entity. Its mechanism is not known, but in occupational settings, it is customary to diagnose PCD when immediate allergy to a proteinaceous material is associated with eczema on the contact site. It may be accompanied by an initial wheal reaction consistent with CU. Work-related exposure to proteinaceous materials such as food is known to carry a risk of occupational CU and occupational PCD.3,6 In fact, CU and PCD are rarely diagnosed outside occupational dermatology.5,6

Previous literature on the epidemiology of CU and PCD is relatively limited. To provide more detailed data on occupations at risk and causative agents of CU and PCD, we analyzed data of the Finnish Register of Occupational Diseases (FROD) in a period of 12 years.
METHODS

In Finland, all employees are insured against occupational disease. The insurance companies provide data on all cases of occupational diseases to the FROD. A register entry on a case comprises data on, for example, occupation, branch of industry, and up to three causes of occupational disease and their respective diagnoses. In the FROD, cases with suspected and recognized occupational disease are recorded. Since 2005, it has been possible to distinguish the recognized cases of occupational disease in the register. We have limited the present analyses to recognized cases of CU and PCD.

For the purposes of this study, we retrieved and analyzed data on CU and PCD cases reported in FROD in years 2005–2016. In FROD, cases with CU and PCD cannot be reliably separated from each other. Consequently, we have analyzed them as one group.

Occupations are coded according to the Finnish Classification of Occupations 2010 (based on ISCO-08) since 2011. The preceding 2001 version of the national classification (based on ISCO-88) was used during 2005–2010. Statistics Finland provides conversion tables between the two classifications of occupations in Finnish. We have previously described the problems encountered in the conversion.8 The conversion of some occupations (eg, chefs in this study) was impossible, and in those occupations, we decided to analyze only the latter period (2011–2016). We calculated incidences by using national labor force data of the year 2012 that we had retrieved from the web page of Statistics Finland on June 6, 2015 (no longer available on the internet).

RESULTS

Skin diseases are among the most common occupational diseases in Finland. During the 12-year period 2005–2016, the FROD included a total of 5265 newly recognized cases of occupational skin disease.9 During this period, a total of 570 cases were filed in the FROD with a diagnosis of CU and/or PCD, which represents 11% of all recognized cases of occupational skin diseases. Among these, CU or PCD was reported as the first diagnosis in 556 cases, in 13 as the second, and in one as the third diagnosis. Occurrence of CU and/or PCD per year shows a decreasing trend in 2005–2016 as is illustrated by Figure 1. The incidence of CU and/or PCD in the total labor force of 2 339 904 was 2.03 per 100,000 person-years (95% confidence interval [CI] 1.87-2.20).

Causes

The reported causes of CU and/or PCD are presented in Table 1. Proteins of animal origin defined as animal dander and excretions, and animal-derived foods, were reported as causes of CU and PCD in 326 cases (57% of cases with CU and/or PCD). In 265 (81%) of these, the cause was cow dander. Proteins of plant origin including flours, other plant-derived foods, grain, animal feed, and ornamental and other plants were the causes of CU and PCD in 171 cases (30% of all cases with CU and/or PCD). The most common individual causative allergen among plant proteins was wheat flour, which was the reported cause in 41 cases. However, in 20% of the cases caused by flours, the culprit grain was not defined in register data (Table 1). Natural rubber latex (NRL) proteins were the cause in 48 cases (8.4% of cases with CU and/or PCD) and thus constituted the third most common allergen group among cases with CU and/or PCD. There is a clear decrease in the amount of annually registered cases of CU and/or PCD caused by NRL (Figure 2). Chemicals were the cause of CU in 25 cases (4.4%). Among chemicals, the persulfates present in hair bleach products were the most commonly recorded cause of CU, followed by carboxylic acid anhydrides, which are used as epoxy hardeners by the electronics industry. Enzymes such as those used as flour additives were an uncommon cause of CU and/or PCD.

Occupations at risk

Incidences of CU and/or PCD in occupations at risk and their main causes of CU and/or PCD are presented in Table 2. The occupations with the highest incidence of CU and/or PCD included bakers, pastry-cooks and confectionery makers, farmers (mixed crop and animal producers) and farm relief workers involved in cattle breeding and milk production, veterinarians, veterinary technicians and assistants, chefs and cooks, gardeners, and hairdressers. The highest number of cases of CU and/or PCD were seen in farm work (farmers, farm relief workers, dairy and livestock workers), with 287 cases (50% of all CU and/or PCD), followed by food-handling occupations (bakers, cooks, chefs, kitchen and restaurant workers, waiters; n = 116), health care workers (n = 36), beauty sector (hairdressers and beauticians; n = 16), and gardeners (n = 14). In farm work, the most common causative agents were cow dander and flour and grain. Flours were the most important cause of CU and/or PCD in food-handling occupations. NRL was recorded as the cause in nearly all cases of CU and/or PCD in...
occupations of health and dental care. In hairdressers, the most commonly recorded cause was persulfates.

In addition to the occupations shown in Table 2, there were several occupations with a single case of CU and/or PCD. Among them, there were eight cases with higher education in various natural sciences who worked for universities, universities of applied sciences, and other research units, and were therefore likely to be researchers. In most of them (six of eight), the causative agent was rat.

Occupations of 15 cases with CU and/or PCD was recorded as "unknown." In all of them, the industry was "education," mostly vocational education. These cases are likely to represent students. Their causes of CU and/or PCD included cow dander (three cases), animal-derived foods (three cases), ammonium persulfate (two cases), NRL (two cases), flour and plant-derived foods (three cases), and rat and ornamental plants (one case of each).

4 | DISCUSSION

In the present study based on nationwide registry data, CU and PCD were analyzed as one group, since they are not reliably distinguishable in the registry. With the share of 11% of all recognized occupational skin diseases in the years 2005–2016, CU and PCD represented the third most frequent type of occupational dermatitis, after irritant and

| Allergen group                  | N (cases) | Main cause(s), n (cases) | Other causes, n (cases) |
|---------------------------------|-----------|--------------------------|------------------------|
| Animal dander and excretions    | 293 (51%) | Cow dander, 265 (46%)    | Rat, 10                |
|                                 |           |                          | Pig, 8                 |
|                                 |           |                          | Dog, 3                 |
|                                 |           |                          | Mouse, 3               |
|                                 |           |                          | Single cases: Fox, cat, sheep, mink, fur dust, spider |
| Flour, grain and animal feed    | 124 (22%) | Wheat, 41 (7.2%)         | Oat, 30                |
|                                 |           |                          | Barley, 27             |
|                                 |           |                          | Flour n.s., 25         |
|                                 |           |                          | Rye, 23                |
|                                 |           |                          | Buckwheat, 3           |
| Natural rubber latex            | 48 (8.4%) |                         | Carboxylic acid anhydrides, 6 |
|                                 |           |                          | Chloramine T (N-chloro p-toluene sulfonylamide), 2 |
|                                 |           |                          | Hair dyes and p-phenylenediamine, 2 |
|                                 |           |                          | Single cases: Epoxy compounds, isocyanates, sorbic acid |
| Animal derived foods            | 33 (5.8%) | Fish, fish flour, 19 (3.3%) | Shrimp, 5 |
|                                 |           |                          | Egg, 3                 |
|                                 |           |                          | Meat and entrails, 4   |
|                                 |           |                          | Milk, 1                |
| Chemicals                       | 25 (4.4%) | Persulfates, 13 (2.3%)   | Carboxylic acid anhydrides, 6 |
|                                 |           |                          | Chloramine T (N-chloro p-toluene sulfonylamide), 2 |
|                                 |           |                          | Hair dyes and p-phenylenediamine, 2 |
|                                 |           |                          | Single cases: Epoxy compounds, isocyanates, sorbic acid |
| Plant derived foods (flours excluded) | 23 (4.0%) | Root vegetables (carrot, celery root parsnip, potato), 9 (1.6%) | Cucumber, 3 |
|                                 |           |                          | Tomato, 2              |
|                                 |           |                          | Paprika, 2             |
|                                 |           |                          | Single cases: Chili, white pepper, peppermint, pine nut, cinnamon, thyme, fruits n.s., apple, sweet potato, herbs, vegetables n.s., spices, kiwi |
| Ornamental plants               | 15 (2.6%) | Ornamental plants n.s., 6 (1.0%) | Single cases: Tulip, ivy, freesia, narcissus |
|                                 |           |                          | Ficus benjamina, 5 (0.9%) |
| Other plants                    | 9 (1.6%)  |                          | Single cases: Hay, strawberry leaf, wood dusts, almond (cosmetic ingredient), wheat germ (cosmetic ingredient), henna, pectin, timothy, plants n.s. |
| Enzymes                         | 5 (0.9%)  | Enzymes n.s., 3          | Single cases: Alpha-amylase, flour additives n.s., pepsin |

*A case may have several causes of CU/PCD recorded. n(cases), number of cases with the given cause recorded. n.s., not specified. Percentages of the total number of cases in parentheses.*
allergic contact dermatitis. Occupations with the highest incidence of CU and/or PCD included bakers, pastry cooks and confectionery makers, farmers (mixed crop and animal producers) and farm relief workers, occupations in veterinary medicine, chefs and cooks, gardeners, and hairdressers. The most common causes of CU and/or PCD were cow dander, flour and grain, NRL, and food.

According to the underlying mechanism, CU may be classified into immunological or allergic CU (ICU) and nonimmunological CU (NICU). ICU occurs in previously sensitized individuals and is a type I hypersensitivity reaction mediated by allergen-specific immunoglobulin E (IgE) and may be complicated with mucosal and systemic symptoms. The mechanism of NICU is not completely understood, but it is a nonimmunologic immediate reaction that occurs without prior sensitization and limits itself to the skin. In CU, concomitant airway diseases caused by the same allergen is common. PCD is an allergic skin reaction induced by proteins of plant or animal origin, which clinically is a recurrent, itchy, sometimes vesicular eczema on the contact site of the causative agent. The immunological mechanisms of PCD remain to be fully elucidated. It is considered mainly to be caused by type I allergy, although also a combination of types I and IV hypersensitivities has been suggested. In practice, PCD is largely a clinical diagnosis, as a diagnostic test is lacking. Open application only very rarely produces vesicles that are an indisputable sign of eczema. At Finnish Institute of Occupational Health (FIOH), we have assumed that the minute papules that are commonly seen in open application tests are small wheals and not eczematous papules. Patients we diagnosed with PCD often have had a clear wheal reaction consistent with CU in open application test. On the other hand, in most patients, there is no way to reliably differentiate PCD from irritant contact dermatitis caused by the same culprit material and other concomitant irritant factors.

Owing to the lack of generally accepted diagnostic criteria for CU and PCD, there may be differences in the diagnostic procedures used in different countries. In addition, the methods of surveying and collecting data on occupational diseases are variable. Consequently, it is challenging to compare the results of studies on the frequency and causes of CU and PCD. Previous literature on the incidence of CU and PCD based on labor force numbers is sparse. From the British THOR network based on voluntary reporting by physicians, the annual incidence rate of occupational CU was reported to be 3.1/100 000 as reported by dermatologists, and 12.6 as reported by occupational physicians. In a review of the literature before 2010, occupational CU accounted for 1 to 8% of all occupational skin diseases. In Australia, in a clinic specializing in occupational dermatitis, 9.9% of patients with occupational skin disease had CU in 1993–2004. Similar to our present results, the share of reported cases of CU and PCD was 11.2% of all cases of occupational skin disease in Finland according to previous FROD data in 2002. Workers involved in handling of food are a known risk group of CU and PCD. In a Danish study, 22% of patients with occupational food-related skin diseases had PCD and 2.4% had CU. The frequency of CU or PCD in the general population is unknown. Based on German patient cohorts, the frequency of CU has been estimated to be <0.4%.

Previously reported causes of CU and PCD include a variety of proteinaceous substances such as plant- and animal-derived foodstuffs, NRL, enzymes, and in cases of CU, some chemicals. In our data, the most common causative agent was cow dander, which was recorded as a cause in 46% of cases with CU and/or PCD. Cow dander has for long been the most frequent cause of occupational CU in Finland. PCD caused by cow dander has been reported previously. It is also a well-known cause of occupational asthma and allergic rhinoconjunctivitis in farmers.

Grain, in the form of flour, cultivated grain, or animal feed, was the second most important cause of CU and PCD in our data. Flour was the most frequent cause in bakers and other food-handling occupations, and a frequent cause in occupations involved in cattle breeding. Immediate allergy to flour is among the most frequent causes of occupational respiratory diseases, and bakers are a known risk group of occupational asthma and rhinitis. In contrast to our results, in a study from Denmark on professional food handlers with hand dermatitis, flour was not so prominent among the skin prick test–positive allergens. Instead, vegetables and fruits were the most commonly positive allergen groups. The reason for this difference might be that in the Danish study, the flours were tested as commercial extracts, whereas in Finland, the flours have since the early 1990s been skin-moistened with a small amount of water, with prick-to-prick technique. This was based on findings that fresh foods are more effective in the skin-prick test than commercial food extracts. More recently, a concern has been raised on the variable and sometimes low antigen content of commercial skin-prick test extracts for several important occupational allergens including wheat flour and cow dander.

Occupational type 1 allergy to NRL was a major concern in health care workers in the 1990s. In the 2000s, a decline in new cases of occupational CU caused by NRL has been observed. This decline in incidence has been attributed to a ban on powdered NRL gloves in the health care sector and limitation of leachable NRL protein in gloves. In our data, NRL was the cause in nearly all cases of occupational CU and/or occupational PCD in health and dental care. In this
| Occupation                                      | Occupational code (earlier occupational code) | N cases | Incidence per 10 000 person years (95% CI) | Most common cause(s) of CU/PCD (n cases) |
|------------------------------------------------|-----------------------------------------------|---------|-------------------------------------------|------------------------------------------|
| **Food-related**                                |                                               |         |                                           |                                          |
| Bakers, pastry-cooks, and confectionery makers | 7512 (7412)                                   | 31      | 10.54 (7.29–14.78)                       | Flour (26)                               |
| Chefsᵇ                                         | 3434, 6 years                                 | 3       | 2.61 (0.66–7.11)                         | Flour (3)                                |
| Cooks                                          | 51201 (5122)                                  | 49      | 1.84 (1.38–2.41)                         | Flour (27), fish (14)                    |
| Food and related products machine operators   | 8160 (827)                                    | 14      | 0.78 (0.44–1.27)                         | Flour and grain (8)                      |
| Kitchen helpers                                | 9412 (91323)                                  | 9       | 0.41 (0.20–0.72)                         | Flour (7)                                |
| Restaurant services supervisors and shift managers | 51202 (51211)                              | 7       | 0.29 (0.13–0.58)                         | Flour (3)                                |
| Waiters, waitresses, and bartenders           | 5131, 5246, 9411, 5132 (5123)                 | 3       | 0.08 (0.02–0.22)                         | Wheat (2), food n.s. (1)                 |
| **Farming and animal care**                    |                                               |         |                                           |                                          |
| Mixed crop and animal producers               | 6130 (6130)                                   | 223     | 8.62 (7.54–9.81)                         | Cow dander (196), flour and grain (34)   |
| Farm relief workers                           | 61214 (6123)                                  | 60      | 8.61 (6.57–11.08)                        | Cow dander (50), flour and grain (3)     |
| Veterinary technicians and assistants         | 3240 (3227)                                   | 3       | 5.68 (4.46–15.46)                        | Cow dander (3)                           |
| Veterinarians                                 | 2250 (2223)                                   | 5       | 3.18 (1.17–7.06)                         | Cow dander (3), dog (1), entrails (1)    |
| Dairy and livestock workers                   | 61212 (6122)                                  | 4       | 1.77 (0.56–4.28)                         | Cow dander (2), grain (2)                |
| **Health care**                                |                                               |         |                                           |                                          |
| Life science technicians                      | 3141 (3211)                                   | 3       | 0.73 (0.19–1.98)                         | Rat (2)                                  |
| Dental assistants                             | 53291 (51325)                                 | 4       | 0.64 (0.20–1.55)                         | NRL (4)                                 |
| Dentists                                      | 2261 (2222)                                   | 3       | 0.60 (0.15–1.63)                         | NRL (3)                                 |
| Medical and pathology laboratory technicians  | 3212 (32314)                                  | 3       | 0.44 (0.11–1.19)                         | NRL (2)                                 |
| Nursing and midwifery associate professionals | 322 (32311, 32312, 3232)                      | 10      | 0.13 (0.06–0.23)                         | NRL (10)                                |
| Health care assistants                        | 5321 (513, 51321, 51322, 51324, 51326)       | 12      | 0.12 (0.07–0.21)                         | NRL (9), Chloramine T (1), isocyanates n.s. (1) |
| Medical doctors                               | 221 (2221)                                    | 2       | 0.09 (0.01–0.29)                         | NRL (1), rat (1)                         |
| **Industrial**                                |                                               |         |                                           |                                          |
| Plastic products machine operators            | 8142 (8232)                                   | 2       | 0.28 (0.05–0.93)                         | NRL (1)                                 |
| Electrical and electronic equipment assemblers| 8212 (8282, 8283)                            | 2       | 0.26 (0.04–0.87)                         | Carboxylic acid anhydrides (2)           |
| Electrical mechanics and fitters              | 7412 (7241)                                   | 2       | 0.16 (0.03–0.53)                         | Carboxylic acid anhydrides (2)           |
| **Miscellaneous**                             |                                               |         |                                           |                                          |
| Gardeners, horticultural, and nursery growers | 6113 (6112)                                   | 14      | 1.63 (0.93–2.67)                         | Ficus benjamina (5)                      |
| Hairdressers                                  | 5141 (51411)                                  | 15      | 0.91 (0.53–1.47)                         | Persulfates (11)                         |
| Cleaners                                      | 91121, 91122, 91129 (91322)                   | 4       | 0.06 (0.02–0.15)                         | NRL (3), Chloramine T (1)               |
| Heavy truck and lorry drivers                 | 8332 (8324)                                   | 2       | 0.04 (0.01–0.13)                         | Pig (1), molds n.s. (1)                  |

Occupational codes are according to the Finnish classification of occupations 2010 (in use since year 2011). Earlier occupational codes are according to the previous version of the national classification. Incidences calculated based on Finnish labor force in year 2012 according to Statistics Finland.

Abbreviations: CI, confidence interval; n.s., not specified; NRL, natural rubber latex.

ᵃA case may have several causes of CU/PCD recorded.

ᵇFor chefs, only data from years 2011–2016 is included because this occupation does not appear in the previous classification of occupations in use until year 2011; see Methods.
sector, the largest number of cases were seen in “nursing and midwife-ry associate professionals” and “health care assistants,” whereas the dental assistants and dentists had the highest incidence. In addition, individual cases caused by NRL occurred in a variety of other occupations, which might reflect the fact that natural rubber gloves are widely used in various work tasks.

The present study provides data from a nationwide register of occupational diseases, the FROD. In Finland, all employees are statutorily insured against occupational disease, and the insurance companies involved are obliged to provide data on suspected and recognized cases of occupational diseases to the FROD.5 Based on this, we assume that the present data reflect the incidence of CU and PCD in the Finnish working population more accurately than data based on voluntary reporting might do. As a limitation of the FROD data, insurance against occupational disease is mandatory for employees but voluntary to entrepreneurs and self-employed persons. Therefore, the occupational diseases of entrepreneurs without insurance will not be notified to the insurance companies, and consequently are not registered in the FROD. Another important limitation is that from the registry data, it is not possible to review the diagnostic methods used in each case. It therefore is not possible to evaluate the accuracy of the diagnoses and causes. However, all recognized cases of occupational diseases filed in the FROD have been evaluated by an insurance company that has had access to the relevant medical data. In the FROD, the individual information is not sufficiently detailed in all cases to permit a reliable distinction of cases with CU, PCD or both, which is a limitation. The consequences of CU and PCD for the patient’s ability to work are different. CU is often a mild condition, and easily preventable with personal protective equipment, whereas PCD as an eczematous disease with tendency to reoccur may necessitate treatment and sick-leave, and might compromise the patient’s ability to continue in a work with exposure to the causative agent.40

In conclusion, CU and PCD comprise approximately 11% of all occupational skin diseases in Finland. Occupations with a high incidence include bakers, cooks, chefs, and other food-handling occupations; farmers, farm workers and other occupations with exposure to cattle; gardeners, and hairdressers. Main causes of CU and PCD in Finnish workers are animal dander, grain, NRL, and plant- and animal-derived foods. It is noteworthy that among food-related occupations, wheat and other flours constitute by far the largest causative group of CU/PCD, with a 2- to 3-fold number of cases as compared with those caused by other foods.

AUTHOR CONTRIBUTIONS

Maria Pesonen: Conceptualization; data curation; investigation; visualization; writing-original draft. Kirsi Koskela: Data curation; formal analysis; writing-review and editing. Kristina Aalto-Korte: Conceptualization; data curation; formal analysis; methodology; project administration; writing-review and editing.

ORCID

Maria Pesonen https://orcid.org/0000-0003-0356-7064
Kristina Aalto-Korte https://orcid.org/0000-0002-5595-5512

REFERENCES

1. Fisher AA. Contact Urticaria. Contact Dermatitis. 2nd ed. Philadelphia, PA: Lea & Febiger; 1973:686-709.
2. Giménez-Arnau A, Maurer M, De La Cuadra J, Maibach H. Immediate contact skin reactions, an update of contact urticaria, contact urticaria syndrome and protein contact dermatitis -- "a never ending story". Eur J Dermatol. 2010;20(5):552-562.
3. Vester L, Thyssen JP, Menné T, Johansen JD. Occupational food-related hand dermatoses seen over a 10-year period. Contact Dermatitis. 2012;66(5):264-270.
4. Barbaud A, Poreaux C, Penven E, Waton J. Occupational protein contact dermatitis. Eur J Dermatol. 2015;25(6):527-534.
5. Aalto-Korte K, Suomela S. Contact urticaria syndrome: epidemiology and occupational relevance. In: Giménez-Arnau AM, Maibach HI, eds. Contact Urticaria Syndrome. Boca Raton, FL: CRC Press, Taylor & Francis Group; 2015:13-20.
6. Süß H, Döllé-Bierke S, Geier J, et al. Contact urticaria: frequency, elicitors and cofactors in three cohorts (information network of departments of dermatology; network of anaphylaxis; and Department of Dermatology, university hospital Erlangen, Germany). Contact Dermatitis. 2019;81(5):341-353.
7. Statistics Finland. Conversion table for 2010 and 2001 versions of Finnish classification of occupations. http://www.stat.fi/meta/luokitukset/ammatti/001-2010/luokitusavain_2.html#7. (In Finnish. Accessed March 6, 2020.
8. Aalto-Korte K, Koskela K, Pesonen M. 12-year data on skin diseases in the Finnish register of occupational diseases I: distribution of different diagnoses and main causes of allergic contact dermatitis. Contact Dermatitis. 2019;81(5):341-353.
9. Statistics Finland. Conversion table for 2010 and 2001 versions of Finnish classification of occupations. http://www.stat.fi/meta/luokitukset/ammatti/001-2010/luokitusavain_2.html#7. (In Finnish. Accessed March 6, 2020.
10. Wakelin SH. Contact urticaria. Clin Exp Dermatol. 2001;26(2):132-136.
11. Helaskoski E, Suojalehto H, Kuuliala O, Aalto-Korte K. Occupational contact urticaria and protein contact dermatitis: causes and concomitant airway diseases. Contact Dermatitis. 2017;77(6):390-396.
12. Hjorth N, Roed-Petersen J. Occupational protein contact dermatitis in food handlers. Contact Dermatitis. 1976;2(1):28-42.
13. Matsuo H, Uemura M, Yorozuya M, Adachi A, Morita E. Identification of IgE-reactive proteins in patients with wheat protein contact dermatitis. Contact Dermatitis. 2010;63(1):23-30.
14. 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.
15. Nicholson PJ, Llewellyn D, English JS. Evidence-based guidelines for the prevention, identification and management of occupational contact dermatitis and urticaria. Contact Dermatitis. 2010;63(4):177-186.
16. Williams JD, Lee AT, Matheson MC, Frowen KE, Noonan AM, Nixon RL. Occupational contact urticaria: Australian data. Br J Dermatol. 2008;159(1):125-131.
17. Hannukela M. Protein contact dermatitis. In: Frosch PJ, Menné T, Lepoittevin J-P, eds. Contact Dermatitis. 4th ed. Berlin, Germany: Springer; 2006:365-390.
18. Lukacs JS, Schliemann S, Elsen P. Occupational contact urticaria caused by food - a systematic clinical review. Contact Dermatitis. 2016;75(4):195-204.
19. Standardization of Spirometry. Update. American Thoracic Society. Am J Respir Crit Care Med. 1994;159(152):1107-1136.
20. Crépy MN. Dermatite de contact aux protéines. Références en santé au travail. 2017;TA 102(152):131-142.
21. Amaro C, Goossens A. Immunological occupational contact urticaria and contact dermatitis from proteins: a review. Contact Dermatitis. 2008;58(2):67-75.
22. Helaskoski E, Suojalehto H, Kuuliala O, Aalto-Korte K. Prick testing with chemicals in the diagnosis of occupational contact urticaria and respiratory diseases. Contact Dermatitis. 2015;72(1):20-32.
23. Helaskoski E, Suojalehto H, Virtanen H, et al. Occupational asthma, rhinitis, and contact urticaria caused by oxidative hair dyes in hairdressers. Ann Allergy Asthma Immunol. 2014;112(1):46-52.
24. Kanerva L, Susitaival P. Cow dander: the most common cause of occupational contact urticaria in Finland. Contact Dermatitis. 1996;35(5):309-310.
25. Kanerva L, Toikkanen J, Jolanki R, Estlander T. Statistical data on occupational contact urticaria. Contact Dermatitis. 1996;35(4):229-233.
26. Timmer C, Coenraads PJ. Allergic contact dermatitis from cow hair and dander. Contact Dermatitis. 1996;34(4):292-293.
27. Mahler V, Diepgen TL, Heese A, Peters KP. Protein contact dermatitis due to cow dander. Contact Dermatitis. 1998;38(1):47-48.
28. Valero Santiago AL, Rossell Vives E, Lluch Perez M, Sancho Gomez J, Piulats Xanco J, Malet CA. Occupational allergy caused by cow dander: detection and identification of the allergenic fractions. Allergol Immunopathol (Madrid). 1997;25(6):259-265.
29. Rautalahti M, Terho EO, Vohlonen I, Husman K. Atopic sensitization of dairy farmers to work-related and common allergens. Eur J Respir Dis Suppl. 1987;152:155-164.
30. Terho EO, Husman K, Vohlonen I, Rautalahti M, Tukiainen H. Allergy to storage mites or cow dander as a cause of rhinitis among Finnish dairy farmers. Allergy. 1985;40(1):23-26.
31. Malo JL, Chan-Yeung M. Agents causing occupational asthma. J Allergy Clin Immunol. 2009;123(3):545-550.
32. Mcdonald JC, Keynes HL, Meredith SK. Reported incidence of occupational asthma in the United Kingdom, 1989-97. Occup Environ Med. 2000;57(12):823-829.
33. Hytönen M, Kanerva L, Malmberg H, Martikainen R, Mutanen P, Toikkanen J. The risk of occupational rhinitis. Int Arch Occup Environ Health. 1997;69(6):487-490.
34. Storaas T, Steinsvag SK, Florvaag E, Irgens A, Aasen TB. Occupational rhinitis: diagnostic criteria, relation to lower airway symptoms and IgE sensitization in bakery workers. Acta Otolaryngol. 2005;125(11):1211-1217.
35. Ortolani C, Ispano M, Pastorello EA, Ansaloni R, Magri GC. Comparison of results of skin prick tests (with fresh foods and commercial food extracts) and RAST in 100 patients with oral allergy syndrome. J Allergy Clin Immunol. 1989;83(3):683-690.
36. van Kampen V, de Blay F, Folletti I, et al. Evaluation of commercial skin prick test solutions for selected occupational allergens. Allergy. 2013;68(12):651-658.
37. van Kampen V, de Blay F, Folletti I, et al. EAACI position paper: skin prick testing in the diagnosis of occupational type I allergies. Allergy. 2013;68(5):580-584.
38. Bensefa-Colas L, Telle-Lamberton M, Faye S, et al. Occupational contact urticaria: lessons from the French National Network for occupational disease vigilance and prevention (RNV3P). Br J Dermatol. 2015;173(6):1453-1461.
39. Allmers H, Schmengler J, John SM. Decreasing incidence of occupational contact urticaria caused by natural rubber latex allergy in German health care workers. J Allergy Clin Immunol. 2004;114(2):347-351.
40. Vester L, Thyssen JP, Menné T, Johansen JD. Consequences of occupational food-related hand dermatoses with a focus on protein contact dermatitis. Contact Dermatitis. 2012;67(6):328-333.