

REVIEW ARTICLE

FACTORS ASSOCIATED WITH DERMATITIS AMONG FOOD INDUSTRY WORKERS: A SYSTEMATIC REVIEW

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ABSTRACT

Most occupational skin disorders are due to occupational contact dermatitis, which is one of the main concerns in occupational health. This systematic review aimed to systematically explore the factors associated with skin disorders among food industry workers. Thus, articles related to factors associated with skin disorders were electronically retrieved from two different databases, namely EBSCOhost (Medline) and SCOPUS. The titles and abstracts of the collected data were screened by two pairs of independent reviewers, and then stored in Microsoft Excel version 2211 based on the inclusion and exclusion criteria. These articles have also been critically appraised using the Mixed Methods Appraisal Tool (MMAT) to assess the quality of the studies. Of the 126 articles identified, five were included in the final review. Sociodemographic characteristics, irritants, wet work, and history of atopy were some of the factors associated with skin disorders among food industry workers. Meanwhile, age, gender, contact with irritants, exposure to wet work, and history of atopy have been identified as important risk factors for dermatitis among food industry workers. Thus, policies should focus on minimizing exposure to irritants and wet work, implementing routine screenings for workers with a history of atopy, and considering sociodemographic factors to design tailored preventive measures and interventions.

Keywords: occupational, contact dermatitis, eczema, food industry, food service, restaurant

INTRODUCTION

Skin disorders are conditions with malfunctioning skin components, or the presence of abnormalities in the layers of human skin¹. Occupational contact dermatitis (OCD) is an inflammatory skin condition due to cutaneous contact with materials found in the workplace that accounts for 90% to 95% of occupational skin disorders (OSD)². OCD cases can be categorised into irritant and allergic reactions. Approximately 80% of all OCD cases are caused by irritant contact dermatitis (ICD), while the remainder are caused by allergic contact dermatitis (ACD)³.

However, wide variations in the distribution of ICD and ACD in certain countries can be attributed to several factors. In the food and drink industries, occupational dermatitis is one of the main concerns in occupational health⁴. The food industry covers diverse activities including food supply, production, harvesting, processing, packaging, transportation, distribution, consumption, and disposal⁵. Incidence rates per 10,000 workers per year can range from 2.9 (butchers/food processing industries), 6.6 (cooks), up to 23.9 (pastry cooks), and 33.2 (bakers)⁶. Several factors can influence the

development of OCD, including age, gender, ethnicity, atopic history, environmental factors, and specific occupational risks⁷.

Financial costs of OCD treatments contribute to higher medical and treatment expenses, loss of workdays and productivity, workers' compensation, and retraining. There are also economic costs attributable to the effect OCD has on the quality of life (QOL) and activities of daily living⁸. In a study in the United States of America, the economic burden of skin diseases was found to be substantial, estimated at approximately \$35.9 billion in 1997 and \$1.6 billion in indirect costs attributable to loss of workdays⁹. Not only can it impact a worker financially, it can also cause psychosocial disturbances. A review reported that 25% to 43% patients with skin disorders have psychiatric disorders¹⁰. OCD frequently evokes intensely negative emotions, such as frustration, embarrassment, and depression, which reflects the fact that the skin is largely responsible for a person's appearance¹¹.

The work relatedness of contact dermatitis can be complicated, and the evaluation of the impairment and the resultant disability of work-induced OCD can be more difficult. The prognosis

of OCD considers the extent of healing, its effect on the quality of life and employment, and the financial costs on the individual and the wider community. In recent years, response treatments for ACD have significantly improved, as 78% to 84% of patients with OCD recover without impairment when it was appropriately managed¹². The good prognosis of OCD may relate to enhanced diagnostic procedures, more accurate identification of irritants and allergens, and increased preventive efforts, especially worker education¹³.

Initiating workplace risk assessments to identify 'hazards' (anything that has the potential to cause harm) and 'risks' (the likelihood of an event occurring) can reduce sickness absence from work that might be prolonged and costly. Evidence suggests that education and training are effective prevention strategies¹³. Employees can identify and report any signs of occupational skin problems to the management site, and all reasonable steps should be taken to resolve the problem and prevent recurrences. However, it is imperative to identify the relevant factors contributing to the skin disorder among the workers. Hence, this review was conducted to identify the hazards or factors associated with skin disorders among food industry workers.

METHODS

This systematic review was prepared in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) updated guideline. This review aimed to identify the factors associated with skin disorders among food industry workers. The components of mnemonic PEO (population, exposure, outcome) were established as follows:

- Population: food industry workers.
- Exposure: related to occupation.
- Outcome: skin disorders.

Search Strategy

The literature search was conducted in from 15th October 2022 till 30th November 2022 using EBSCOhost (Medline) and SCOPUS databases. The following keywords were used to search for related articles: "restaurant*" OR "food industry*" OR "food service*" AND "contact dermatitis" OR "eczema" AND "occupational" AND "factor*". All retrieved articles were imported into Microsoft Excel version 2211, and duplication by title and author was done by conditional formatting.

Eligibility Criteria

The inclusion criteria were articles that were written in English, and original articles that included cohorts, case-control, and cross-sectional investigations of the associated factors

of skin disorders. Mixed methods and qualitative studies, as well as non-original articles, such as conference proceedings, perspectives, commentaries, opinions, reports, systematic reviews, and meta-analyses were excluded. The publication period was decided starting from 2000 onwards. The publication period was set to begin from the year 2000 onwards to ensure the inclusion of the most relevant and contemporary research on occupational skin disorders among food industry workers. This timeframe allows for the consideration of advancements in industrial practices, changes in regulatory standards, and the latest developments in occupational health and safety. Furthermore, it captures recent trends and emerging risks that may not be reflected in older literature, thereby providing a more accurate and current understanding of the factors associated with skin disorders in this sector.

Study Selection

Two independent reviewers screened the titles and abstracts of the retrieved materials based on the inclusion and exclusion criteria. The potential articles identified during the main screening were kept, and full texts were reviewed independently by the same reviewers according to the inclusion and exclusion criteria. A third reviewer was assigned to resolve any disagreements that arose between each pair of reviewers.

Critical Appraisal and Data Extraction

Quality appraisal was conducted using the Mixed Methods Appraisal Tool (MMAT). The MMAT was used to evaluate the quality of each article by focusing on methodological criteria, namely five core quality criteria for each selected article¹⁴. One reviewer extracted the data, which was then assessed independently by the second reviewer. Eligible articles were analysed in detail using the content analysis method without any statistical tests.

RESULTS

The search yielded 68 articles from EBSCOhost and 58 from SCOPUS, resulting in 126 unique hits. However, only 17 articles undergo the full-text assessment following a rigorous selection screening, as shown in the PRISMA flow diagram (see Figure 1). A list of the authors included in this review and their respective study location and study design is presented in Table 1, with two articles from Germany, one from Finland, one from Vietnam, and one from Singapore. The findings from these five studies have been included in this systematic review, as summarised in Table 2. The analysed articles were published between 2000 and 2015, with three articles were cross-sectional studies, one article was a case-control study, and one was a longitudinal study.

Table 1. A list of authors and study locations of the five selected articles.

Authors	Study Location	Study design
Mälkönen et al. (2009) ¹⁵	Finland	Cross-sectional
Angelova-Fischer et al. (2015) ¹⁶	Germany	Case-control
Teo et al. (2009) ¹⁷	Singapore	Cross-sectional
Bauer et al. (2000) ¹⁸	Germany	Cohort Study
Anh et al. (2007) ¹⁹	Vietnam	Cross-sectional

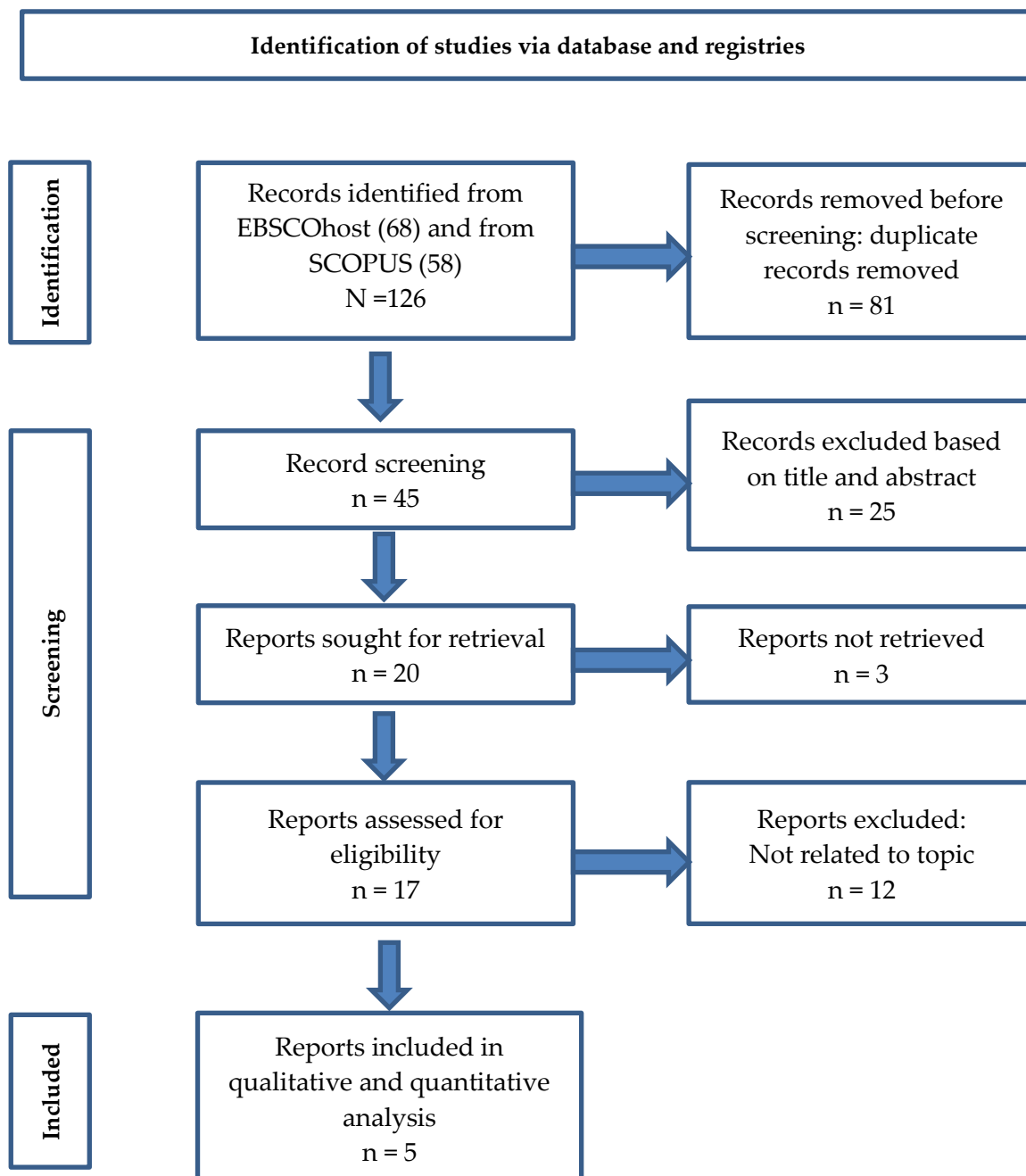


Figure 1. PRISMA flow diagram for the systematic review.

Table 2. A summary of the accepted articles.

Author (Year)	Title	Study Design	Sample Size	Study population	Study Outcome	Factors associated with skin disorders
Mälkönen et al. (2009) ¹⁵	A 6-month follow-up study of 1,048 patients diagnosed with an occupational skin disease.	Cross-sectional study	1,048	Patients investigated at the Finnish Institute of Occupational Health office for occupational skin disease (includes food-related occupations).	<ol style="list-style-type: none"> Occupational consequences after 6 months follow-up: <ol style="list-style-type: none"> 1.1 healing of skin disease 1.2 sick leave 1.3 change of work tasks 1.4 changed job/occupation 1.5 loss of job. Factors predicting continuation of occupational skin disease. 	<ul style="list-style-type: none"> Factors predicting the continuation of occupational skin diseases: Food-related occupation (OR = 2.1; 95% CI = 1.1-4.1). No change in work after 6 months (OR = 2.7; 95% CI = 2.7). Age of more than 45 years old (OR = 2.3; 95% CI = 1.7-3.3). Men (OR = 1.6; 95% CI = 1.9-2.3).
Angelova-Fischer et al. (2015) ¹⁶	Barrier function and natural moisturising factor levels after cumulative exposure to a fruit-derived organic acid and a detergent: different outcomes in atopic and healthy skin, and relevance for occupational contact dermatitis in the food industry.	Case-control study	Case: 20 Control: 20	Case: adult female and male volunteers with atopic dermatitis according to the UK Working Party Criteria. Control: non-atopic, age-matched controls.	<ol style="list-style-type: none"> Measurements of erythema (a*-value). Transepidermal water loss (TEWL). Level of natural moisturising factors (NMF). 	<ul style="list-style-type: none"> Exposure to irritant tandems: Acetic acid (AcA)/Sodium lauryl sulfate (SLS) (p < 0.01) SLS/AcA (p < 0.01) SLS/SLS (p < 0.001)
Teo et al. (2009) ¹⁷	Occupational dermatoses in restaurant, catering, and fast-food outlets in Singapore.	Cross-sectional	457	Restaurant, catering, and fast-food outlet (FFO) staff	Irritant Contact Dermatitis	<ul style="list-style-type: none"> Frequency of Hand wash/day (> 20 times): OR = 2.8; 95% CI = 1.4-5.7 Atopy: OR = 3.9; 95% CI = 1.9-8.0 Contact with Squid: OR = 2.6; 95% CI = 1.2-5.5

Author (Year)	Title	Study Design	Sample Size	Study population	Study Outcome	Factors associated with skin disorders
Bauer et al. (2000) ¹⁸	Occupational hand dermatitis in food industry apprentices: results of a 3-year study.	Cohort Study	91	All food profession apprentices at the Occupational School of Gera (East Thuringia)	Hand Dermatitis	<ul style="list-style-type: none">• Skin Atopy > 10 points:• OR = 4.89; 95% CI = 1.15-20.79• Previous & Present Flexural Dermatitis:• OR = 6.8; 95% CI = 1.72-27.22• Previous Hand Dermatitis:• OR = 41.1; 95% CI = 4.99-339.13• Wet Work + hand washing > 20 times/day• OR = 1.2; 95% CI = 1.05-4.77
Anh et al. (2007) ¹⁹	Dermatitis among farmers engaged in peri-urban aquatic food production in Hanoi, Vietnam.	Cross-sectional	592	100 households were randomly selected and the adult household members were engaged in farming field work.	Dermatitis	<ul style="list-style-type: none">• Wastewater site (OR = 5.5; 95% CI = 2.3-13.5)• Wastewater contact (OR = 3.0; 95% CI = 1.1-7.7)• Previous history of skin problems (OR = 13.0; 95% CI = 6.4-26.6)• Wet season (OR = 3.3; 95% CI = 1.3-8.7)• Washing hands/feet after work (OR = 4.1; 95% CI = 1.8-9.4)

Skin disorders among food industry workers

This article presents five studies that have focused on skin disorders among food industry workers. Factors that facilitate the occurrence of skin disorders have been identified as (i) sociodemographic characteristics, (ii) irritants, (iii) wet work, and (iv) history of atopy. Most of the studies included in this review reported positive effects after the occurrence of skin disorders, particularly the hand region. This systematic review, however, did not look into the protective factors of the prevention of skin disorders among food industry workers.

Sociodemographic characteristics

Age

Age was measured in two of the five studies included in this review. Workers aged more than 45 years old have been shown to have higher risks in the continuation of occupational contact dermatitis (OR = 2.3, 95% CI = 1.7-3.13)¹⁵. However, no significant difference of dermatitis risks was found among workers aged 45 years old and above compared to workers at other ages¹⁹.

Gender

Out of five studies included in this review, only two studies included gender in their analysis. Men have significantly higher odds (OR = 1.6, 95% CI = 1.0-3.1) of the continuation of occupational contact dermatitis compared to women¹⁵. In another study, higher odds for dermatitis were reported among male respondents; however, this finding was deemed insignificant¹⁹.

Irritants

Three studies included in the final review noted that irritants contributed to the occurrence of skin disorders among food industry workers. Study from Singapore reported that workers in contact with squid has 2.6 odds (95% CI = 1.2-5.5) of developing skin disorders¹⁷. Contact with wastewater from aquaculture predisposed workers to a higher odd of 3.0 (95% CI = 1.1-7.7) to develop skin disorder¹⁹. Other study conducted in Germany among volunteers with atopic dermatitis (AD) and a control group of healthy volunteers in relation to exposure to 2.0% acetic acid (AcA) and 0.5% sodium lauryl sulphate (SLS), found that AcA and SLS are commonly found in fruit-derived organic compounds and detergents, respectively. The outcomes were assessed by measuring levels of erythema, transepidermal water loss (TEWL), and natural moisturising factor (NMF). Cumulative exposure to these irritants was

found to reduce the level of NMF in the AD and control groups¹⁶.

Wet work

Exposure to wet work can also play a significant role in the development of skin disorders among food industry workers. Three studies included in this systematic review investigated the association between frequency of hand washing and hand dermatitis. Washing hands > 20 times per day can increase the odds by 1.2 of developing hand dermatitis¹⁸. Similar finding also was found in study among restaurant, catering and fast-food outlets in Singapore whereby the reported odds was 2.8¹⁷. These findings are consistent with another study in Vietnam that showed four times the likelihood of developing dermatitis with frequent hands/feet washing after work¹⁹. Their study also noted that working during the wet season can increase the risk of dermatitis by three times¹⁹.

History of atopy

Based on the five reviewed studies, three of them reported history of skin atopy as an important risk factor in occupational skin disorder among food-related industry workers. Study in Germany showed that atopic individuals have 3.9 times increased risk of developing dermatitis among apprentices in the food processing profession¹⁸. This finding was consistent with the findings by study in Singapore, which reported that the development of dermatitis among those who had a history of skin atopy was 3.9-fold among restaurant/catering workers¹⁷. A study in Vietnam among two groups of farmers (Model A and Model B) reported similar findings¹⁹. They found a significant association between a history of skin atopy and the risk of developing dermatitis within both groups with increased risk of 8.5 and 7.4, respectively¹⁹. With regards to a history of respiratory atopy, only study report from Germany mentioned that it has no association with the development of dermatitis¹⁸.

Risk of Bias

A quality appraisal of all five studies was conducted using the Mixed Method Appraisal Tool (MMAT). The methodology of a qualitative study can be appraised using this tool and this review used five criteria to conduct the assessment¹⁴. Details of the MMAT assessment for the selected studies are reported in Table 3.

Table 3. Details of the MMAT assessment.

Authors	Type of Study	3.1 Is the sample representative of the target population?	3.2 Are the measurements appropriate for both the outcome and intervention (or exposure)?	3.3 Are there complete outcome data??	3.4 Are the confounders accounted for in the design and analysis?	1.5 During the study period, is the intervention administered (or exposure occurred) as intended?
Mälkönen et al. (2009) ¹⁵	Cross-sectional	Yes	Yes	Yes	No	Yes
Angelova-Fischer et al. (2015) ¹⁶	Case-control	Yes	Yes	Yes	Yes	Yes
Teo et al. (2009) ¹⁷	Cross-sectional	Yes	Yes	Yes	Yes	Yes
Bauer et al. (2000) ¹⁸	Cohort Study	Yes	Yes	Yes	Yes	Yes
Anh et al. (2007) ¹⁹	Cross-sectional	Yes	Yes	Yes	Yes	Yes

DISCUSSION

Several factors that contributed to the occurrence of skin disorders among food industry workers have been classified into three categories: (1) sociodemographic characteristics; (2) work environment; and (3) history of atopy.

Sociodemographic characteristics

Age plays an important role in the development of a disease. The continuation of occupational contact dermatitis was significantly higher among workers aged more than 45 years old¹⁵. Apart from food industry workers, they also included other workers with occupational contact dermatitis in their analysis. According to a review on skin health in older age, skin will undergo anatomical and physiological changes as human ages, and these changes will disrupt the protective mechanism of the skin²⁰. This is supported by another study that showed ageing do influence the functions of skin barrier²¹. However, study in Vietnam which was included in this review reported no significant difference in the development of dermatitis among different age groups¹⁹. This is supported by another study that found no difference between age groups in occupational skin symptoms²². This study was not included in this review as this study using different study population.

This review found that gender may or may not impact the occurrence of occupational skin disorders among food industry workers. Report from study in Finland, which studied the continuation of occupational contact dermatitis found to be higher among male workers¹⁵. A similar pattern was found in a 12-year cohort

study in Sweden where symptoms were significantly higher among males after 12 years of notification of occupational skin disease²². This study also revealed that a significantly higher number of female workers recovered from the initial occupational skin symptoms²². In contrast, other studies showed that female workers have a higher incidence of occupational skin disorders compared to male workers^{23,24}. The difference in these findings may be attributed to gender-related hormones affecting skin physiology and hence, the susceptibility to skin diseases²⁵.

Work environment

Exposure to squid was found to be significant in the development of skin disorders among food industry workers¹⁷. They reported that these workers were exposed to the irritant while handling squid tenderised with a proteolytic enzyme called papain, a common tenderiser. Papain has been demonstrated to cause a multitude of skin disorders, including irritant contact dermatitis, allergic contact dermatitis, and contact urticaria²⁶⁻²⁸. Study in Vietnam reported that wastewater contact can significantly increase the risk of developing skin disorders¹⁹. However, they did not investigate the composition of the wastewater to determine the exact chemical or biological agent responsible for the outcome. They also reported that the prevalence of fungal infection of the fingernails or toenails among the study participants was high¹⁹. Study in Germany reported that exposure to ACA and SLS can reduce the NMF level of stratum corneum, which can cause skin dryness and scaling; major clinical hallmarks for chronic irritant hand eczema^{29,30}. Both irritants are commonly used by food industry workers, and

their interactions with intracellular lipids are commonly attributed as the source of skin dryness. Skin lipid content and composition may change due to exposure to these irritants¹⁶.

The majority of food industry workers are routinely exposed to wet work due to the nature of their job. Dermatitis is considered as an occupational health hazard among people involved with wet work, as reported by previous studies^{31,32}. The current widely accepted definition of wet work includes having wet hands for at least 2 hours per working day, washing hands at least 20 times per working day, or wearing occlusive gloves for at least 2 hours per working day³³. One of the studies also reported that working during the wet season can increase the likelihood of developing dermatitis. A wet season can be described as the rainy season during which workers are exposed to rainwater more compared to during the dry season. Extremities were also reported to have higher risks of dermatitis due to exposure to water. All three studies that investigated the association between wet work and dermatitis in this systematic review recommended the use of appropriate protective clothing to reduce the occurrence of skin disorders¹⁷⁻¹⁹.

The incidence of skin disorders among food industry workers may vary across job categories and locations. For example, dermatitis is well reported among bakers, cooks, and food handlers, but not among waitresses and kitchen assistants^{34,35}. The study in Vietnam among aquaculture farmers noted that wastewater contact increased the risk of dermatitis further¹⁹. In terms of location, fast-food workers reported less skin disorders compared to those working in restaurants. A possible explanation for this is workers in fast-food outlets deal with disposable utensils, as well as frozen meats compared to restaurant workers who have to handle fresh raw meats¹⁷.

History of atopy

Endogenous factors, such as atopy also play an important role in the development of occupational dermatitis. Individuals with atopy have an increased chance of developing one or more atopic disorders³⁶. In Swedish population-based study reported that the prevalence of hand eczema among atopic individuals can increase 3-fold²². Based on these findings, those with a history of atopy from an early age or upon diagnoses should be informed through health education of their future career prospects in food industries based on the effects of atopy. These findings have also shown the importance of screening prior to employment for individuals with a history of skin atopy, as there is an increased likelihood for them to leave the industry earlier due to the progression of dermatitis¹⁷.

Recommendation

Based on the findings, several recommendations are proposed to protect food industry workers from skin disorders. Protective measures, such as the use of personal protective equipment (PPE) like gloves and clothing, should be encouraged to reduce exposure to irritants and wet work. Routine health screenings should identify workers with a history of atopy or other risk factors for early intervention. Education and training programs tailored to different sociodemographic groups should emphasize proper hygiene, safe handling of irritants, and the use of PPE. Workplace modifications, including automated cleaning systems and improved ventilation, should be introduced to reduce wet work exposure. Policies must address the identified risk factors, considering age, gender, and atopic history, while ongoing monitoring and evaluation should assess intervention effectiveness and ensure occupational health standards are met.

Limitation

Similar to other systematic reviews, this systematic review has its own limitations. First, there was a time constraint of six weeks to conduct and complete this systematic review, which related to other limitations as well. Second, language bias could not be avoided, since only related articles published in English were reviewed. Third, there was a search engine bias, as this review has mainly focused on articles in EBSCOhost and SCOPUS. Fourth, this review narrowed down the number of keywords used during article search, which could have led to a bias in limited article findings as well. Despite these limitations, this systematic review managed to gather evidence regarding the factors associated with occupational skin disorders among food industry workers. These findings can be used as a guide by health service providers, especially Occupational Health Doctors (OHD) when dealing with food industry employers and employees in the effort to prevent occupational skin disorders.

CONCLUSION

This systematic review conclude that sociodemographic characteristics, irritants, wet work, and history of atopy have contributed towards the occurrence of skin disorders among food industry workers. Nonetheless, tackling occupational skin diseases earlier among food industry workers can be advantageous, such as early treatments could lead to a good prognosis, reduces the cost of occupational skin disease treatment, and improves the quality of life of the workers. In addition, workplace modifications should be introduced to mitigate the risk. Ongoing monitoring and evaluation of workplace conditions and health outcomes should be implemented to assess the effectiveness of these interventions and make necessary adjustments to continually improve occupational health standards for food industry workers.

Author Contributions:

Conceptualisation: RD, MRH, NCD, SSSAR

Methodology: NHR, MM, KTM, MFHAK, RD, MRH, NCD, SSSAR

Writing—original draft: NHR, MM, KTM, MFHAK, RD

Writing—review & editing: NHR, MM, KTM, MFHAK, RD, MRH, NCD, SSSAR

Funding: This research received no external funding.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

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