

ALLERGIES IN THE WORKPLACE

OCCUPATIONAL DERMATITIS IN FOOD PROCESSING WORKERS WITH A SPECIAL FOCUS ON THE SEAFOOD PROCESSING INDUSTRY – A REVIEW

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ABSTRACT

Work-related skin problems are highly prevalent in food handlers and seafood processing workers. More than 50% of seafood processing workers report recurrent symptoms in the past year. Previous studies have reported that a large proportion (75%) of contact dermatitis in these workers is irritant in nature and is due to wet work, exposure to detergents with frequent hand washing, and seafood products such as fish juice and fish skin. Type IV allergic contact dermatitis has been reported to chemical agents such as rubber additives and biological agents such as garlic and onions. Protein contact dermatitis is caused by high-molecular-weight proteins including seafood and other food additives and spices. Future studies need to focus on the prevalence of patterns of type IV allergic sensitisation to various workplace allergens in seafood processing workers, as well as the risk factors for contact dermatitis and other occupational dermatoses among seafood handlers.

INTRODUCTION

The review focuses on occupational contact dermatitis, including protein contact dermatitis. As the available literature about seafood processing workers is limited, the search was extended to cover food handlers more generally. Literature searches were performed on Pubmed and Medline using the keywords 'skin disease/dermatitis/occupational contact dermatitis', 'fish/detergents/preservatives/rubber/metals' and 'seafood workers/seafood processing workers/food handlers'. Abstracts were assessed for relevance of the article and the relevant full articles were obtained where possible. The search was limited to articles published in English, but there was no limit on the time at which they were published. Reference lists of the articles obtained were scanned for additional citations. Articles were appraised for validity and reliability, and limitations were assessed.

Seafood processing industry

The fishing and aquaculture industries have grown in recent years, and it has been estimated that approxi-

mately 44.9 million people are employed in fishing and seafood processing worldwide.¹ In South Africa, the number of workers directly employed in fishing has declined over the past decade from 30 000 people to approximately 16 854.¹ Division of labour is along gender lines with men going out to fish, and women employed in factories to perform the processing work.^{1,2} Reported ill-health may be related to safety risks, noise levels, cold and wet work, exposure to bio-aerosols, bacterial and parasitic infections and ergonomic risks.² Many workers are seasonally employed with precarious employment which has been shown to increase ill health and accidents.¹

Immunological reactions to consumption of seafood are commonly reported, and there has recently been an increase in reporting of occupational immunological reactions to seafood, as a result of the increase in employment in the industry internationally.³ Common type I immune reactions include asthma and contact urticaria.³ Contact dermatitis is commonly due to an irritant reaction to the wet work, use of gloves and exposure to fish juices, but may be due to a type IV allergy (Fig. 1).⁴

Occupational skin disease

Occupational skin diseases are common occupational conditions and account for a large proportion of reported occupational disease in many developed countries.⁵ Between 70% and 90% of occupational skin diseases are due to occupational contact dermatitis,⁶ with contact urticaria and other conditions making up a far smaller proportion. Incidence of occupational contact dermatitis is reported to be between 5 and 19 cases per 10 000 workers per year.⁵ In South Africa, occupational contact dermatitis was the fifth most commonly compensated condition in 2009.⁷

Occupational contact dermatitis is categorised as irritant or allergic in nature. Allergic contact dermatitis is a type IV immune reaction manifesting as eczema. It is diagnosed clinically (history and examination) and may be supported by a relevant patch test to an identified exposure and symptoms and signs precipitated on exposure. A diagnosis of irritant contact dermatitis is made on clinical grounds on the basis of exposure to known irritants, including wet work and occlusive gloves, and a relevant temporal relationship between exposure and skin symptoms.⁸ Irritant dermatitis can be considered as a diagnosis of exclusion if no patch test results are relevant.⁵

In general, irritant contact dermatitis is thought to occur more commonly than allergic contact dermatitis. Dickel *et al.*⁹ reported irritant contact dermatitis in more than half of their patients with occupational skin disease, ranging from 59% of occupational skin disease in automobile workers and locksmiths and up to 76% in pastry cooks. In the past there was dissension with some authors reporting that allergic contact dermatitis may be more common than generally acknowledged. Kucenic and Belsito¹⁰ argued that cases of allergic contact dermatitis are missed because of limited allergens available commercially and the time investment necessary for patch testing. However, their study, which found a prevalence of allergic contact dermatitis of 60%, was



Fig. 1. Work processes in the seafood processing industry: a – additives used in fish canning; b – fish handling and degutting; c – lobster washing.

based at a tertiary referral centre, so there may have been a bias towards more severe cases of dermatitis. Recently published guidelines indicate that in the general workforce, irritant occupational contact dermatitis occurs more commonly than allergic occupational contact dermatitis.⁶ However, the latter condition frequently coexists with irritant contact dermatitis and it seldom occurs on its own or without a break in the skin barrier function.

A subcategory of allergic contact dermatitis which is particularly associated with the food processing industry is protein contact dermatitis.⁸ First described in 1976,¹¹ this is a condition in which individuals experience immediate symptoms (itching, erythema and occasionally vesicles) with exposure to high-molecular-weight proteins, such as animal and vegetable proteins. With chronic exposure, a contact dermatitis develops. Although the mechanism is not completely understood, it is thought to be an IgE-mediated reaction, and diagnostic investigations should include a relevant skin-prick test¹¹ and the presence of allergen specific IgE antibodies in the serum to confirm its presence in symptomatic workers.¹²

OCCUPATIONAL SKIN DISEASE IN FOOD HANDLERS

Although irritant dermatitis is the most common condition, most of the literature has focused on protein contact dermatitis.

Protein contact dermatitis

Several studies have considered skin conditions in food processing workers, as they are known to be a high-risk group with exposures to wet work, gloves and various chemicals and proteins. A seminal study, published in 1976, described 15 food handlers who all noted that their dermatitis was aggravated by contact with fish or particular vegetables. They reported itching within 10–30 minutes of exposure, and some developed erythema and vesicles at the site of contact. On patch testing, they were noted to be sensitised to metals, onion and garlic. On scratch testing, 8 of 15 cases had immediate reactions to fish, whereas patch testing was negative. The authors concluded that the symptoms were caused by an immediate hypersensitivity reaction, and surmised that high-molecular-weight proteins are able to penetrate the skin. It is thought that pre-existing irritant dermatitis may impair the skin barrier sufficiently to allow this to happen.¹¹

A 1983 study¹² of 3 664 people with contact dermatitis revealed a high proportion of food processing workers with an occupational cause (91/180) and a particularly high proportion among fish factory workers (20/24). A large proportion of the dermatitis was deemed to be protein contact dermatitis due to fish, meats and vegetables, as scratch tests and RASTs (radio-allergosorbent tests) were positive in symptomatic workers. Mackerel was the commonest sensitiser among the fish factory workers. Similarly, in a Finnish study¹³ comparing occurrence of eczema in various departments of a large factory which produced canned meats, snacks, chocolates, liquorice, chewing gum and fish (herring) products, the eczema in 16 of the 23 affected fish workers was thought to have an occupational cause. Overall, 23% (16/69) of the workers in the fish department had occupational eczema compared with an average of 8.5% (99/541) across departments. Only one worker had a positive prick test and scratch test to fish, but the majority of workers were not tested with prick and scratch tests (only 10 tests performed) since not all seafood products were tested for. In this study it was felt that the majority of irritant dermatitis was due to brine, dressings and detergents. They also found a high prevalence of delayed sensitivity reactions to rubber chemicals (5 of the 10 positive patch tests which were relevant to work).

Cronin¹⁴ described skin conditions in 50 catering workers. Ultimately, 21 (42%) were diagnosed with irritant contact dermatitis alone, while 17 (34%) had irritant dermatitis with a food allergy and only 3 (6%) had irritant changes with a 'relevant hand allergen', such as rubber or perfume mix. Type I sensitisation was most commonly related to fish (4 of 9 with a positive scratch test to food), and garlic was the most common type IV reaction (7 of 8 with a positive patch test to food), similar to Hjorth and Roed-Petersen's findings.¹¹ Two people were sensitised to their gloves.¹⁴

An Australian case series presented 'urticarial contact dermatitis' in 14 food handlers.¹⁵ Seafood (including fish, crustaceans and molluscs) was the most common cause of allergic wheal and flare reaction on skin-prick testing, but not one of the 14 cases had a positive patch test to fish. One person had a positive reaction to nickel and one to thiuram mix on patch testing, but both also had reactions to fish on the prick test.

Irritant and allergic contact dermatitis

Although the studies mentioned above have concentrated on protein contact dermatitis, in fact, irritant contact dermatitis is far more common in food processing workers, because of wet work, occlusive glove use, detergent and disinfectant exposures and contact with irritant food ingredients.

Dickel *et al.*⁹ reported irritant contact dermatitis as the cause of occupational skin disease in 63% (29/46) of butchers and food processing workers, 69% of cooks (78/113) and 76% (34/45) of pastry cooks. Halkier-Sørensen⁴ noted irritant contact dermatitis as the cause of skin disease in 75% of workers in the seafood processing industry.

In a large-scale retrospective German study,¹⁶ data from 873 food processing industry workers were analysed. Irritant contact dermatitis and allergic contact dermatitis comprised 38.3% (334/873) and 24.4% (213/873) of occupational contact dermatitis respectively, while protein contact dermatitis was diagnosed in only 2.7% of workers (24/873). Food processing workers had a higher prevalence of nickel sulphate (160/815) and thiuram (31/815) contact sensitisation on patch testing compared with a control group of other workers undergoing patch testing. It was postulated that thiurams could be released from gloves worn by these workers as a result of occlusion and sweating, contributing to the higher rate of sensitisation. Food processing workers also had a nearly twofold increase in sensitisation to formaldehyde compared with the control group, possibly because of exposure to disinfectants used to clean machinery and surfaces.

Aside from studies looking at food processing workers in particular, larger epidemiological and surveillance studies across various industries mention food processing workers as they often have above average rates of contact dermatitis. In surveillance data reported voluntarily by dermatologists and occupational physicians in the UK,¹⁷ dermatologists reported an annual incidence rate of 30.5 cases of contact dermatitis per 100 000 workers in chefs and cooks (470 cases in total), and the most frequent causative agents were food and flour (245/470), wet work (117/470), soap (92/470), nickel (62/470) and rubber (40/470). Chrome and fragrances were reported as additional causative agents in other food processing workers (13/96 and 5/96 cases respectively). There is probable over-reporting of occupational contact dermatitis in this database as doctors are encouraged to report even suspected cases. However, Nettis *et al.*¹⁸ reported similarly that food service workers ($n=24$) commonly had a relevant allergy to nickel (9/24), cobalt (3/24) and rubber additives (3/24) on patch testing.

Metals

Further reports from the voluntary surveillance program in the UK looked at the role of nickel as an occupational allergen.¹⁹ It is difficult to ascertain the relevance of a positive patch test to nickel as sensitisation commonly occurs in the general population following ear piercing, and exposure to nickel in the food industry is difficult to quantify. In 64% of cases, nickel was not considered relevant to the skin condition, despite a positive patch test. Conversely, in 36% of cases, nickel sensitisation was thought to be relevant to the patient's occupational skin disease after taking into consideration their job exposures. Irritant dermatitis from wet work may predispose to sensitisation. Furthermore, Shah *et al.*²⁰ postulate that nickel exposure may be high in food handlers, as the fluids involved in wet work can leach nickel from utensils. Primary sensitisation may well be due to ear

piercing, but secondary exposure in the workplace can lead to an allergic contact dermatitis.

Often cobalt and nickel allergy coexist,²¹ particularly in women, and this may again be as a result of ear piercing and wearing of costume jewellery. Both cobalt and nickel sensitisation are associated with an increase in hand dermatitis but the mechanism is unclear²¹ and dermatitis may develop in the absence of occupational exposure. Although cobalt was reported to be a frequent sensitizer (3 of 24 patients) by Nettis *et al.*¹⁸ this may have been due to coexisting nickel and cobalt allergy rather than occupational exposure. Generally, larger epidemiological studies do not report an association of cobalt allergy and food processing work.^{21,22} However, in the study by Rui *et al.*²² food workers made up only 1% of the population studied, so the numbers may have been too small to identify an association.

Rubber and rubber additives

In addition to metal exposure, workers doing wet work can be exposed to allergens in gloves. Peltonen *et al.*¹³ reported high rates of positive patch tests to rubber additives in seafood workers (cause of 4 of 16 cases of occupational contact dermatitis). A German contact dermatitis surveillance network²³ found that food workers had high rates of thiuram sensitisation, with a prevalence of 5% per annum. This was a similar prevalence to that found in cleaners and healthcare workers, and gave a prevalence ratio of 3.48 (confidence interval (CI) 2.16-5.31), when compared with office workers and teachers.

In a Spanish study²⁴ comparing non-healthcare workers and healthcare workers – who have traditionally had a high incidence of type I sensitisation to latex – food handlers had the same incidence of positive prick tests to latex (7/41) as healthcare workers (13/78), higher than other professions such as hairdressers and cleaners. Nearly 75% of patients with a positive prick test to latex had hand eczema. The authors suggest that hand eczema may predispose to sensitisation. Sommer *et al.*²⁵ looked at type IV sensitisation to natural rubber latex, even though most type IV reactions to gloves are thought to be due to the rubber additives, such as accelerators and vulcanisers. There was a positive patch test prevalence of 1% in patients with contact dermatitis, suggesting that delayed hypersensitivity to latex does exist although at a lower prevalence than type I sensitivity.

Table I lists studies which reported results of patch tests in groups of food handlers and seafood processing workers. Aside from food products, rubber additives and metals were often the cause of a positive patch test.

OCCUPATIONAL SKIN DISEASE IN SEAFOOD WORKERS

Epidemiology and environmental risk factors

As noted, seafood processing workers feature prominently in the literature of dermatitis in food handlers, as they have a high prevalence of skin conditions.

Studies from South Africa²⁶ and Australia²⁷ used questionnaires to ascertain employer-reported health problems among workers in seafood processing plants. In Australia, there was a very low response rate of 18%, (140/779) but the results were similar to those seen in South Africa. Employer surveys in South African ($n=68$) and Australian ($n=140$) workplaces reported a high prevalence of skin problems, with skin rash accounting for 78-81% of all reported health problems associated with seafood processing. Skin symptoms were more

Table 1. Studies of occupational contact dermatitis in food handlers and seafood processing workers

Occupation	Subjects	Prevalence of contact dermatitis n (%)	Skin-prick test (number positive)	Other immunological evidence	Patch test (number positive)	Other evidence
Epidemiological studies						
a) Food handlers Catering workers ¹⁴	50 (symptomatic workers)	47 (94%)	11+ to foods 4 + to fish	ND	10 + to food products 1 + to herring 9 + to nickel sulphate 2 + to thiurams and carbamates	Clinical examination
Food processing factory workers ¹³	541 (all workers)	46 (8.5%)	1 + to commercial fish antigen and herring from workplace	ND	7 of 72 + to nickel sulphate 3 of 72 + to thiurams 1 of 72 + to carbamix 5 of 72 + to formaldehyde 4 of 72 + to balsam of Peru 2 of 72 + to p-phenylenediamine 3 of 15 + to rubber gloves	Clinical examination
Food service workers ¹⁸	24 (symptomatic workers)	16 (66.7%)	ND	ND	9 + to nickel sulphate 3 + to cobalt chloride 1 + to p-phenylenediamine 1 + to potassium dichromate 1 + to formaldehyde 1 + to isopropyl-N-phenylenediamine 22 + to thiuram mix	Clinical examination
Meat and fish processors ²³	436 (symptomatic workers)	NA*	ND	ND		
Food processing occupations ¹⁶	816 (symptomatic workers)	NA*	ND	ND	160 of 815 + to nickel 31 of 815 + to thiuram mix 19 of 816 + to formaldehyde	
Fish fillet and fish-stick producers ³⁶	102 122 (all workers)	14 (13.7%) 29 (23.8%)	1 + to mustard alone; 6 + to fish 2 + to mustard and fish 3 + to fish	ND	6 + to nickel 1 + to colophony 1 + to fragrance mix 1 + to balsam of Peru	
Case reports and series						
Biology student handling trout ³³	1	NA	+ to cod and sardine	RAST: + to cod, sardine and oily fish HRT: + to cod	Open patch test: negative	Rub test: + to cod
Dolphinarium worker ³²	1	NA	+ for herring, anchovy, sardine, salmon, cod, tunny	RAST (herring): + HRT: + to herring, sardine, anchovy, cod, salmon, tunny	Open and closed patch tests: all negative	Rub test: + to herring, anchovy, sardine
Unknown: handling raw fish ³⁴	1	NA	+ for commercial fish extracts and raw extracts made in-house (cod, hake, salmon, tuna, trout)	RAST: + to sole, hake and cod	Closed patch tests all negative	Prick-by-prick: + to raw and cooked sole, hake and cod Rub test: + to raw sole and hake
Food handlers ¹⁵	14	NA	10 + to seafood 5 + to vegetables, fruit 1 + to meat 1 + to grains	ND	1 + to nickel and fragrance 1 + to thiuram mix and rubber glove	

ND = not done; NA = not applicable; RAST = radio-allergosorbent test (specific IgE); HRT = histamine release test.

*All subjects in the study had contact dermatitis

common than upper and lower airway symptoms, and the authors postulated that the skin symptoms could be caused by wet work, as well as exposure to irritants present in the sea water, food additives such as garlic and other spices, and high-molecular-weight proteins from seafood itself.

A Norwegian study²⁸ administered questionnaires to employees in seafood-processing plants. More than half of the employees ($n=210$) reported symptoms of dry skin, itch, rash, eczema, or chapped skin and fissures in the preceding 12 months. In white fish processing, the most common self-reported causes for symptoms were contact with the fish itself (70/210), glove use (60/210) and contact with fish juice (56/210).

In an earlier study in Danish fish processing workers²⁹ 80% of workers (156/196) reported skin symptoms such as itching, redness and stinging. Symptoms were predominantly located on the forearms rather than the hands. This was thought to be due to the low temperature of the fingers and palms inhibiting itch. On the other hand, Bang *et al.*³⁰ found that seafood workers ($n=1\ 767$) who felt cold reported itch and dry skin more frequently than workers who did not feel cold, and concluded that cold work might be an independent risk factor for reported skin symptoms.

A mechanism for dry skin and impaired barrier function of the skin with cold exposure was advanced by Halkier-Sørensen *et al.*³¹ Skin barrier function was disrupted in mice by treating the skin with acetone. Transepidermal water loss was monitored after exposure to either ice cubes or tap-water. In those mice exposed to ice, the cold exposure initially masked defective barrier function, but barrier recovery was slower, and there was a decreased return of lipids to the stratum corneum after cold exposure. This mechanism would explain chapped skin in fish workers who are exposed to wet work at cold temperatures.

As with food handlers in general, contact with high-molecular-weight proteins is thought to cause conditions such as contact urticaria and protein contact dermatitis. Several case reports³²⁻³⁴ describe these conditions in people handling fish at work. Case series of food handlers with protein contact dermatitis note a preponderance of seafood-exposed workers.^{11,15} Halkier-Sørensen *et al.*³⁵ performed scratch tests on 75 volunteers using low- and high-molecular-weight compounds found in fish juice, and found that the high-molecular-weight compounds were responsible for skin symptoms.

Fish products are not the only high-molecular-weight compounds to which seafood processing workers are exposed. Kavli and Moseng³⁶ reported immediate wheal and flare reactions to mustard among fish-stick production workers. Recently, Nieuwenhuizen *et al.*³⁷ have characterised sensitisation to a fish parasite, *Anisakis*, as another source of skin problems in fish processors. Of 578 seafood processing workers, 8% (46/578) had positive skin-prick tests to *Anisakis*, and sensitisation to the parasite was associated with a twofold increased odds of having recurrent skin symptoms (odds ratio = 2.24; 95% CI, 1.01-4.97). Seafood processing workers may also be sensitised to natural rubber latex found in gloves, as shown in other food handlers.²⁴

However, it is generally thought that the majority of dermatitis in the seafood processing industry is in fact irritant contact dermatitis due to wet work, occlusive glove use and the irritant properties of fish juice.⁴ There may be an additive effect on skin barrier function when irritants in fish and meat products are combined with detergent use.³⁸ A Danish study³⁹ showed that fish products (fish juice, fish meat, fish skin, fish juice and entrails) caused skin irritation leading to itch and ery-

thema, and that this effect was more profound with increasing postmortem age of the fish. Furthermore, fish scales have been shown to have an irritant effect on the skin.⁴⁰ This clinical and histological study reported that scales can adhere to skin, and generate an irritant contact dermatitis. A case report in a recreational fisherman ascribed his irritant contact dermatitis to fish skin.⁴¹

No published studies could be found looking specifically at the prevalence of type IV sensitisation to rubbers, metals or detergents in seafood processing workers. In France, a record review of 35 563 professional fisherman revealed allergic contact dermatitis to mercapto-benzothiazole in only 3 individuals.⁴²

Individual host risk factors

Atopy and atopic dermatitis

Atopy has been previously reported as a risk factor for developing occupational irritant contact dermatitis.⁴³ However, a recent statement⁶ challenges this earlier understanding as there are equal numbers of studies showing no increased risk of contact dermatitis in atopic subjects and atopy as an independent risk factor. Atopy has been associated with positive skin-prick tests to fish and meat in some case series investigating protein contact dermatitis,¹⁴ being present in 7 of the 9 patients who had positive prick tests to food. However, this finding was not apparent in Hjorth and Roed-Petersen's study¹¹ or in Veien *et al.*'s study¹² in which half of the patients with protein contact dermatitis were atopic, whereas the other half were not. It is likely that selection bias was present in the Cronin study.¹⁴

On the other hand, a history of atopic dermatitis is considered to be a specific risk factor for occupational contact dermatitis.⁶ Pre-existing defects of the skin barrier as present in atopic patients and those with pre-existing skin disease (e.g. irritant contact dermatitis) also play a role in the development of protein contact dermatitis.⁴⁴

Gender

Women have been reported to have a higher prevalence of irritant contact dermatitis.⁵ However, this is thought to be related to the gendered nature of work in the seafood processing industry. In Aasmoe *et al.*'s study²⁸ women reported symptoms more often than men, but observation of the workplace revealed differences in the types of work performed as well as gloves worn. Therefore, it was concluded that the difference between men and women could be attributed to 'different work tasks rather than [to] sex itself' because of the gendered distribution of work evident in a number of industries.

Age

It is thought that the irritancy of the skin decreases with age^{5,43} and that irritant contact dermatitis therefore occurs more commonly in younger people at the start of their careers. However, some studies have shown that this association disappears when the nature of the work performed by different age groups is taken into account.⁴³ Current evidence is that occupational contact dermatitis can occur at any time during a person's career.⁶

CONCLUSION

The seafood processing industry is an important economic sector in South Africa providing an important food source for the Southern African region. Several environmental factors predispose workers to the development of occupational skin disease. These include wet

work, exposure to irritant substances, and exposure to allergens including high-molecular-weight proteins in the seafood such as muscle proteins and haptens such as rubber additives. The prevalence of skin symptoms is high and is estimated to be almost 80%.

Studies in other groups of food handlers have reported increased rates of sensitisation to nickel, cobalt, thiurams and formaldehyde, but there have not been any studies that have reported on patterns of sensitisation to commonly used chemical products containing allergens such as metals and detergents in seafood processing workers in particular, and only one has reported on sensitisation to a specific rubber additive, mercapto-benzothiazole, in fish handlers.

Future studies need to focus on the prevalence of patterns of type IV sensitisation to workplace allergens in seafood processing workers, as well as the prevalence and the risk factors for contact dermatitis and other occupational dermatoses in this group.

Declaration of conflict of interest

The authors declare no conflict of interest.

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