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Lifestyle factors and hand eczema: a systematic review and meta-analysis of observational studies

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Abstract

Evidence regarding the association between lifestyle factors and hand eczema is limited. To extensively investigate the association between lifestyle factors (smoking, alcohol consumption, stress, physical activity, body mass index, diet, and sleep) and the prevalence, incidence, subtype, severity, and prognosis of hand eczema, a systematic review and meta-analysis were conducted in accordance with the Meta-analysis Of Observational Studies in Epidemiology consensus statement. MEDLINE, Embase, and Web of Science were searched up to October 2021. The (modified) Newcastle-Ottawa Scale was used to judge risk of bias. Quality of the evidence was rated using the Grades of Recommendation, Assessment, Development and Evaluation approach. Eligibility and quality were blindly assessed by two independent investigators, disagreements were resolved by a third investigator. Data were pooled using a random-effects model, and when insufficient for a meta-analysis, evidence was narratively summarized. Fifty-five studies were included. The meta-analysis (17 studies) found very low quality evidence that smoking is associated with a higher prevalence of hand eczema (odds ratio 1.18, 95% confidence interval: 1.09-1.26). No convincing evidence of associations for the other lifestyle factors with hand eczema were found, mostly due to heterogeneity, conflicting results and/or the limited number of studies per outcome.

Key words: alcohol consumption, BMI, hand dermatitis, hand eczema, lifestyle, physical activity, smoking, stress.

1. Introduction

Hand eczema (HE) is a common skin disease with a considerable patient burden regarding psychosocial and economic consequences.^{1,2} Current risk factors for HE are classified as exogenous and endogenous, with atopic dermatitis (AD)³ as the most well-known endogenous risk factor, and exposure to irritants (wet work, friction)^{4,5} and contact allergens⁶ as exogenous factors. Its etiology is complex and multifactorial, including genetic predisposition, immune dysfunction, and environmental factors.

Lifestyle has been the subject of increased research for preventing disease and improving health and wellbeing. For skin diseases like AD⁷⁻⁹ and psoriasis¹⁰ there is already increased awareness of lifestyle factors and modifiable behavior. However, little is known about the association between lifestyle factors and HE. It could be hypothesized that lifestyle factors such as smoking¹¹ and stress¹² may skew the immune system towards T helper (Th) 2 immunity that could, at least in theory, increase the occurrence, severity and/or prognosis of HE. Likewise, obesity is associated with a chronic low-grade inflammatory state, which might also influence HE.¹³ In addition, for smoking, also non-immunologic effects as cutaneous vasoconstriction with delayed wound healing might play a role in the severity and/or prognosis of HE.¹⁴ Following this hypothesis, it is possible that more inflammatory subtypes as vesicular hand eczema, or hand eczema accompanied by atopic dermatitis, are more influenced by lifestyle factors compared to other subtypes. The aim of this systematic review and meta-analysis was to assess the association between lifestyle factors (including smoking, alcohol consumption, stress, physical activity, body mass index (BMI), diet, and sleep) and prevalence, incidence, subtype, severity, and prognosis of HE. Because lifestyle factors relate to human behaviour and exposing subjects to unfavourable conditions might be harmful and unethical, this study focused on observational studies including subjects with all subtypes of HE.

2. Methods

This study was conducted in accordance with the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) consensus statement.^{15,16} A protocol was registered prospectively in PROSPERO (International Prospective Register of Systematic Reviews) (CRD42020207731).

2.2 Data sources

A literature search was conducted in MEDLINE, Embase, and Web of Science from inception

to 14 October 2021, supervised by an experienced research librarian. Search terms included all terms regarding HE and synonyms, combined with synonymous and related terms for lifestyle factors (see Appendix S1 in the supplement for the full search strategy).

2.3 Study selection

After deduplication¹⁷ all studies were uploaded in RAYYAN (<http://rayyan.qcri.or/>)¹⁸ for blinded and independent screening for eligibility based on title, abstract, and keywords by two investigators (LL, MJB). Disagreements were resolved by reaching consensus or otherwise treated as a provisional inclusion awaiting full text. References of included studies and possibly relevant reviews were manually searched for additional studies. Broad inclusion criteria were applied, and all human studies that assessed the association between lifestyle factors and HE, regardless of the underlying etiology, were included. Excluded were studies without primary data, case reports, case series (n<10), reviews, studies that only assessed the association between HE and second-hand smoking, tobacco allergy, skin exposure and (part of) food(substances), or the use of topical alcohol as disinfectant. We applied no language restrictions.

Subsequently, full texts were retrieved of all the (provisionally) included studies. Studies published in languages other than English, Dutch or German, were translated by colleagues with sufficient knowledge of the particular language. Abstracts from unpublished studies were also included if sufficient data was provided. Multiple papers from a single study were included if each presented unique data. Final inclusion was assessed independently by two authors (LL, MJB), and any disagreements were resolved by consulting a third author (BWMA).

2.4 Data extraction

From each included study, first author name, publication year, country, study setting and design, number of total subjects, and number of subjects with HE were extracted. For study outcomes, assessment of HE, outcome ascertainment, instruments used, and primary study outcomes, were recorded. A list of excluded studies based on full text, including justifications, was maintained. Authors were contacted in case of insufficient information or in case full text was not available.

2.5 Assessment of risk of bias and overall quality of the evidence

We used the Newcastle-Ottawa Scale (NOS) for cohort and case-control studies for quality assessment.¹⁹ An adapted version of the NOS was used for cross-sectional studies, as per

Quaade et al.² Each study was assessed independently in pairs of two amongst three authors (LL, MJB, AALMP); a fourth author (BWMA) was asked to resolve differences. If studies reported results on multiple lifestyle factors and/or outcome measures, quality assessment was conducted per reported outcome measure. Cohort and case-control study outcomes with ≥ 6 points on the NOS, and cross-sectional study outcomes with ≥ 7 points, were considered as low risk of bias. To easily identify the NOS-items that were low (1 or 2 stars) or high risk of bias (0 stars), we used Cochrane's RevMan version 5.4.1.²⁰ for a visual presentation, as was previously done by Papola *et al.*²¹ Of the three NOS-scales used (case-control, cohort and cross-sectional) we divided the item comparability in two (sex and age) so that these are also easily identifiable. For the meta-analyses the Grades of Recommendation, Assessment, Development and Evaluation (GRADE)²² methodology was used to assess the overall quality of the evidence (high, moderate, low or very low).

2.6 Data synthesis

In case of missing summary statistics, ORs were calculated from raw data, if possible. From the studies included in the meta-analyses, forest plots with estimated pooled ORs with 95% confidence intervals (CIs) were generated using Cochrane's RevMan version 5.4.1.²⁰ We chose the random effects model for meta-analyses as variability between studies was assumed to be high. Overlap of confidence intervals or point estimates were used to judge inconsistency. To explore possible causes of heterogeneity among study results, a subgroup analysis based on setting (occupational vs non-occupational) was performed. To assess the robustness of the synthesized results, a sub-analysis was performed including only studies with an overall low risk of bias. If the number of studies allowed it, funnel plot visualization was used to inspect potential publication bias. When data was insufficient to conduct a meta-analysis, the evidence was narratively summarized.

3. Results

3.1 Literature search

The search identified 5 686 records for screening after deduplication,¹⁷ of which 140 met the criteria for full text extraction. Of these 91 were excluded, mainly based on not reporting (separate) data for HE or lifestyle factors (see Table S2 in the Supplement for a list of excluded studies with justification). Six studies were included from references. See Figure 1 for the PRISMA 2020 flowchart.¹⁵

3.2 Study characteristics

A total of 55 studies (n=40-65 261),^{1,5,31-40,23,41-50,24,51-60,25,61-70,26,71-75,27-30} comprising more than 42 500 individuals with HE on 98 different lifestyle factors and/or outcome measures, were included (Table 1). Study design included cohort (prospective (n=13)^{23,24,69,74,75,29,36-38,51,52,56,58} and retrospective (n=6)^{27,44,55,57,61,62}), case-control (n=7),^{1,25,39,46,53,64,71} and cross-sectional studies (n=29).^{5,26,41-43,45,47-50,54,59,28,60,63,65-68,70,72,73,30-35,40} HE was assessed in different study settings, including clinical (n=15),^{1,23,68,69,71,74,75,29,44,53,54,61,64,66,67} occupational (n= 22),^{5,24,50,52,55-60,62,63,25,65,73,27,30,36,40,45,47,49} and the general population (n=18).^{26,28,41-43,46,48,51,70,72,31-35,37-39} The diagnoses of HE was either retrieved from medical records (n=5),^{23,44,55,61,62} self-reported (n=24),^{5,26,37,39-41,43,45,46,49-51,27,53,59,70,73,28,30-35} or physician diagnosed (n=23),^{1,24,58,60,63-69,71,25,72,74,75,29,42,47,48,54,56,57} or a combinations of self-reported and physician diagnoses (n=3).^{36,38,52} For the association between smoking and prevalence of HE a meta-analysis could be performed. No meta-analysis was possible for all other lifestyle factors and/or outcome measures due to heterogeneous methods and/or outcomes, and/or insufficient reporting of data. See Figure S3 in the Supplement for the risk of bias assessment of all outcomes.

3.3 Smoking

Seventeen^{23,27,41-43,45-47,50,30-34,36,38,39} out of the twenty-nine included studies reporting the association between smoking and prevalence of HE could be included in a meta-analysis. This included 23 983 subjects with HE and 191 352 subjects without HE, and showed a positive overall effect in the direction of HE compared with no HE (OR 1.18: 95% CI 1.09-1.26) (Figure 2). Sub-analysis of studies with a low risk of bias (N=8)^{30-34,41-43} demonstrated only a minor difference (OR 1.16; 95% CI 1.07-1.26) (see Figure S4 in the Supplement). A sub-analysis comparing studies in non-occupational setting (n= 11)^{23,31,46,32-34,38,39,41-43} versus occupational setting (n=6)^{27,30,36,45,47,50} showed an OR of 1.21 (95% CI 1.12-1.31) and 1.09 (95% CI 0.92-1.28), respectively (see Figure S5 and Figure S6 in the Supplement). According to the GRADE approach, the quality of the evidence was very low (Table 2). Twelve studies could not be included in the meta-analysis due to lack of data (n=8),^{5,28,29,37,40,44,48,49} other categorization of smoking habits than yes/no (n=3),²⁴⁻²⁶ or outcome measures not convertible to ORs (n=1).³⁵ Of these, four reported a positive association between smoking and prevalence of HE,^{24,26,35,44} and eight reported no association between smoking and HE.^{5,25,28,29,37,40,48,49} Two studies on smoking and HE incidence found no association.^{51,52} Regarding the association between smoking and specific subtypes of HE no consistent results

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were found.^{44,53–57} Of the seven studies reporting on smoking and severity of HE results were contradictory, two studies reporting a positive association,^{58,59} one a negative association,³⁹ and four no association.^{5,50,56,60} Two studies reported a worse prognosis for patients who smoked,^{61,62} and two studies reported no association between smoking and longstanding HE or persistence of HE.^{29,57} A possible publication bias was detected for the outcome smoking and prevalence of HE, based on asymmetric funnel plots (see Figure S7 and Figure S8 in the supplement). In combination with the findings above, this warrants caution regarding generalization.

3.4 Stress

Twelve studies reported the association between stress and HE on fourteen outcomes, of which seven^{1,35,41,45,59,62,63} outcomes had an overall low risk of bias. Stress was assessed in different ways. Five studies analyzing stress and prevalence of HE found a positive association^{1,35,41,45,63} and one reported no association.⁵⁰ In four studies stress was mentioned as an aggravating factor,^{29,50,64,66} and four studies did not find an association between stress and severity of HE.^{50,59,60,65} One retrospective cohort study reported more persistence of occupational HE in subjects with higher self-reported frequencies of stress.⁶²

3.5 BMI

Twelve studies reported results on thirteen outcomes of BMI and HE. Eight outcomes proved to have a low risk of bias.^{35,43,44,59,67–69} Five studies reported results on BMI and prevalence of HE, of which four reported a positive association between BMI ≥ 30 and HE.^{35,41,43,45} One study found no association between BMI and prevalence of HE.⁴² Two studies included results on BMI and subtype of HE, with different results.^{67,44} Three out of four cross-sectional studies reported no association between BMI and severity of HE,^{59,60,68} and one found a positive association between BMI and severe chronic HE in a subgroup of the included study population.⁶⁷ One study did not find an association between BMI and the persistence of HE,⁶² and another study reported no significant difference in Physician Global Assessment (PGA) change for HE up to 24 months after baseline when comparing different categories of BMI.⁶⁹

3.6 Physical activity

Eleven studies reported results on twelve outcomes of physical activity and HE, of which seven^{35,37,42,44,48,62,71} outcomes proved to have a low risk of bias. Eight studies included results on physical activity and prevalence of HE of which four^{5,37,48,71} found no association between physical activity and HE. One reported increasing HE frequencies with higher physical

activity levels at work only in women.⁷⁰ Two reported a negative association between physical activity during leisure time and HE.^{35,41} Another study reported varying outcomes in multiple categories of physical activity with various associations with HE.⁴² One study found no association between physical activity and hyperkeratotic HE compared to other subtypes of HE.⁴⁴ Two other studies found no association between physical activity and severity of HE.^{5,60} One clinical occupational retrospective cohort study found that moderate physical activity >4 hours weekly, or regular strenuous exercise was associated with less persistent HE.⁶²

3.7 Alcohol consumption

Seven included studies reported on the association between alcohol consumption and HE, of which four^{31,35,48,51} of the outcomes were assessed as having a low risk of bias. These studies used varying definitions of alcohol consumption. Six of them reported results on HE prevalence, of which five^{28,31,42,48,73} did not find an association between alcohol consumption and the prevalence of HE. One study reported a negative association between alcohol consumption and HE.³⁵ No associations between alcohol consumption and incidence or severity of HE were reported.^{51,60}

3.8 Diet

Three studies reported the association between diet and HE of which one study³³ was of low risk of bias. That study did not find an association between a vegetarian/vegan diet and the prevalence of HE in upper-secondary school children.³³ Another study reported that all patients with vesicular HE who completed an elimination diet (n=20/40) had recurrences of vesicles within five days after introducing particular food groups.⁷⁴ The third study reported results of an elimination diet in 56 patients with vesicular (patch-test negative) HE, who reacted to metal salts orally.⁷⁵ Thirty-six of the patients improved or cleared after one month of dieting and twenty-eight of them followed the prescribed diet for at least one year because of recurrences when stopping the diet.

3.9 Sleep No studies could be identified reporting the association between the amount of sleep and HE.

4. Discussion

Main findings

The results of the meta-analysis provided very low quality evidence that smoking is

associated with a higher prevalence of HE. No firm conclusions could be drawn about the association between smoking and incidence, subtype, severity, or prognosis of HE. The limited available evidence may suggest a positive association between stress, BMI, and prevalence of HE, and a possible role for stress as aggravating factor of HE. None of the studies reported a positive association between alcohol consumption and HE, or BMI, stress, physical activity and severity of HE. Both positive and negative associations between physical activity and prevalence of HE were found. Data were insufficient to make a statement regarding the association between diet and HE and lifestyle factors and prognosis of HE in general. In addition, limited and contradictory evidence on lifestyle factors and the subtypes of HE was found.

Interpretation

Two previous studies, one meta-analysis and a systematic review, also reported on smoking and HE.^{76,77} No association between smoking and the prevalence of HE was found in the meta-analysis. However, this conclusion was based on only three studies conducted in the same country.⁷⁶ On the other hand, the systematic review indicated that smoking might cause an increased prevalence and severity of HE, especially in high-risk occupations.⁷⁷ The exact mechanism behind the association between lifestyle factors and HE remains unknown. It has been described that lifestyle factors such as smoking¹¹ and stress¹² may influence the immune system towards T helper (Th) 2 immunity. In addition, obesity is associated with a chronic low-grade inflammatory state, which might also influence HE.¹³ Furthermore, it is also possible that a healthier lifestyle improve overall health, of which HE might benefit in conjunction. Although, the reverse might also be defensible: HE impairs quality of life, which may negatively influence health behavior in subjects affected. However, as it is (almost) impossible to study lifestyle factors in other designs than observational studies, results should be interpreted with caution, as no conclusions on the direction of found associations can be drawn. Negative associations were reported for physical activity and HE. The direction of the association between physical activity might vary by the used definition of physical activity. It might be hypothesized that performing physical activity at work might contribute to the occurrence, severity and prognosis of HE due to the exposure of irritants. On the other hand, physical activity during leisure time might be avoided by those affected by HE due to symptoms. For the majority of the lifestyle factors and outcomes of HE no convincing evidence was found. Yet this does not exclude that they might influence HE. The simplest explanation may be that the well-known endogenous and exogenous factors are of far greater

influence than lifestyle on the prevalence, severity or prognosis of HE.

Heterogeneity and confounders

In the current systematic review, inconsistencies for all lifestyle factors and almost all outcomes were reported. Part of the conflicting results might be attributed to the high heterogeneity between studies, with varying study populations (clinical, occupational and general population), with various levels of disease severity, underlying etiologies, concomitant of lifestyle factors, differences in study design, and the use of different, mostly not validated, measurement instruments to assess outcomes. The results of the sub-analysis of smoking and prevalence of occupational HE were not in line with the previously published systematic review that reported an increased prevalence of HE, especially in high-risk occupations.⁷⁷ However, it should be noticed that the current meta-analysis was based on six studies of which five had an overall high risk of bias. And a possible explanation might be that the overall contribution of smoking to the occurrence of HE is rather small and, especially in occupational settings with other more predominant risk factors such as exposure to allergens and irritants, the effect of smoking on HE might be of less significance than other risk factors.

In addition, confounding factors have to be considered, as both HE and lifestyle factors can be influenced by patient characteristics and environment, including age, sex, socio-economic, and psychosocial factors. This is partly covered in the quality assessment where comparability was scored based on adjustment for age and sex, resulting in a lower score for studies only showing unadjusted results. Multivariate analyses were reported with different combinations of included confounders, so data could not be pooled.

Strengths and limitations

This thorough and robust systematic review with meta-analysis gives a comprehensive overview of the existing literature on a possible association between HE and multiple lifestyle factors. In addition, it includes, besides the occurrence of HE, several other clinically important outcomes as severity and prognosis of HE. Broad inclusion criteria were applied, with no restrictions on publication year, language, or study design. In accordance with the study design, the recommended instrument for quality assessment was chosen: the (adapted) Newcastle-Ottawa Scale. Moreover, the confidence in estimate of the pooled evidence for smoking and prevalence of HE was assessed with GRADE. However, there are also several limitations: as studies of lifestyle factors cannot be randomized, all evidence came from

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observational studies with high heterogeneity. The study setting, population, and design, together with the degree of adjustment for confounders, varied widely across the studies. Due to the limited number of studies for each outcome, it was not possible to incorporate all these aspects into subgroup analyses. Heterogeneity did not permit, besides smoking, to conduct meta-analyses and assess pooled outcomes of major concern, and use GRADE for rating of the evidence. In addition, visual inspection of the funnel plots, detected a possible risk of publication bias for smoking and HE. Also reporting bias could not be excluded. The majority of the studies which could not be included in the meta-analysis, due to lack of numerical data, reported no association between smoking and the occurrence of HE. If data was sufficiently reported it is not unimaginable that including those (in some cases large) studies would alter the overall estimated effect. Lastly, information bias should also be taken into account, as self-reported lifestyle behavior might be prone to be influenced by socially desirable answers.

This extensive systematic review and meta-analysis found very low quality evidence that smoking is associated with the prevalence of HE. No convincing evidence of associations for the other lifestyle factors with HE were found. The data from this systematic review did not enable differentiation in setting, diagnosis or population. Therefore it is still possible that lifestyle factors might be more relevant for specific subgroups of patients with HE. This should be incorporated in the design of future studies. And if done so, these studies require using validated and well-defined measurement instruments and need to be complete in reporting interpretational data.

References

1. Marron SE, Tomas-Aragones L, Navarro-Lopez J, et al. The psychosocial burden of hand eczema: Data from a European dermatological multicentre study. *Contact Dermatitis*. 2018;78(6):406-412.
2. Quaade AS, Simonsen AB, Halling A-S, Thyssen JP, Johansen JD. Prevalence, incidence, and severity of hand eczema in the general population - A systematic review and meta-analysis. *Contact Dermatitis*. February 2021.
3. Ruff SMD, Engebretsen KA, Zachariae C, et al. The association between atopic dermatitis and hand eczema: a systematic review and meta-analysis. *Br J Dermatol*. 2018;178(4):879-888.
4. Behroozy A, Keegel TG. Wet-work Exposure: A Main Risk Factor for Occupational Hand Dermatitis. *Saf Health Work*. 2014;5(4):175-180.
5. Ibler KS, Jemec GBE, Agner T. Exposures related to hand eczema: a study of healthcare workers. *Contact Dermatitis*. 2012;66(5):247-253.
6. Bryld LE, Hindsberger C, Kyvik KO, Agner T, Menné T. Risk factors influencing the development of hand eczema in a population-based twin sample. *Br J Dermatol*. 2003;149(6):1214-1220.
7. Kantor R, Kim A, Thyssen JP, Silverberg JI. Association of atopic dermatitis with smoking: A systematic review and meta-analysis. *J Am Acad Dermatol*. 2016;75(6):1119-1125.e1.
8. Ali Z, Suppli Ulrik C, Agner T, Thomsen SF. Is atopic dermatitis associated with obesity? A systematic review of observational studies. *J Eur Acad Dermatol Venereol*.
9. Halling-Overgaard A-S, Hamann CR, Holm RP, et al. Atopic dermatitis and alcohol use - a meta-analysis and systematic review. *J Eur Acad Dermatol Venereol*. 2018;32(8):1238-1245.
10. Ko S-H, Chi C-C, Yeh M-L, Wang S-H, Tsai Y-S, Hsu M-Y. Lifestyle changes for treating psoriasis. *Cochrane database Syst Rev*. 2019;7(7):CD011972.
11. Arnson Y, Shoenfeld Y, Amital H. Effects of tobacco smoke on immunity, inflammation and autoimmunity. *J Autoimmun*. 2010;34(3):J258-65.
12. Elenkov IJ. Glucocorticoids and the Th1/Th2 balance. *Ann N Y Acad Sci*. 2004;1024:138-146.
13. Gregor MF, Hotamisligil GS. Inflammatory mechanisms in obesity. *Annu Rev Immunol*. 2011;29:415-445.

- Accepted Article
14. Ortiz A, Grando SA. Smoking and the skin. *Int J Dermatol*. 2012;51(3):250-262.
 15. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
 16. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;283(15):2008-2012.
 17. Bramer WM, Giustini D, de Jonge GB, Holland L, Bekhuis T. De-duplication of database search results for systematic reviews in EndNote. *J Med Libr Assoc*. 2016;104(3):240-243.
 18. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan---a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1):210.
 19. Wells G, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed December 7, 2021.
 20. The Cochrane Collaboration. Review Manager (RevMan Web) version 5.4.1. 2020.
 21. Papola D, Ostuzzi G, Thabane L, Guyatt G, Barbui C. Antipsychotic drug exposure and risk of fracture: a systematic review and meta-analysis of observational studies. *Int Clin Psychopharmacol*. 2018;33(4):181-196.
 22. Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group. <https://gdt.grade.pro.org/app/handbook/handbook.html>. Published 2013. Accessed December 7, 2021.
 23. Edman B. Palmar eczema: a pathogenetic role for acetylsalicylic acid, contraceptives and smoking? *Acta Derm Venereol*. 1988;68(5):402-407.
 24. Uter W, Gefeller O, Schwanitz HJ. Occupational dermatitis in hairdressing apprentices. Early-onset irritant skin damage. *Curr Probl Dermatol*. 1995;23:49-55.
 25. Berndt U, Hinnen U, Iliev D, Elsner P. Hand eczema in metalworker trainees--an analysis of risk factors. *Contact Dermatitis*. 2000;43(6):327-332.
 26. Montn  mery P, Nihl  n U, L  fdahl CG, Nyberg P, Svensson A. Prevalence of hand eczema in an adult Swedish population and the relationship to risk occupation and smoking. *Acta Derm Venereol*. 2005;85(5):429-432.
 27. Lind M-L, Albin M, Brisman J, et al. Incidence of hand eczema in female Swedish hairdressers. *Occup Environ Med*. 2007;64(3):191-195.

- Accepted Article
28. Bø K, Thoresen M, Dalgard F. Smokers report more psoriasis, but not atopic dermatitis or hand eczema: results from a Norwegian population survey among adults. *Dermatology*. 2008;216(1):40-45.
 29. Veien NK, Hattel T, Laurberg G. Hand eczema: causes, course, and prognosis I. *Contact Dermatitis*. 2008;58(6):330-334.
 30. Meding B, Alderling M, Albin M, Brisman J, Wrangsjö K. Does tobacco smoking influence the occurrence of hand eczema? *Br J Dermatol*. 2009;160(3):514-518.
 31. Thyssen JP, Linneberg A, Menné T, Nielsen NH, Johansen JD. The effect of tobacco smoking and alcohol consumption on the prevalence of self-reported hand eczema: a cross-sectional population-based study. *Br J Dermatol*. 2010;162(3):619-626.
 32. Meding B, Alderling M, Wrangsjö K. Tobacco smoking and hand eczema: a population-based study. *Br J Dermatol*. 2010;163(4):752-756.
 33. Röhl K, Stenberg B. Lifestyle factors and hand eczema in a Swedish adolescent population. *Contact Dermatitis*. 2010;62(3):170-176.
 34. Stenberg B, Meding B, Svensson A. Dermatology in public health--a model for surveillance of common skin diseases. *Scand J Public Health*. 2010;38(4):368-374.
 35. Anveden Berglind I, Alderling M, Meding B. Life-style factors and hand eczema. *Br J Dermatol*. 2011;165(3):568-575.
 36. Kütting B, Uter W, Weistenhöfer W, Baumeister T, Drexler H. Does smoking have a significant impact on early irritant hand dermatitis in metal workers? *Dermatology*. 2011;222(4):375-380.
 37. Johannisson A, Pontén A, Svensson Å. Prevalence, incidence and predictive factors for hand eczema in young adults - a follow-up study. *BMC Dermatol*. 2013;13:14.
 38. Mortz CG, Bindslev-Jensen C, Andersen KE. Hand eczema in The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis (TOACS): prevalence, incidence and risk factors from adolescence to adulthood. *Br J Dermatol*. 2014;171(2):313-323.
 39. Patruno C, Ayala F, Zagaria O, Balato N. Is cigarette smoking dangerous for chronic hand eczema in housewives? *Dermat contact, atopic, Occup drug*. 2014;25(4):201-204.
 40. Hougaard MG, Winther L, Søsted H, Zachariae C, Johansen JD. Occupational skin diseases in hairdressing apprentices - has anything changed? *Contact Dermatitis*. 2015;72(1):40-46.
 41. Wrangsjö K, Alderling M, Lindahl G, Meding B. Hand eczema and use of snus (moist

- snuff) - a population-based study. *Acta Derm Venereol.* 2015;95(3):298-302.
42. Lai YC, Yew YW. Smoking and Hand Dermatitis in the United States Adult Population. *Ann Dermatol.* 2016;28(2):164-171.
43. Vindenes HK, Svanes C, Lygre SHL, Hollund B-E, Langhammer A, Bertelsen RJ. Prevalence of, and work-related risk factors for, hand eczema in a Norwegian general population (The HUNT Study). *Contact Dermatitis.* 2017;77(4):214-223.
44. van der Heiden J, Agner T, Rustemeyer T, Clemmensen KKB. Hyperkeratotic hand eczema compared to other subgroups of hand eczema - a retrospective study with a follow-up questionnaire. *Contact Dermatitis.* 2018;78(3):216-222.
45. Hamnerius N, Svedman C, Bergendorff O, Björk J, Bruze M, Pontén A. Wet work exposure and hand eczema among healthcare workers: a cross-sectional study. *Br J Dermatol.* 2018;178(2):452-461.
46. Hajaghazadeh M, Jafari A, Jafari S, Hekmatirad S, Didarlo A. The Prevalence of Hand Eczema and Its Determinants Among Female Hairdressers: A Cross-Sectional Survey. *Open Public Health J.* 2018;11:170-176.
47. Erdem Y, Altunay IK, Aksu Çerman A, et al. The risk of hand eczema in healthcare workers during the COVID-19 pandemic: Do we need specific attention or prevention strategies? *Contact Dermatitis.* 2020;83(5):422-423.
48. Jing D, Li J, Tao J, et al. Associations of second-hand smoke exposure with hand eczema and atopic dermatitis among college students in China. *Sci Rep.* 2020;10(1):17400.
49. Chiriac AE, Azoicai D, Wollina U, Chiriac A, Podoleanu C, Stolnicu S. Smoking Habit and Correlation with Hand Eczema in Healthcare Workers in the Time of COVID-19. *J Interdiscip Med.* 2021;6(2):100-102.
50. Falay Gür T, Savaş Erdogan S, Doğan B. Investigation of the prevalence of hand eczema among healthcare professionals in Turkey: A cross-sectional study. *J Cosmet Dermatol.* July 2021.
51. Lerbaek A, Kyvik KO, Ravn H, Menné T, Agner T. Incidence of hand eczema in a population-based twin cohort: genetic and environmental risk factors. *Br J Dermatol.* 2007;157(3):552-557.
52. Reich A, Wilke A, Gediga G, et al. Health education decreases incidence of hand eczema in metal work apprentices: Results of a controlled intervention study. *Contact Dermatitis.* 2020;82(6):350-360.
53. Weigl LB, Wildner M. Zigarettenrauchen als Risikofaktor für das dyshidrosiforme

Handekzem? Fall-Kontroll-Studie eines ambulanten Kollektivs. In: ; 2011.

54. Molin S, Ruzicka T, Herzinger T. Smoking is associated with combined allergic and irritant hand eczema, contact allergies and hyperhidrosis. *J Eur Acad Dermatol Venereol*. 2015;29(12):2483-2486.
55. Brans R, John SM. Clinical patterns and associated factors in patients with hand eczema of primarily occupational origin. *J Eur Acad Dermatol Venereol*. 2016;30(5):798-805.
56. Brans R, Wilke A, Rodríguez E, et al. Effectiveness of secondary prevention in metalworkers with work-related skin diseases and comparison with participants of a tertiary prevention program: A prospective cohort study. *Contact Dermatitis*. 2020;83(6):497-506.
57. Obermeyer L, Skudlik C, John SM, Brans R. Treatment with alitretinoin in patients taking part in a tertiary individual prevention program for work-related skin diseases. *Contact Dermatitis*. 2021;85(4):446-453.
58. Brans R, Skudlik C, Weisshaar E, et al. Association between tobacco smoking and prognosis of occupational hand eczema: a prospective cohort study. *Br J Dermatol*. 2014;171(5):1108-1115.
59. Sørensen JA, Fisker MH, Agner T, Clemmensen KKB, Ebbelhøj NE. Associations between lifestyle factors and hand eczema severity: are tobacco smoking, obesity and stress significantly linked to eczema severity? *Contact Dermatitis*. 2017;76(3):138-145.
60. Hafsia M, Kacem I, El Maalel O, et al. Relationship between Hand Eczema Severity and Occupational Stress: A Cross-Sectional Study. *Dermatol Res Pract*. 2019.
61. Douwes KE, Karrer S, Abels C, Landthaler M, Szeimies RM. Does smoking influence the efficacy of bath-PUVA therapy in chronic palmoplantar eczema? *Photodermatol Photoimmunol Photomed*. 2000;16(1):25-29.
62. Olesen CM, Agner T, Ebbelhøj NE, Carøe TK. Factors influencing prognosis for occupational hand eczema: new trends. *Br J Dermatol*. 2019;181(6):1280-1286.
63. Magnavita N, Elovainio M, Heponiemi T, Magnavita AM, Bergamaschi A. Are skin disorders related to work strain in hospital workers? A cross-sectional study. *BMC Public Health*. 2011;11:600.
64. Lodi A, Betti R, Chiarelli G, Urbani CE, Crosti C. Epidemiological, clinical and allergological observations on pompholyx. *Contact Dermatitis*. 1992;26(1):17-21.
65. Böhm D, Stock Gissendanner S, Finkeldey F, et al. Severe occupational hand eczema, job stress and cumulative sickness absence. *Occup Med (Lond)*. 2014;64(7):509-515.

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66. Janardhanan AK, Sukumarakurup S, Abdul Latheef EN, et al. Therapeutic considerations related to stress levels associated with hand eczema: A clinico-etiological study. *Dermatol Ther*. 2020;33(6):e14508.
 67. Cazzaniga S, Apfelbacher C, Diepgen T, et al. Patterns of chronic hand eczema: a semantic map analysis of the CARPE registry data. *Br J Dermatol*. 2018;178(1):229-237.
 68. Cazzaniga S, Ballmer-Weber BK, Gräni N, et al. Medical, psychological and socio-economic implications of chronic hand eczema: a cross-sectional study. *J Eur Acad Dermatol Venereol*. 2016;30(4):628-637.
 69. Cazzaniga S, Ballmer-Weber BK, Gräni N, et al. Chronic hand eczema: A prospective analysis of the Swiss CARPE registry focusing on factors associated with clinical and quality of life improvement. *Contact Dermatitis*. 2018;79(3):136-148.
 70. Kavli G, Førde OH. Hand dermatoses and sick-leave: relationship between educational level, physical activity at work and housework as main occupation. *Contact Dermatitis*. 1984;11(2):70-73.
 71. Pitché P, Boukari M, Tchangai-Walla K. [Factors associated with palmoplantar or plantar pompholyx: a case-control study]. *Ann Dermatol Venereol*. 2006;133(2):139-143.
 72. Lai YC, Yew YW. A Relationship between Physical Activities and Hand Dermatitis: An Epidemiology Study of the USA Population. *Indian J Dermatol*. 2015;60(6):584-587.
 73. Smith DR, Wei N, Zhao L, Wang R-S. Hand dermatitis among nurses in a newly developing region of Mainland China. *Int J Nurs Stud*. 2005;42(1):13-19.
 74. Counter CE. Discoid eczema of the hands. *Calif Med*. 1954;80(5):377-379.
 75. Veien NK, Hattel T, Justesen O, Nørholm A. Oral challenge with metal salts. (I). Vesicular patch-test-negative hand eczema. *Contact Dermatitis*. 1983;9(5):402-406.
 76. Lukács J, Schliemann S, Elsner P. Association between smoking and hand dermatitis--a systematic review and meta-analysis. *J Eur Acad Dermatol Venereol*. 2015;29(7):1280-1284.
 77. Sørensen JA, Clemmensen KK, Nixon RL, Diepgen TL, Agner T. Tobacco smoking and hand eczema - is there an association? *Contact Dermatitis*. 2015;73(6):326-335.

Table 1: Details of included studies on lifestyle factors and hand eczema

Author	Year	Country	Study design	Setting	N (HE)	N (total)	Assessment of HE	Included subtype(s) of hand eczema as reported in the study	Assessment of lifestyle factor	Conclusion reported in article	NOS score
Smoking											
Prevalence											
Edberg ²³	1988	Sweden	Prospective cohort	Clinical	153	425	Medical records	Vesicular palmar eczema	Yes/no	Smoking was positively associated with HE in males (P=0.029 OR 2.4).	5
Uebachs ²⁴	1995	Germany	Prospective cohort	Occupational (hairdressing apprentices)	126	859	Physician diagnosed	HE (pompholyx or eczema)	>5 cigarettes/≤ 5 cigarettes daily	Smoking was positively associated with HE (OR 1.92 95% CI: 1.27-2.91).	5
Berndt ²⁵	2000	Switzerland	Prospective cohort with a nested case-control	Occupational (metalworker trainees)	47	201	Physician diagnosed	HE not specified	Number of cigarettes	No association between smoking amount and HE.	4
Montgomery ²⁶	2005	Sweden	Cross-sectional	General population	593 [†]	9316	Self-reported	HE not specified	>5 cigarettes/≤ 5 cigarettes daily	Smoking was positively associated with HE in the last year (OR 1.35 95% CI: 1.04-1.75).	8
Lind ²⁷	2006	Sweden	Retrospective cohort	Occupational/general population (hairdressers, controls from general population)	1068	8699	Self-reported	HE not specified	Never/former/current	Smoking was positively associated with HE in hairdressers but not in controls (Hairdressers: current/former smokers: 31% and never-smokers: 27% HE (p=0.017), controls: current/former smokers: 20% and never-smokers: 18% HE (p=0.054)).	5
Børresen ²⁸	2008	Norway	Cross-sectional	General population	1096	18747	Self-reported	HE not specified	Never/former/current + amount	No association between HE and smoking (Current (m): OR 0.97 95% CI 0.68-1.38 Previous (m): OR 0.99 95% CI 0.73-1.36 compared to never smoking. ≥ 20 cigarettes daily (m): OR 1.07 95% CI: 0.73-1.56. Current (f): OR 0.92 95% CI 0.73-1.16 Previous (f): OR 1.03 95% CI 0.83-1.28, ≥ 20 cigarettes daily (f): OR 1.20 95% CI 0.87-1.65).	6
Veien ²⁹	2008	Denmark	Prospective cohort	Private dermatological practice	522	522	Physician diagnosed	HE not specified	Yes/no	No association between smoking and HE (not further specified).	5
Meding ³⁰	2008	Sweden	Cross-sectional	Occupational/general population (bakers, hairdressers, dental technicians, controls from general population)	1761 [†]	13452	Self-reported	HE not specified	Yes/no + amount	Smoking was negatively associated with HE in bakers PPR 0.67 95% CI 0.49-0.92. No association was found for the other groups. Amount of smoking was positively associated with HE in hairdressers (Smoking >10 cigarettes/day in hairdressers: 22,6% HE, <10 cigarettes/day: 17,4% HE (p=0.01)).	7

Thygesen ³¹	2009	Denmark	Cross-sectional	General population	748	3471	Self-reported	All types of HE further categorized as: Atopic HE/ Allergic HE/ Allergic and atopic HE /Other HE	Never, former, current + amount	Smoking was positively associated with HE Previous: OR 1.13 95% CI 0.90-1.40, Current <15 g daily: OR 1.51 95% CI 1.14-2.02, Current >15 g daily: OR 1.38 95% CI 0.99-1.92.	7
Medstrand ³²	2010	Sweden	Cross-sectional	General population	2344	25428	Self-reported	HE not specified	Never/former/current/ occasional (not daily) + amount	Former smoking and smoking > 15 cigarettes/day were positively associated with HE in the last year Ex-smokers: PPR 1.14 95% CI 1.04-1.25, Occasional smokers: PPR 1.01 95% CI 0.84-1.21, 1-7 cigarettes/day: PPR 1.10 95% CI 0.92-1.32, 8-15 cigarettes/day: PPR 1.18 95% CI 1.00-1.39, >15 cigarettes/day: PPR 1.40 95% CI 1.15-1.71) There was a dose-response relation between amount of cigarettes and HE. (PPR 1.05 (P <0.001)).	8
Röhrl ³³	2010	Sweden	Cross-sectional	General population (upper secondary school children)	350 [†]	6095	Self-reported	HE not specified	Yes/no	No association between smoking and HE (OR 0.85 95% CI 0.59-1.23)	7
Stenberg ³⁴	2010	Sweden	Cross-sectional	General population	6135 [†]	65261	Self-reported	HE not specified	Yes/no and daily snuff use	Daily smoking and the use of snuff were positively associated with HE (Smoking: OR 1.18 95% CI 1.09-1.27, Snuff use: OR 0.88 95% CI 0.80-0.97)	7
Arvidsson Berglund ³⁵	2011	Sweden	Cross-sectional	General population	2746	27793	Self-reported	HE not specified	Yes/no	Smoking was positively associated with HE (PPR 1.025 95%CI 1.006-1.044).	7
Küttling ³⁶	2011	Germany	Prospective cohort	Occupational (metalworkers)	217	1020	Self-reported/Physician diagnosed	HE not specified	Yes/no	No association between smoking and HE.	4
Ibren ³⁷	2012	Denmark	Cross-sectional	Occupational (healthcare workers)	397 [†]	2269	Self-reported	HE not specified	Not specified	No association between smoking and HE (not further specified).	3
Johnsen ³⁷	2013	Sweden	Prospective cohort	General population (upper secondary school children)	500	1516	Self-reported	HE not specified	Yes/ no + amount	Persons with HE in 2008 smoked more cigarettes persons without HE ever (p=0.012) No association between amount of smoking and HE ever.	7
Mortz ³⁸	2014	Denmark	Prospective cohort	General population (school children)	127	891	Self-reported and point prevalence physician-diagnosed	HE not specified	Yes/no	No association between smoking and HE (OR 1.4 95% CI 0.9-2.1).	5
Patruno ³⁹	2014	Italy	Case-control	General population (housewives)	214	516	Self-reported	Chronic HE not specified	Yes/no + amount	No association between smoking and HE (p=0.859).	5

Holger et al. ⁴¹	2014	Denmark	Cross-sectional	Occupational/general population (hairdressers and controls from general population)	437	1904	Self-reported	HE not specified	Never/former/current + amount	Smoking was not associated with HE (not further specified).	6
Wrangsjö ⁴¹	2015	Sweden	Cross-sectional	General population	2681	27466	Self-reported	HE not specified	Yes/no	Daily snus use was negatively associated with HE and smoking was not associated with HE (PPR 0.813 95% CI 0.686-0.964 and PPR 1.023 95% CI 0.848-1.234, respectively)	7
Lai ⁴²	2016	USA	Cross-sectional	General population	38	1301	Physician-diagnosed	HE not specified	Non/current/smoked at least 100 cigarettes + amount (gram per day)	Smoking was positively associated with HE. (Current: OR 4.02 95% CI 1.13-14.24, >15/day: OR 4.69 95% CI 1.17-18.76, <15/day: OR 3.82 95% CI 0.89-16.36, Smoked at least 100 cigarettes: OR 1.21 95% CI 0.58-2.52)	7
Vindenes ⁴³	2017	Norway	Cross-sectional	General population	5757	50781	Self-reported	HE not specified	Never, former, current	Smoking was positively associated with HE. (Former: RR 1.11 95% CI 1.05-1.19, current: RR 1.17 95% CI 1.09-1.26)	7
Van der Heiden ⁴⁴	2018	Denmark	Retrospective cohort	Clinical	120	120	Medical reports	Hyperkeratotic endogenous HE/ irritant contact dermatitis/ allergic contact dermatitis/ atopic HE/ contact urticaria/ vesicular endogenous HE	Yes/no	Smoking was positively associated with HE (p=0.049).	8
Wang et al. ⁴⁵	2018	Sweden	Cross-sectional	Occupational (healthcare workers)	1870	9051	Self-reported	HE not specified	Yes/no (daily)	No association between smoking and HE. (OR 1.15, 95% CI 0.84-1.57).	6
Halaghzadeh ⁴⁶	2018	Iran	Case-control	General population (housewives and hairdressers)	158	770	Self-reported	HE not specified	Yes/no	Smoking was positively associated with HE. (OR=3.44 95%CI=1.73-6.85).	5
Erden ⁴⁷	2020	Turkey	Cross-sectional	Occupational (health care workers)	54	107	Physician diagnosed	HE not specified	Yes/no	No association between smoking and HE.	3
Jing ⁴⁸	2020	China	Cross-sectional	General population (adolescents)	674	20129	Physician diagnosed	All types of HE further categorized as: interdigital eczema/ recurrent vesicular HE/ other types (combined chronic fissured	Yes/no	No association between active smoking and HE (OR 1.33 95% CI 0.68-2.60)	9

								HE, hyperkeratotic HE, nummular HE)			
Chiriac ⁴⁹	2020	Romania	Cross-sectional	Occupational (health care workers)	247	247	Self-reported	HE not specified	Yes/no + amount and duration in years	No association between years of smoking and HE. No association between number of cigarettes per day and HE.	2
Falay Gür ⁵⁰	2021	Turkey	Cross-sectional	Occupational (health care workers)	308	601	Self-reported	HE not specified	Yes/no	No association between smoking and HE.	3
Incidence											
Leljaek ⁵¹	2007	Denmark	Prospective cohort	General population (twins)	244	3297	Self-reported	HE not specified	Never, former, current + ≤ 15/> 15 pack years	No association for current or former smokers and HE (IRR: 1.1 95% CI 0.8-1.5 and 1.1 95% CI 0.8-1.6, respectively) No association for packyears and HE.	7
Rei	2020	Germany	Prospective controlled intervention study	Occupational (metal work apprentices)	83	421	Physician diagnosed and self-reported	HE not specified	Yes/no + amount	Smoking was positively associated with incident HE. (P <0.01). The amount of cigarettes smoked was not associated with incident HE.	8
Subtype of hand eczema											
Weigl ⁵³	2011	Germany	Case-control	Clinical	132	132	Self-reported	Dyshidrotic HE	Yes/no	No association between smoking and vesicular HE compared to non-vesicular HE. (OR 1.10 95%CI 0.43-2.81)	7
Molin ⁵⁴	2014	Germany	Cross-sectional	Clinical	153	153	Physician diagnosed	All types of chronic HE further categorized as: allergic contact dermatitis/combined allergic and irritant contact dermatitis/ atopic HE/ idiopathic HE/ dyshidrotic HE/ hyperkeratotic HE/ mixed HE	Never, former, current	Smoking was positively associated with combined allergic and irritant HE (p<0.05) but not with other forms of HE.	6
Brä	2016	Germany	Retrospective cohort	Occupational	723	723	Medical records	Atopic HE/irritant contact dermatitis/allergic contact dermatitis/ hyperkeratotic HE/ HE with erythema and desquamation/vesicular HE	Never/former/current + amount	Smoking was positively associated with vesicular HE and negatively associated with hyperkeratotic HE (both p < 0.001) In multivariate logistic regression analysis smoking was positively associated with vesicular HE (OR 2.86 (1.59–5.13)). No association for the other subtypes of HE was found.	7
Van der Heiden ⁴⁴	2018	Denmark	Retrospective cohort	Clinical	120	120	Medical reports	Hyperkeratotic endogenous HE irritant contact dermatitis/ allergic	Yes/no	Prevalence of hyperkeratotic HE and smoking compared to other subtypes of HE: OR 1.00, 95% CI 0.27-3.74.	8

								contact dermatitis/ atopic HE/ contact urticaria/ vesicular endogenous HE			
Bräns ⁵⁶	2020	Germany	Prospective cohort	Clinical occupational	197	197	Physician diagnosed	All types of HE further categorized as: Atopic HE/ Irritant contact dermatitis/ Allergic contact dermatitis/ Hyperkeratotic HE	Yes/no + amount	Smoking was positively associated with vesicular HE in subjects taking part in the tertiary individual prevention program (P < .05 at baseline and P < .001 at follow up) but not in the secondary prevention program. Smoking was not associated with any of the other subtypes of HE in both prevention programs.	4
Obermayer ⁵⁷	2021	Germany	Retrospective cohort	Clinical occupational	1614	1614	Physician diagnosed	All types of HE further categorized as: Atopic HE/ Irritant contact dermatitis/ Allergic contact dermatitis/ Hyperkeratotic HE/Vesicular HE	Yes/no	Vesicular HE was more frequent among smokers than non-smokers (45.7% vs 26.9%, P < .001).	4
Severity											
Iblir ⁵⁸	2012	Denmark	Cross-sectional	Occupational (healthcare workers)	397	2269	Self-reported	HE not specified	Not specified	No association between smoking and severity of HE (not further specified).	3
Bräns ⁵⁸	2014	Germany	Prospective cohort	Occupational (healthcare, metal industry, hairdressing trade)	1608	1608	Physician diagnosed	All types of HE further categorized as: Atopic HE/ Irritant contact dermatitis/ Allergic contact dermatitis	Yes/no + amount	Smoking was positively associated with severity of HE (p<0.01/p=0.02). No dose-dependent association between the amount of cigarettes and severity of HE was reported.	5
Patrino ³⁹	2014	Italy	Case-control	General population (housewives)	214	516	Self-reported	Chronic HE not specified	Yes/no + amount	Smoking amount was negatively associated with severity of HE. Almost clear HE was more frequent among smokers (p<0.05). 'severe' form more frequently in non-smokers (p=0.01). No differences: mild and moderate disease (p=0.39 and p=0.17). No dose-dependent association with amount of cigarettes was found.	5
Sørensen	2017	Denmark	Cross-sectional	Occupational	773	773	Self-reported	HE not specified	Yes/no	Smoking was positively associated with severity of HE (OR 2.15, 95% CI 1.29-3.59).	7

Halicioglu ⁶⁰	2019	Tunisia	Cross-sectional	Occupational (administrative, employee, labour, technician, doctor, paramedical staff)	109	109	Physician diagnosed	HE not specified	Never/former/current	No association between smoking and severity of HE.	5
Brans ⁶¹	2020	Germany	Prospective cohort	Clinical occupational	197	197	Physician diagnosed	All types of HE further categorized as: Atopic HE/ Irritant HE/ Allergic contact dermatitis/ Hyperkeratotic HE	Yes/no + amount	No association between smoking or smoking amount and severity of HE.	4
Falay Gür ⁶²	2021	Turkey	Cross-sectional	Occupational (health care workers)	308	601	Self-reported	HE not specified	Yes/no	No association between smoking and severity of HE.	3
Prognosis											
Douwes ⁶³	2000	Germany	Retrospective cohort	Clinical	62	62	Medical report	Palmoplantar eczema	Yes (>10 cigarettes)/no	Smoking was associated with a worse prognosis of HE (p<0.05).	6
Veien ²⁹	2008	Denmark	Prospective cohort	Private dermatological practice	522	522	Physician diagnosed	HE not specified	Yes/no	No association between smoking and long-standing HE (not further specified).	4
Olesen ⁶²	2019	Denmark	Retrospective cohort	Clinical occupational	1491	1491	Medical records	HE not specified	Never/former/current	Smoking was associated with persistence of HE (OR 0.48, 95% CI 0.31-0.72).	6
Oberneyer ⁶⁴	2021	Germany	Retrospective cohort	Clinical occupational	1614	1614	Physician diagnosed	All types of HE further categorized as: Atopic HE/ Irritant contact dermatitis/ Allergic contact dermatitis/ Hyperkeratotic HE/Vesicular HE	Yes/no	Nearly 58.4% of tobacco smokers claimed no response or worsening of HE vs. 47.6% of the non-smokers (P =.134).	4
Stress Prevalence											
Anveden Berglund ³⁵	2011	Sweden	Cross-sectional	General population	2747 [†]	27793	Self-reported	HE not specified	How often do you feel stressed? High exposure: a couple of days per week/ most days of the week. Low exposure: never or a few times per year/about once a month/about 1 day	Stress was positively associated with HE in the past year (PPR 1.326, 95%CI 1.303-1.350).	7

									per week.		
Magnavita ⁶³	2011	Italy	Cross-sectional	Occupational (healthcare workers)	138	1744	Physician diagnosed	HE not specified	Occupational stress factors (demand/Control/Support model): Job control, job demands, social support, high strain, high iso-strain.	High job demands, high strain and high iso-strain were positively associated with current HE (OR 1.13 95% CI 1.06-1.22, OR 1.91 95% CI 1.29-2.91 and OR 2.07 95% CI 1.37-3.11, respectively). High social support and higher job control were negatively associated with current HE (OR 0.87 95% CI 0.82-0.91 and OR 0.93 95% CI 0.88-0.98).	10
Wångsjö ⁶²	2015	Sweden	Cross-sectional	General population	2681	27466	Self-reported	HE not specified	How often do you feel stressed? High exposure: a couple of days per week/ most days of the week. Low exposure: never or a few times per year/about once a month/about 1 day per week.	Stress was positively associated with HE in the past year (PPR 1.528 95% CI 1.420-1.643).	7
Mallon ⁶¹	2018	Europe	Case-control	Clinical	143	1496	Physician diagnosed	HE not specified	Stressful life event in the last 6 months (yes/no)	Reporting a stressful life event was associated with HE (p=0.044 (f), p=0.045 (m))	7
Hallerius ⁴⁵	2017	Sweden	Cross-sectional	Occupational (healthcare workers)	1870	9051	Self-reported	HE not specified	How often do you feel stressed? Never or only a few times per year, sometime every month, sometime every week, some days every week, most days of the week	Stress was positively associated with HE in the past year. Sometime every month: OR 1.1, 95% CI 0.9-1.5, Sometime every week: OR 1.4, 95% CI 1.1-1.9, Some days every week: OR 2.0, 95% CI 1.5-2.6, Most days of the week: OR 2.2, 95% CI 1.6-3.1	6
Falek Çiğdem ⁴⁷	2021	Turkey	Cross-sectional	Occupational (health care workers)	308	601	Self-reported	HE not specified	Exposure to stress: Once a week or less vs more than once a week	No association between exposure to stress and HE.	4
Severity											
Lodi ⁶⁴	1992	Italy	Case-control study	Clinical	104	312	Physician diagnosed	Pompholyx	Emotional stress as aggravating factor (yes/no)	18/104 (17.3%) mentioned stress as aggravating factor of HE	2
Veien ²⁹	2008	Denmark	Prospective cohort	Clinical	522	522	Physician diagnosed	HE not specified	Psychological stress as aggravating	Men (6%) and women (13%) mentioned stress as aggravating factor	5

									factor (yes/no)		
Bonin ⁵⁹	2014	Germany	Cross-sectional	Occupational	122	122	Physician diagnosed	HE not specified	High chronic stress or low chronic stress (based on the mean TICS-score)	No association between chronic stress and severity of HE.	5
Sørensen ⁵⁹	2016	Denmark	Cross-sectional	Occupational	773	773	Self-reported	HE not specified	How often do you feel stressed? A few times a year, approximately once a month, weekly, a few times a week, most days.	No association between stress and current severity of HE.	8
Hafsia ⁶⁰	2019	Tunisia	Cross-sectional	Clinical	109	109	Physician diagnosed	HE not specified	Score of PSS-10 score ≤ 27 or > 27 , and occupational stress Siegre's "effort reward imbalance" questionnaire (ratio > 1 defines an imbalance between efforts and rewards).	No association between stress and severity of HE.	6
Jararchana ⁶⁰	2020	India	Cross-sectional	Clinical	62	62	Physician diagnosed	HE not specified	Emotional stress as aggravating factor	25/62 (40.3%) mentioned emotional stress as aggravating factor of HE.	3
Erdem Cürü ⁶⁰	2021	Turkey	Cross-sectional	Occupational (health care workers)	308	601	Self-reported	HE not specified	1. Stress as aggravating factor (yes/no) 2. Exposure to stress: Once a week or less vs more than once a week	1. 9/308 (2.9%) mentioned stress as aggravating factor of HE. 2. No association between exposure to stress and severity of HE.	4
Prognosis											
Olesen ⁶²	2019	Denmark	Retrospective cohort	Occupational	1491	1491	Medical records	HE not specified	How often do you feel stressed? Low: A few times per year, approximately once per month. High: Weekly, a couple of times per week, most days.	Higher level of stress was associated with persistence of HE (OR 0.72, 95% CI 0.53-0.97).	6

Prevalence											
Anveden Berglund ⁴¹	2011	Sweden	Cross-sectional	General population	2747 [†]	27793	Self-reported	HE not specified	>30 or ≤30	BMI > 30 was positively associated with HE in the past year (PPR 1.204 (95%CI 1.174-1.234))	7
Wrangsjö ⁴¹	2015	Sweden	Cross-sectional	General population	2681	27466	Self-reported	HE not specified	>30 or ≤30	BMI > 30 was positively associated with HE in the past year (PPR 1.232 95% CI 1.104-1.376)	5
Lai ⁴²	2016	USA	Cross-sectional	General population	38	1301	Physician diagnosed based on photographs	HE not specified	Continuous variable	No association between BMI and current HE.	5
Vindenes ⁴³	2017	Norway	Cross-sectional	General population	5757	50781	Self-reported	HE not specified	<18.5, ≥18.5- <25, ≥25-<30, ≥30	BMI ≥30 was positively associated with HE (RR 1.11 95% CI 1.03-1.20)	8
Hallnerius ⁴⁵	2017	Sweden	Cross-sectional	Occupational (healthcare workers)	1870	9051	Self-reported	HE not specified	<30 and ≥30	BMI was positively associated with HE (OR 1.35, 95%CI 1.03-1.78)	5
Subtypes of HE											
van de Heide ⁴⁴	2018	Denmark	Retrospective cohort	Clinical	120	120	Medical reports	Hyperkeratotic endogenous HE/ irritant contact dermatitis/ allergic contact dermatitis/ atopic HE/ contact urticaria/ vesicular endogenous HE	≤24.9 and >24.9	No association between BMI and hyperkeratotic HE compared to other subgroups of HE (OR 0.87, 95% CI 0.27-2.78).	8
Cazzaniga ⁴⁶	2018	Switzerland and Germany	Cross-sectional	Clinical	1466	1466	Physician-diagnosed	Vesicular HE/ hyperkeratotic HE fingertip dermatitis	<25.0, 25.0-29.9 and ≥30.0	In the semantic map analysis there seemed to be a link between a BMI > 30 kg m2, fingertip dermatitis and hyperkeratotic HE with additional involvement of the feet.	7
Severity											
Sørensen ⁴⁷	2016	Denmark	Cross-sectional	Occupational	773	773	Self-reported	HE not specified	≤24.9 and >24.9	No association between BMI and severity of HE.	7
Cazzaniga ⁴⁶	2016	Switzerland	Cross-sectional	Clinical	199	199	Physician-diagnosed	Fingertip dermatitis/ hyperkeratotic HE/ Vesicular HE	<25.0, 25.0-29.9 and ≥30.0	No association between BMI and moderate to severe HE. (BMI 25.0-29.9: OR 1.09 95% CI 0.52–2.27, and BMI ≥30.0: OR 1.12 95% CI 0.42–2.96)	7
Cazzaniga ⁴⁶	2018	Switzerland and Germany	Cross-sectional	Clinical	1466	1466	Physician-diagnosed	Fingertip dermatitis/ hyperkeratotic HE/ Irritant contact dermatitis/Vesicular HE	<25.0, 25.0-29.9 and ≥30.0	Association between BMI ≥30.0 and severe chronic HE (Only reported for the cohort of Switzerland n=199).	7
Hachissia ⁶⁰	2019	Tunisia	Cross-sectional	Clinical	109	109	Physician diagnosed	HE not specified	Normal vs. Overweight and obesity (not further specified)	No association between BMI and severity of HE (OR 1.08 95%CI 0.47–2.47).	4
Prognosis											
Olesen ⁶²	2019	Denmark	Retrospective cohort	Occupational	1491	1491	Medical records	HE not specified	<18.5, 18.5-<25, 25-<30 and ≥30	No association between BMI and persistence of HE. (<18.5: 0.26 (0.03–2.01), 18.5-<25 ref, 25-<30: 0.89 (0.64–1.24), ≥30: 1.01 (0.69–1.49))	6

Cazabian ⁶⁷	2018	Switzerland	Prospective cohort	Clinical	199	199	Diagnosed by physician	Vesicular HE/ Hyperkeratotic-fissured HE/ Allergic contact dermatitis/ Fingertip dermatitis/ Atopic HE/Irritant contact dermatitis	<25.0, 25.0-29.9, ≥30.0	No significant difference in PGA MCID 6 months. (BMI: 25.0-29.9: OR 1.00 95% CI 0.51-1.95 and BMI: ≥30.0: OR 0.95 95% CI 0.39-2.31). No significant difference in PGA change up to 24 months after baseline. (BMI: 25.0-29.9: 0.12 95% CI (-0.15 to 0.39) and BMI: ≥30.0: 0.05 95%CI (-0.36 to 0.46))	8
Physical activity											
Prevalence											
Kalish ⁷⁰	1984	Norway	Cross-sectional	General population	1322	14667	Self-reported	Allergic eczema of the hands	Sedentary work, work leading to much walking, work leading to much walking and lifting, heavy manual labour	With the exception of the small group doing heavy manual work, a trend towards increasing frequency of HE with greater physical activity was found in women (sedentary work: 11.5%, work leading to much walking: 13.6%, work leading to much walking and lifting: 15.8%, heavy manual labour: 6.9%) this trend was not seen in men (5.0%, 5.0%, 4.9% and 4.2%, respectively).	5
Pitche ⁷¹	2006	France	Case-control	Clinical	100	300	Physician diagnosed	Pompholyx	Sport (yes/no)	Positive association between sport and HE (OR = 8.8; CI 95 %: 3.9 - 20.8). After adjustment no significant association.	6
Anveden Rosell ³⁵	2011	Sweden	Cross-sectional	General population	2747 [†]	27793	Self-reported	HE not specified	How much exercise and physical exertion have you engaged in during your leisure time over the past 12 months? High: regular exercise and workouts or moderate regular exercise during leisure time. Low: sedentary leisure time, or moderate exercise during leisure time	Physical activity during leisure time was negatively associated with HE in the past year. (PPR 0.818 (95% CI 0.804-0.832))	7
Iblor ⁵	2012	Denmark	Cross-sectional	Occupational (healthcare workers)	397	2269	Self-reported	HE not specified	Not specified	No association between physical activity and HE (not further specified)	3
Johannisson ⁷²	2013	Sweden	Prospective cohort	General population (upper secondary school children)	500 [†]	1516	Self-reported	HE not specified	Hours per week doing sports	No association between hours per week doing sports and HE. (HE (mean. Median, Q1-Q3) 4.1, 2, (1 – 4), No HE: 4.1, 2, (1 – 4) P>0.05.	8
Lai ⁷²	2015	USA	Cross-sectional	General population	42	2688	Physician diagnosed based on photographs	HE not specified	Vigorous physical activity (>10 min), moderate physical activity (>10	Moderate and vigorous physical activity was negatively associated with present HE (OR 0.515 p=0.043 and OR 0.396 p=0.011, respectively). Lifting heavy weights was positively associated with HE (OR 2.743 p=0.075.	7

									minutes), average daily activity (Sits during the day and does not walk about very much, stand or walk about a lot during the day, lift light load or has to climb stairs or hills often, heavy work or carries heavy loads, total time spent on walking/cycling, mean MET scores)	). Mean MET score and total time spent on walking/cycling were not associated with HE. Mean MET score daily activities was positively associated with HE (OR 1.088 p=0.042).	
Wrona ⁴³	2015	Sweden	Cross-sectional	General population	2681	27466	Self-reported	HE not specified	How much exercise and physical exertion have you engaged in during your leisure time over the past 12 months? High: regular exercise and workouts or moderate regular exercise during leisure time. Low: sedentary leisure time, or moderate exercise during leisure time.	Physical activity was negatively associated with HE in the past year. (PPR 0.780, 95%CI 0.724-0.840)	5
Jing ⁴⁸	2020	China	Cross-sectional	General population (adolescents)	674	20129	Physician diagnosed	All types of HE further categorized as: interdigital eczema/ recurrent vesicular HE/ other types (combined chronic fissured HE, hyperkeratotic HE, nummular HE)	Minutes per week No/1-419 and ≥420 min/wk	No association between physical activity and HE (1-419 min: OR 0.88 95% CI 0.71-1.09, ≥420 OR 0.99 95%CI 0.82-1.18)	8
Subtype of HE											
Van der Heijden ⁴⁴	2018	Denmark	Retrospective cohort	Clinical	120	120	Medical reports	Hyperkeratotic endogenous HE/ irritant contact dermatitis/ allergic contact dermatitis/ atopic HE/ contact urticaria/ vesicular	Almost physically passive or only light physical activity for <2h per week, light physical activity for 2-3h per week, light physical activity for	No association between physical activity and hyperkeratotic HE compared to other subtypes (light physical activity for 2-3h/week: OR 2.72, 95%CI 0.20-36.5, light physical activity for >4h/week or more strenuous physical activity for 2-4h/week: OR 2.46, 95% CI 0.20-30.4, more strenuous physical activity for >4h/week or regular hard training or competitions several	8

								endogenous HE	>4h per week or more strenuous physical activity for >4h per week, or regular hard training or competitions several times per week.	times/week: OR 5.66, 95% CI 0.33-97.6).	
Severity											
Ibller ⁵	2012	Denmark	Cross-sectional	Occupational (healthcare workers)	397	2269	Self-reported	HE not specified	Not specified	No association between physical activity and severity of HE (not further specified).	3
Harada	2019	Tunisia	Cross-sectional	Clinical	109	109	Physician diagnosed	HE not specified	Yes/no (sports and leisure time separately)	No association between sports and severity of HE (OR 0.48 95% CI 0.13–1.70), Leisure activity was negatively associated with HE OR 0.27 95%CI 0.09–0.80.	4
Persistence											
Olesen ⁶	2019	Denmark	Retrospective cohort	Occupational	1491	1491	Medical records	HE not specified	Physical activities during spare time, including transportation to and from work within the last year. Light ≤3h weekly, light ≥4h weekly or moderate 2-4h weekly, moderate >4h weekly or regular strenuous exercise.	Moderate >4h weekly or regular strenuous exercise was associated with less persistence of HE (OR 1.93, 95% CLI 1.16-3.21).	6
Alcohol consumption											
Prevalence											
Smith ⁷³	2005	China	Cross-sectional	Occupational (clinical nurses)	50	282	Self-reported	HE not specified	Occasional alcohol consumption or no alcohol consumption	No association between alcohol consumption and HE (OR 12.9 95%CI 0.03–11681.2)	3
Borg ⁷⁸	2008	Norway	Cross-sectional	General population	1096	18747	Self-reported	HE not specified	Alcohol intake: 4-7 times/week, 2-3 times/week, approximately once a week, 2-3 times per month, approximately once a month, sometimes last year, not last year, never	Except for a reduced reporting of HE among women drinking 4–7 times no association between alcohol consumption and HE was found.. (M: 4–7 times per week: OR 0.97 95%CI 0.45-2.09, 1-3 times per week OR 95%CI 1.35 0.71-2.57, sometimes last year up to 2-3 times per month OR 1.09 95%CI 0.57-2.11) (F: 4–7 times per week OR 0.37 95%CI 0.20-0.68, 1-3 times per week OR 0.73 95%CI 0.51-1.05, sometimes last year up to 2-3 times per month OR 0.83 95%CI 0.59-1.17)	6
Thygesen	2009	Denmark	Cross-sectional	General population	748	3471	Self-reported	All types of HE further categorized as:	Amount: 0, 1-7, 8-14 and ≥15 drinks	No association between alcohol consumption and HE. 1-7: 0.84 95%CI 0.63-1.11, 8-14: 0.80 95%CI 0.57-1.12,	7

								Atopic HE/ Allergic HE/ Allergic and atopic HE /Other HE	weekly	≥15: 0.82 95%CI 0.58-1.16)	
Anveden Berglund ³⁵	2011	Sweden	Cross-sectional	General population	2746	27793	Self-reported	HE not specified	>35 g/day in men and >25 g/day in women / <35 g/day or <25g/day	Alcohol consumption was negatively associated with HE (PPR 0.978 95%CI 0.961-0.995).	7
Lai ⁴²	2016	USA	Cross-sectional	General population	38	1301	Physician diagnosed based on photographs	HE not specified	At least 12 drinks in the past year (yes/no)	No association between alcohol consumption and HE OR 0.86 95%CI 0.37-1.97	6
Jin ⁴⁰	2020	China	Cross-sectional	General population (adolescents)	674	20129	Physician diagnosed	All types of HE further categorized as: interdigital eczema/ recurrent vesicular HE/ other types (combined chronic fissured HE, hyperkeratotic HE, nummular HE)	Yes/no	No association between alcohol consumption and HE (OR 0.96 95%CI 0.64-1.43)	8
Incidence											
Lerbaek ⁵¹	2007	Denmark	Prospective cohort	General population (twins)	244	3297	Self-reported	HE not specified	Never, ≤ 21, > 21 drinks/week	No association between alcohol consumption and incidence of HE (≤ 21 drinks IR 1.3 95%CI 0.9-1.8, > 21 drinks IR 1.05 95%CI 0.7-3.3)	7
Severity											
Harsta ⁵⁰	2019	Tunisia	Cross-sectional	Clinical	109	109	Physician diagnosed	HE not specified	Alcoholism yes/no (not further specified)	No association between alcohol consumption and severity of HE. OR 2.34 95%CI 0.48–11.36, After adjustment no significant association.	4
Diet											
Prevalence											
Röhl	2010	Sweden	Cross-sectional	General population (upper secondary school children)	350 [†]	6095	Self-reported	HE not specified	Vegetarianism/veganism: yes/no	No association between Vegetarianism/veganism and HE in the past year (OR 0.97 95% CI 0.67-1.41)	7
Severity											
Counsell	1954	USA	Prospective cohort	Clinical	40	40	Physician diagnosed	Discoid eczema of hands	Elimination diet excluding: nuts, onions, tomatoes, chocolate, coffee, and pork. After clinical improvement: food groups were restored to the diet one at a time and if no reaction after	Several patients had recurrences of vesicles within 5 days after introduction of particular food groups. Nuts (2), onions (5), tomatoes (1), chocolate (10), coffee (4), pork (2).	4

									five days occurred the food group was considered safe for inclusion as a usual part of the diet.		
Prognosis											
Veien	1983	Denmark	Prospective cohort	Clinical	202	202	Physician-diagnosed	Vesicular HE	When patients reacted to the mixture as well as to one or two of the individual metal salts (nickel, cobalt or chromate), they were asked to reduce their daily oral intake of foods suspected of containing significant amounts of the metal(s).	Fifty-six patients followed the diet. Thirty-six patients cleared or improved after 1 month of dieting. Twenty-eight of them followed the prescribed diet rigorously or intermittently for at least a year, because they experienced recurrence of the dermatitis if they stopped. Six noted no long-term benefit and two were lost to follow-up.	3

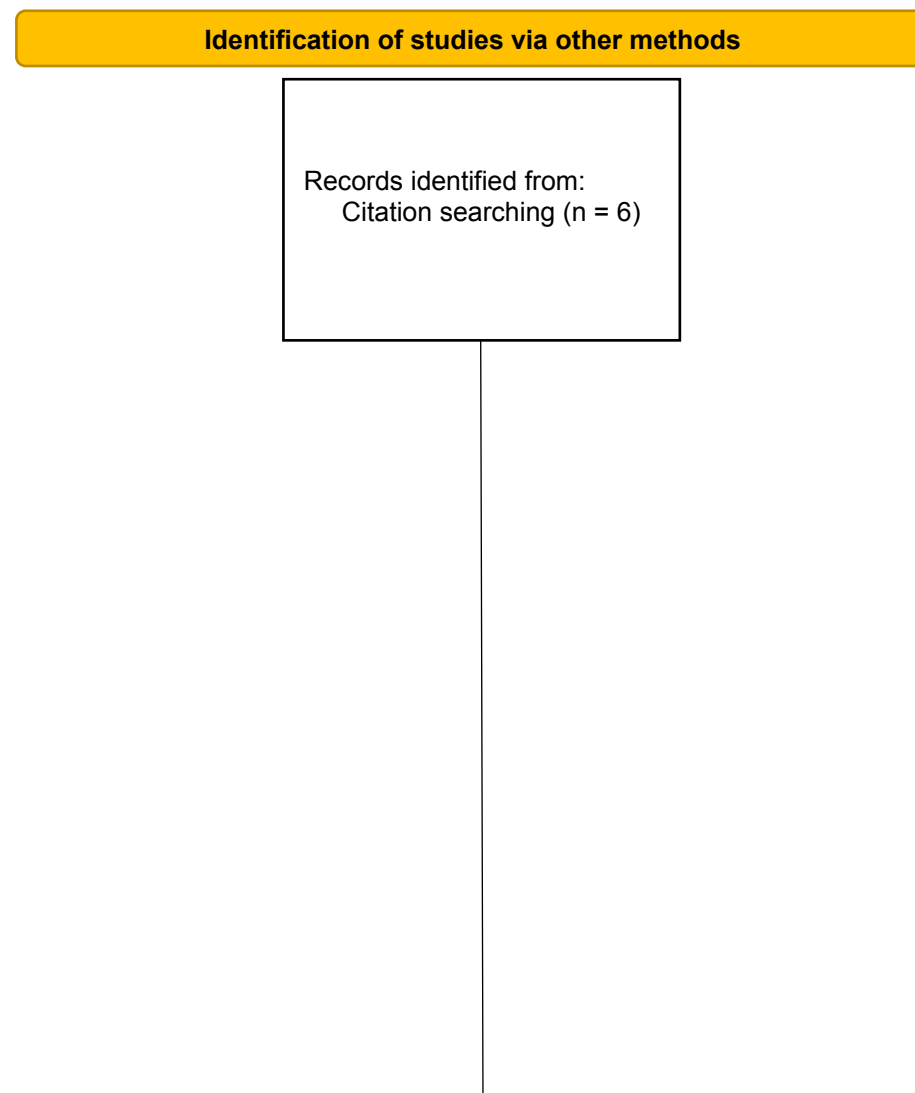
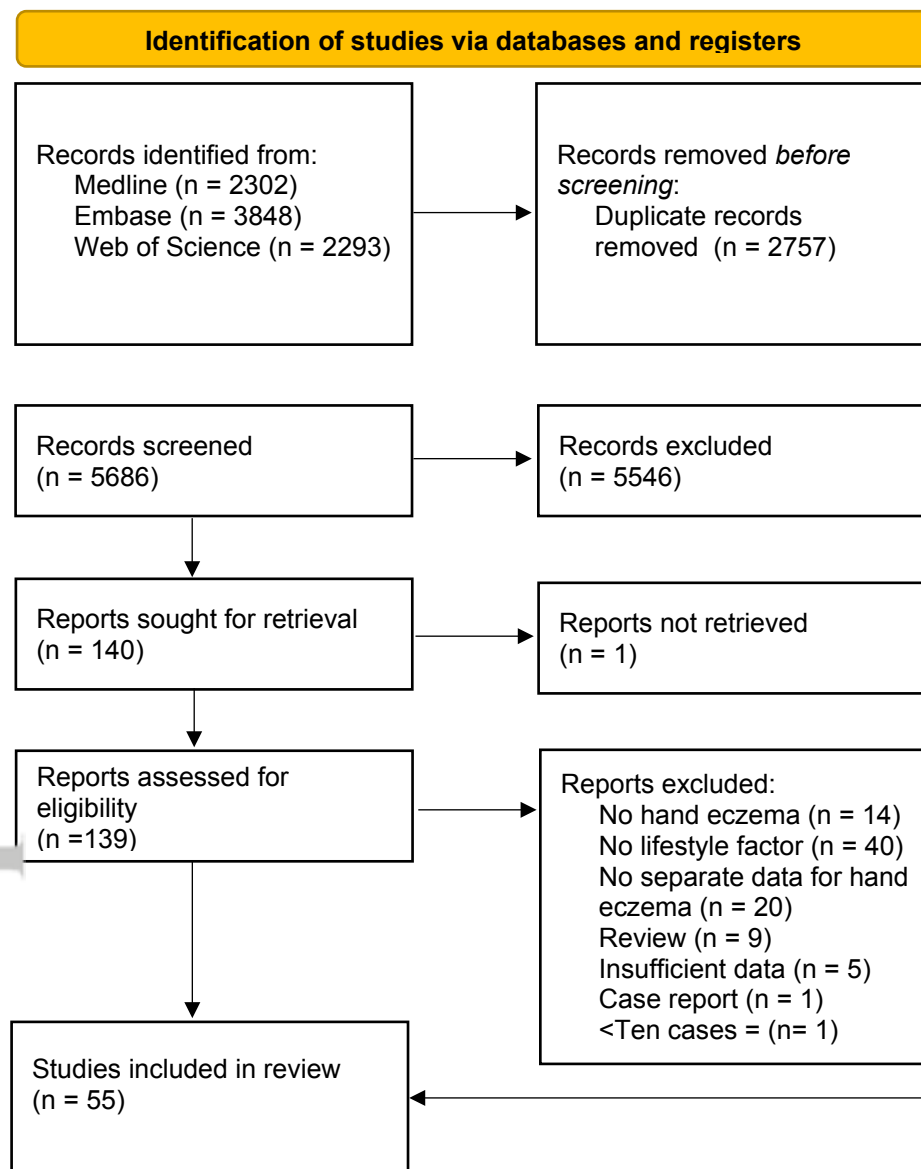
Studies occurring multiple times due to multiple studied lifestyle factors or outcome measures.
When studies reported both unadjusted and adjusted results, adjusted results are reported.
Cohort and case-control study outcomes with ≥ 6 points on the NOS, and cross-sectional study outcomes with ≥ 7 points, were considered low risk of bias.
[†]Calculated from reported percentages
Abbreviations: n, number; HE, hand eczema; NOS, Newcastle-Ottawa Scale, OR, odds ratio; CI, confidence interval; m, males; f, females; g, gram; PPR, population prevalence ratio; USA, United States of America; IR, incidence rate; RR, Risk ratio; IRR, incidence rate ratio; TICS, Trier Inventory for the Assessment of Chronic Stress; PSS, Perceived Stress Scale; BMI; Body Mass Index; PGA, Physician Global Assessment; MCID, Minimal Clinical Important Difference; MET, metabolic equivalent of ta

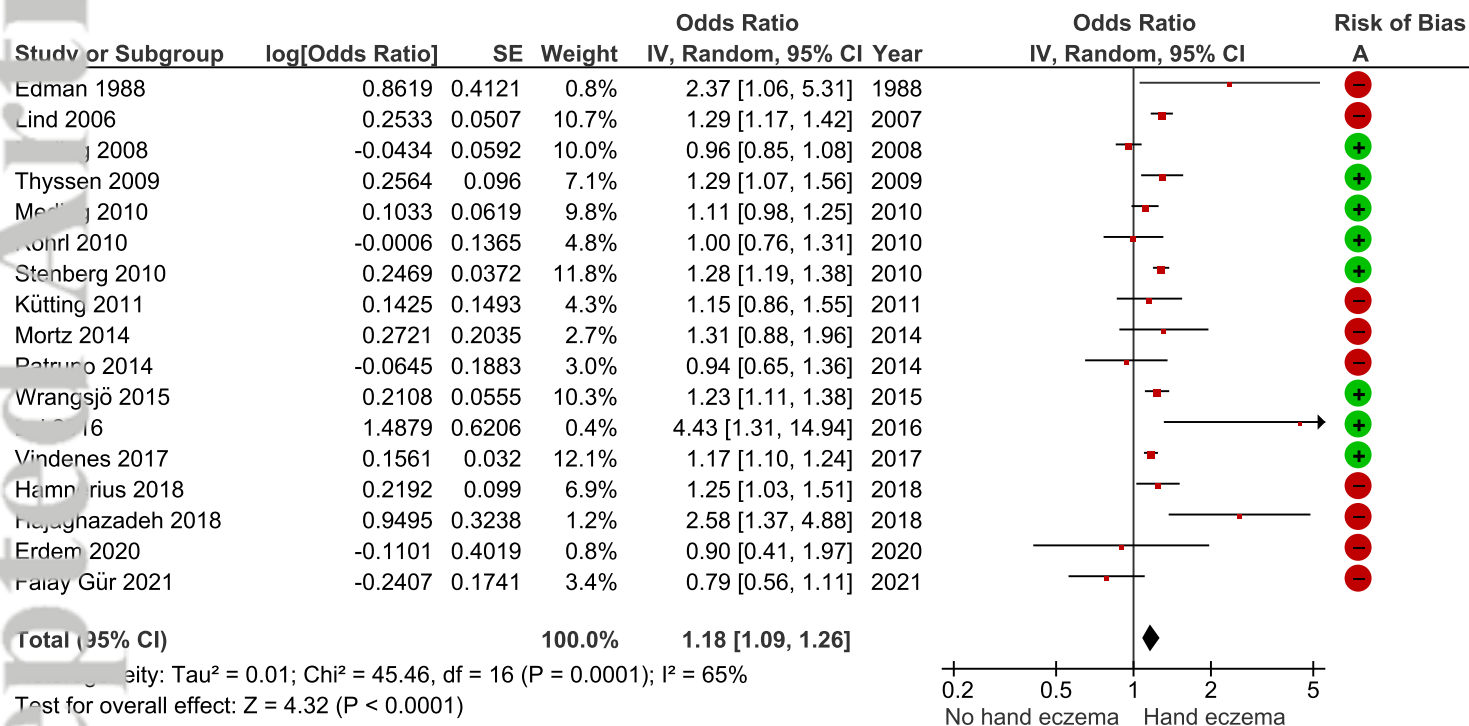
Figure legends:

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources.

Figure 2: Forest plot smoking and prevalence of hand eczema.

Cross-sectional study outcomes with ≥ 7 points on the Newcastle-Ottawa Scale were considered low risk of bias. Abbreviations: CI, confidence interval; df, degrees of freedom.





Risk of bias legend

(+) red, low quality study; green, high quality study

Lifestyle factors and hand eczema: a systematic review and meta-analysis of observational studies

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3. Medical Center Leeuwarden, Department of Dermatology, Leeuwarden, the Netherlands

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- This extensive systematic review and meta-analysis found very low quality evidence that smoking is associated with the prevalence of hand eczema.
- Due to the limited number of studies per outcome, heterogeneity, and/or conflicting results, no firm conclusions can be drawn regarding other lifestyle factors.
- However, the limited available evidence may suggest a positive association between stress, BMI, and prevalence of hand eczema, and a possible role for stress as aggravating factor of hand eczema.



COD_14102_Graphical abstract SR lifestyle.png

Lifestyle factors and hand eczema: a systematic review and meta-analysis of observational studies

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Online-only Supplements

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Appendix S1: Full search strategy for Pubmed, EMBASE, and Web of Science.

Pubmed

((("Hand"[Mesh] AND "Dermatitis"[Mesh]) OR (("hand"[tiab] OR "hands"[tiab]) AND ("dermatitis"[tiab] OR "dermatosis"[tiab] OR "eczema"[tiab]))) OR "Hand Dermatoses"[Mesh] OR "Eczema, Dyshidrotic"[Mesh] OR (("dyshidrotic"[tiab] OR "vesicular"[tiab] OR "palmoplantar"[tiab]) AND "eczema"[tiab]) OR "Acrodermatitis"[Mesh] OR "acrodermatit"[tiab] OR "pompholyx"[tiab]) AND ("Life Style"[Mesh] OR "life style"[tiab] OR "lifestyle"[tiab] OR "Risk Factors"[Mesh] OR "risk"[tiab] OR "Smoking"[Mesh] OR "smok"[tiab] OR "Drinking Behavior"[Mesh] OR "drinking"[tiab] OR "alcohol"[tiab] OR "Exercise"[Mesh] OR "exercis"[tiab] OR "Sports"[Mesh] OR "sport"[tiab] OR "physical activit"[tiab] OR "sedentar"[tiab] OR "physical inactiv"[tiab] OR "Body Weight"[Mesh] OR "body weight"[tiab] OR "Body Mass Index"[Mesh] OR "Body Mass"[tiab] OR "BMI"[tiab] OR "lean"[tiab] OR "underweight"[tiab] OR "obes"[tiab] OR "overweight"[tiab] OR "Stress, Psychological"[Mesh] OR "stress"[tiab] OR "Sleep"[Mesh] OR "sleep"[tiab] OR "Nutritional Sciences"[Mesh] OR "nutrition"[tiab] OR "Diet, Food, and Nutrition"[Mesh] OR "diet"[tiab])
2,302 results (20211014)

EMBASE

((('hand'/exp AND 'dermatitis'/exp) OR (('hand':ti,ab,kw OR 'hands':ti,ab,kw) AND ('dermatitis':ti,ab,kw OR 'dermatosis':ti,ab,kw OR 'eczema':ti,ab,kw)) OR 'hand eczema'/exp OR 'hand dermatitis'/exp OR 'pompholyx'/exp OR 'pompholyx':ti,ab,kw OR (('dyshidrotic':ti,ab,kw OR 'vesicular':ti,ab,kw OR 'palmoplantar':ti,ab,kw) AND 'eczema':ti,ab,kw) OR 'acrodermatitis'/exp OR 'acrodermatit':ti,ab,kw) AND ('lifestyle'/exp OR 'life style':ti,ab,kw OR 'lifestyle':ti,ab,kw OR 'risk factor'/exp OR 'risk':ti,ab,kw OR 'smoking'/exp OR 'smok':ti,ab,kw OR 'alcohol':ti,ab,kw OR 'drinking':ti,ab,kw OR 'physical activity, capacity and performance'/exp OR 'sport'/exp OR 'exercis':ti,ab,kw OR 'inactivity'/exp OR 'physical activ':ti,ab,kw OR 'sedentar':ti,ab,kw OR 'physical inactiv':ti,ab,kw OR 'sport':ti,ab,kw OR 'body weight'/exp OR 'body mass'/exp OR 'leanness'/exp OR 'underweight'/exp OR 'obesity'/exp OR 'body weight':ti,ab,kw OR 'lean':ti,ab,kw OR 'underweight':ti,ab,kw OR 'BMI':ti,ab,kw OR 'obes':ti,ab,kw OR 'overweight':ti,ab,kw OR 'body mass':ti,ab,kw OR 'stress'/exp OR 'stress':ti,ab,kw OR 'sleep'/exp OR 'sleep':ti,ab,kw OR 'nutritional science'/exp OR 'nutrition'/exp OR 'nutrition':ti,ab,kw OR 'diet':ti,ab,kw OR 'food':ti,ab,kw)
3,848 results (20211014)

Web of Science

((("hand" OR "hands") AND ("dermat" OR "eczema")) OR (("dyshidrotic" OR "vesicular" OR "palmoplantar") AND "eczema")) OR "acrodermatit" OR "pompholyx") AND ("life style" OR "lifestyle" OR "risk" OR "smok" OR "drinking" OR "alcohol" OR "exercis" OR "sport" OR "physical activit" OR "sedentar" OR "physical inactiv" OR "body weight" OR "body mass" OR "BMI" OR "lean" OR "underweight" OR "obes" OR "overweight" OR "stress" OR "sleep" OR "nutrition" OR "diet" OR "food")
2,293 results (20211014)

Table S2: List of excluded studies with justification.

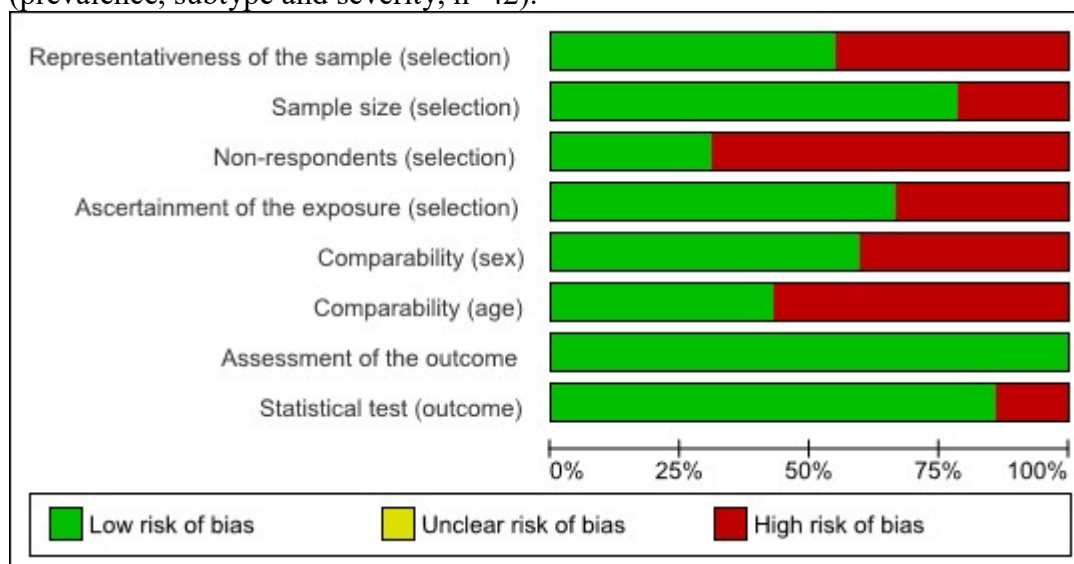
First author	Year	Reason of exclusion
Agner ¹	2009	No lifestyle factor
Agner ²	2000	Review
Ahmed ³	2015	No lifestyle factor
Ahmed ⁴	2021	No hand eczema
Ali ⁵	2020	No lifestyle factor
Alluhayyan ⁶	2020	No lifestyle factor
Alsaidan ⁷	2020	No lifestyle factor
Apfelbacher ⁸	2013	Insufficient data
Apfelbacher ⁹	2013	No lifestyle factor
Arrandale ¹⁰	2014	No separate data hand eczema
Attwa ¹¹	2009	No separate data hand eczema
Aydin ¹²	2021	No lifestyle factor
Babić ¹³	2020	No lifestyle factor
Becker ¹⁴	1995	Review
Bewley ¹⁵	2013	No lifestyle factor
Bjelajac ¹⁶	2020	Insufficient data
Boehm ¹⁷	2012	No lifestyle factor
Brans ¹⁸	2015	Review
Brans ¹⁹	2015	No separate data hand eczema
Celik ²⁰	2020	No lifestyle factor
Chen ²¹	2008	Insufficient data
Chen ²²	2017	No separate data hand eczema
Cheon ²³	2016	No hand eczema
Chiriac ²⁴	2020	No lifestyle factor
Chirico ²⁵	2004	Insufficient data
Chou ²⁶	2016	No hand eczema
Collier ²⁷	1956	Case-report
Cvetkovski ²⁸	2006	No lifestyle factor
Dalgard ²⁹	2015	No lifestyle factor
Devold ³⁰	2019	No lifestyle factor
Dietz ³¹	2021	No lifestyle factor
Dogan ³²	2021	Report could not be retrieved
Dotterud ³³	2007	No lifestyle factor
Drewitz ³⁴	2021	No lifestyle factor
Fei ³⁵	2019	No hand eczema
Fors ³⁶	2012	No hand eczema
Gallicchio ³⁷	2011	No hand eczema
Grabenhenrich ³⁸	2011	No separate data hand eczema
Holm ³⁹	2016	No separate data hand eczema
Hougaard ⁴⁰	2014	No lifestyle factor
Huang ⁴¹	2020	No lifestyle factor
Kashyap ⁴²	2021	No lifestyle factor
Kendziora ⁴³	2020	No lifestyle factor
Khalili ⁴⁴	1999	No separate data hand eczema
Lee ⁴⁵	2011	No hand eczema

Liang ⁴⁶	2021	No lifestyle factor
Linnainmaa ⁴⁷	1997	No separate data hand eczema
Lysdal ⁴⁸	2014	No hand eczema
Maarouf ⁴⁹	2018	No separate data hand eczema
McArthur ⁵⁰	1992	No hand eczema
Metin ⁵¹	2020	No lifestyle factor
Moldovan ⁵²	2021	No lifestyle factor
Mortz ⁵³	2014	No lifestyle factor
Murota ⁵⁴	2012	Insufficient data
Nakamoto ⁵⁵	2018	No hand eczema
Niemeier ⁵⁶	2002	No separate data hand eczema
Nørreslet ⁵⁷	2018	No lifestyle factor
O'Neill ⁵⁸	2021	No lifestyle factor
Patruno ⁵⁹	2020	Review
Pourani ⁶⁰	2021	No lifestyle factor
Pourani ⁶¹	2021	No lifestyle factor
Riala ⁶²	1998	No lifestyle factor
Rizzi ⁶³	2021	No lifestyle factor
Rönmark ⁶⁴	2012	No separate data hand eczema
Rosén ⁶⁵	1988	No lifestyle factor
Rystedt ⁶⁶	1989	Review
Saha ⁶⁷	2021	No lifestyle factor
Sato ⁶⁸	2004	No hand eczema
Silverberg ⁶⁹	2015	No hand eczema
Silverberg ⁷⁰	2018	No separate data hand eczema
Simonsen ⁷¹	2021	No lifestyle factor
Singh ⁷²	2021	No lifestyle factor
Singh ⁷³	2020	No lifestyle factor
Smith ⁷⁴	2003	No separate data hand eczema
Smith ⁷⁵	2005	No separate data hand eczema
Smith ⁷⁶	2006	No separate data hand eczema
Son ⁷⁷	2017	No hand eczema
Svensson ⁷⁸	2013	Review
Szepietowski ⁷⁹	2002	No lifestyle factor
Techasation ⁸⁰	2021	No lifestyle factor
Thuesen ⁸¹	2014	Review
Veien ⁸²	1983	No separate data hand eczema
Veien ⁸³	1987	No separate data hand eczema
Veien ⁸⁴	1987	No separate data hand eczema
Veien ⁸⁵	1983	No separate data hand eczema
Veien ⁸⁶	1987	<10 cases
Von Manteuffel ⁸⁷	2005	Review
Weistenhöfer ⁸⁸	2019	No separate data hand eczema
Xerfan ⁸⁹	2021	Review
Yuan ⁹⁰	2021	No hand eczema
Zeerak ⁹¹	2021	No lifestyle factor

Figure S3: Risk of bias graphs and summaries.

Smoking

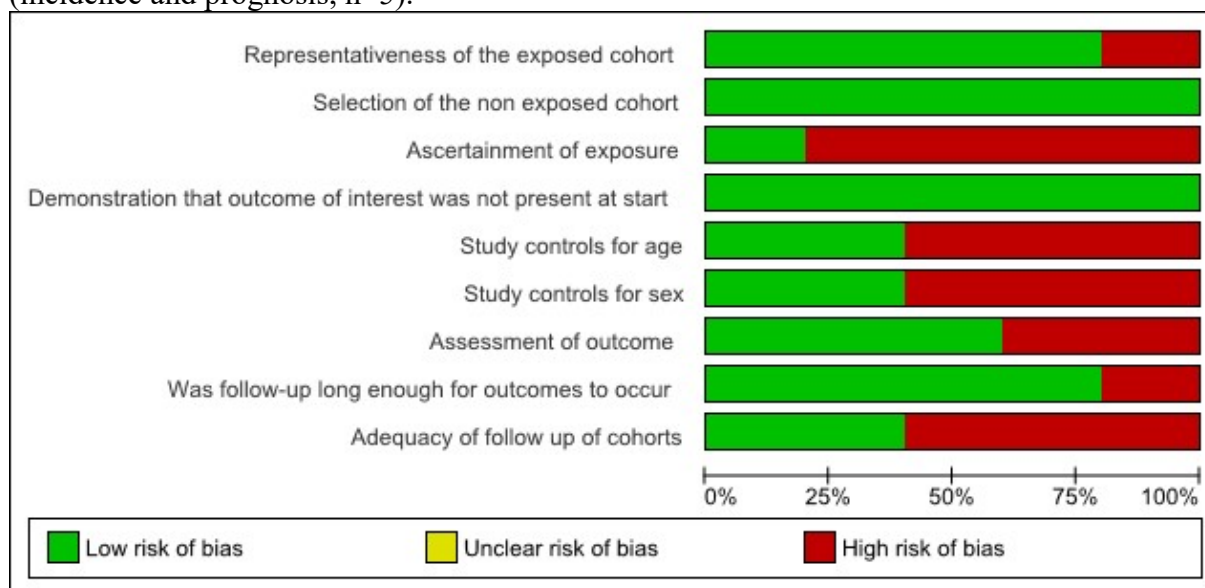
Risk of bias graph 1: review authors' judgements about each risk of bias item presented as percentages across all included cross-sectional study outcomes for smoking and hand eczema (prevalence, subtype and severity, n=42).



Risk of bias summary 1: review authors' judgements about each risk of bias item for each included cross-sectional study outcome for smoking and hand eczema (prevalence, subtype and severity, n=42) .

	Representativeness of the sample (selection)	Sample size (selection)	Non-respondents (selection)	Ascertainment of the exposure (selection)	Comparability (sex)	Comparability (age)	Assessment of the outcome	Statistical test (outcome)
Anveden 2011 smoking prevalence	+	+	+	+	+	+	+	+
Bo 2007 smoking prevalence	+	+	+	+	+	+	+	+
Brans 2014 smoking severity	+	+	+	+	+	+	+	+
Brans 2016 smoking subtype HE	+	+	+	+	+	+	+	+
Brans 2020 smoking severity	+	+	+	+	+	+	+	+
Brans 2020 smoking subtype HE	+	+	+	+	+	+	+	+
Chiriac 2020 smoking prevalence	+	+	+	+	+	+	+	+
Edman 1988 smoking prevalence	+	+	+	+	+	+	+	+
Erdem 2020 smoking prevalence	+	+	+	+	+	+	+	+
Falay Gür 2021 smoking prevalence	+	+	+	+	+	+	+	+
Falay Gür 2021 smoking severity	+	+	+	+	+	+	+	+
Hafsia 2019 smoking severity	+	+	+	+	+	+	+	+
Hajaghadzadeh 2018 smoking prevalence	+	+	+	+	+	+	+	+
Hamnerius 2018 smoking prevalence	+	+	+	+	+	+	+	+
Hougaard 2014 smoking prevalence	+	+	+	+	+	+	+	+
Ibler 2012 smoking prevalence	+	+	+	+	+	+	+	+
Ibler 2012 smoking severity	+	+	+	+	+	+	+	+
Jing 2020 smoking prevalence	+	+	+	+	+	+	+	+
Johanisson 2013 smoking prevalence	+	+	+	+	+	+	+	+
Kutting 2011 smoking prevalence	+	+	+	+	+	+	+	+
Lai 2016 smoking prevalence	+	+	+	+	+	+	+	+
Lind 2006 smoking prevalence	+	+	+	+	+	+	+	+
Meding 2008 smoking prevalence	+	+	+	+	+	+	+	+
Meding 2010 smoking prevalence	+	+	+	+	+	+	+	+
Molin 2014 smoking prevalence	+	+	+	+	+	+	+	+
Molin 2014 smoking subtype HE	+	+	+	+	+	+	+	+
Montnemery 2005 smoking prevalence	+	+	+	+	+	+	+	+
Mortz 2014 smoking prevalence	+	+	+	+	+	+	+	+
Obermeyer 2021 smoking subtype HE	+	+	+	+	+	+	+	+
Patruno 2014 smoking prevalence	+	+	+	+	+	+	+	+
Patruno 2014 smoking severity	+	+	+	+	+	+	+	+
Rohrl 2010 smoking prevalence	+	+	+	+	+	+	+	+
Stenberg 2010 smoking prevalence	+	+	+	+	+	+	+	+
Sørensen 2017 smoking severity	+	+	+	+	+	+	+	+
Thyssen 2009 smoking prevalence	+	+	+	+	+	+	+	+
Uter 1995 smoking prevalence	+	+	+	+	+	+	+	+
Van der Heiden 2017 smoking prevalence	+	+	+	+	+	+	+	+
van der Heiden 2018 smoking subtype HE	+	+	+	+	+	+	+	+
Veien 2008 smoking prevalence	+	+	+	+	+	+	+	+
Vindenes 2017 smoking prevalence	+	+	+	+	+	+	+	+
Weigl 2011 smoking subtype HE	+	+	+	+	+	+	+	+
Wrangsjö 2015 smoking prevalence	+	+	+	+	+	+	+	+

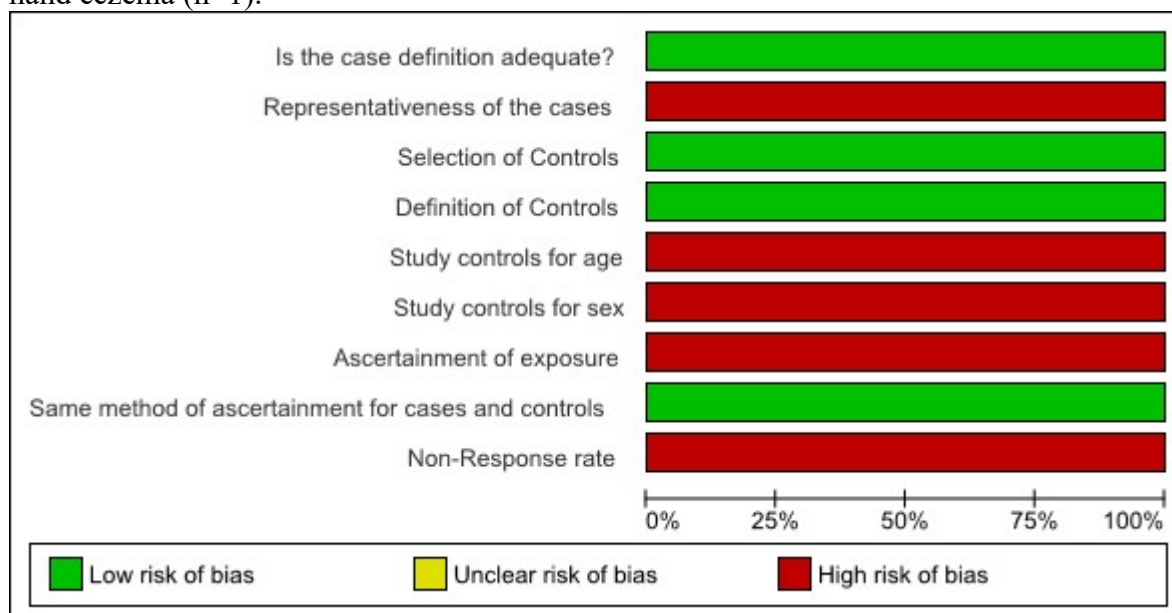
Risk of bias graph 2: review authors' judgements about each risk of bias item presented as percentages across all included cohort study outcomes for smoking and hand eczema (incidence and prognosis, n=5).



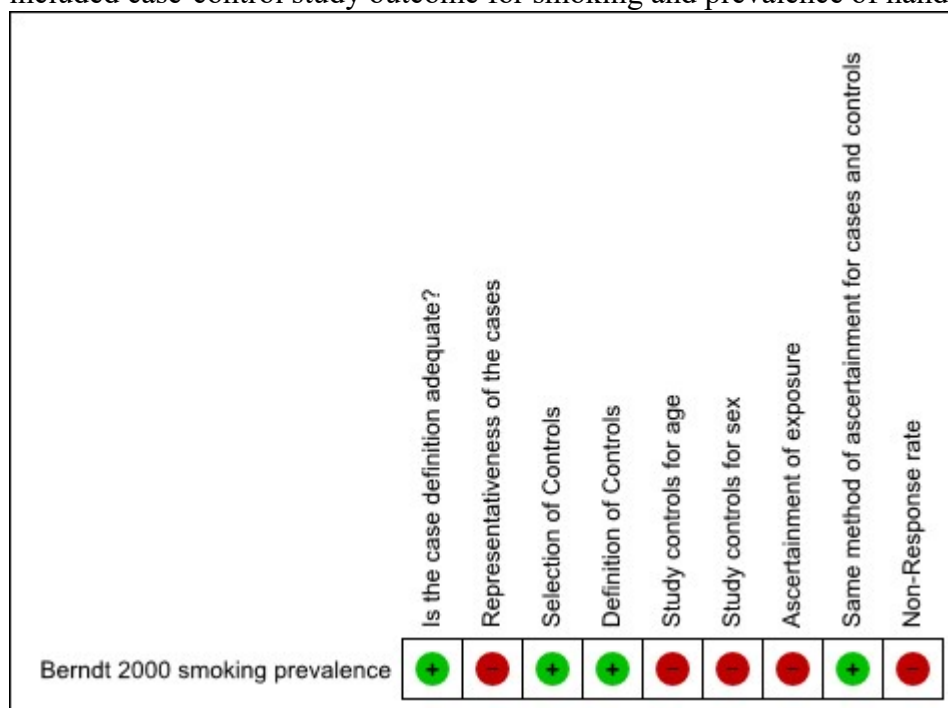
Risk of bias summary 2: review authors' judgements about each risk of bias item for each included cohort study outcomes for smoking and hand eczema (incidence and prognosis, n=5).

	Representativeness of the exposed cohort	Selection of the non exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start	Study controls for age	Study controls for sex	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow up of cohorts
Douwes 2000 smoking prognosis	+	+	+	+	+	+	+	+	+
Lerbaek 2007 smoking incidence	+	+	+	+	+	+	+	+	+
Obermeyer 2021 smoking prognosis	+	+	+	+	+	+	+	+	+
Olesen 2019 smoking prognosis	+	+	+	+	+	+	+	+	+
Veien 2008 smoking prognosis	+	+	+	+	+	+	+	+	+

Risk of bias graph 3: review authors' judgments about each risk of bias item presented as percentages across the included case-control study outcome for smoking and prevalence of hand eczema (n=1).

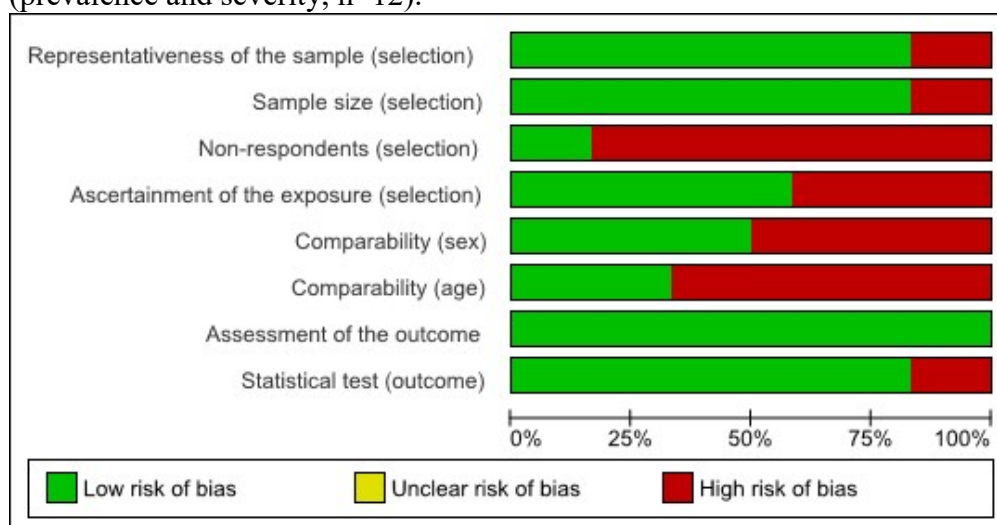


Risk of bias summary 3: review authors' judgements about each risk of bias item for the included case-control study outcome for smoking and prevalence of hand eczema (n=1).



Stress

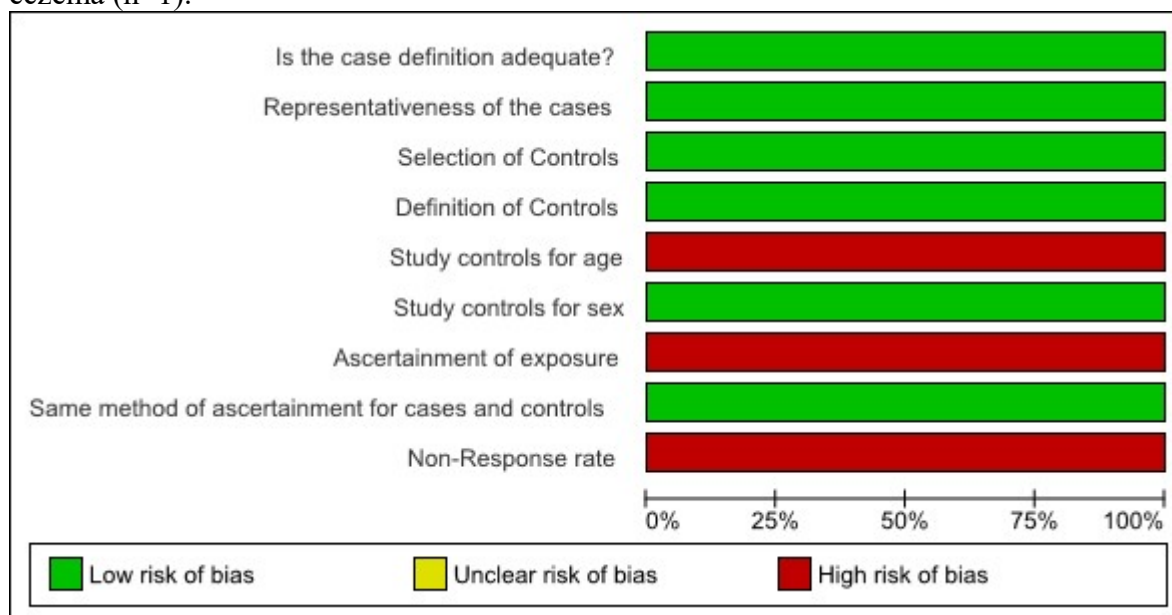
Risk of bias graph 4: review authors' judgments about each risk of bias item presented as percentages across all included cross-sectional study outcomes for stress and hand eczema (prevalence and severity, n=12).



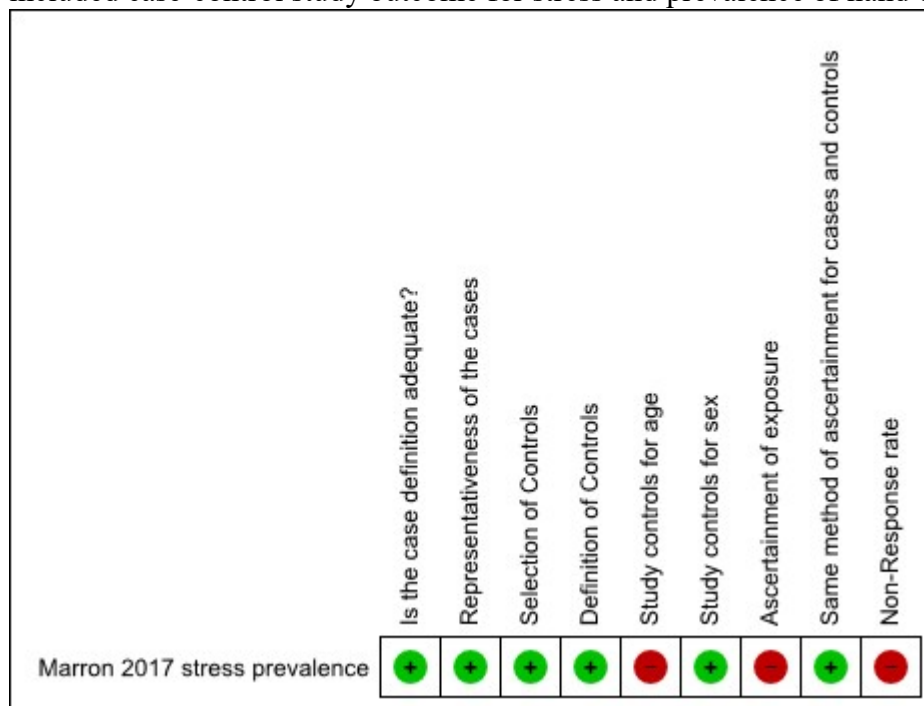
Risk of bias summary 4: review authors' judgements about each risk of bias item for each included cross-sectional study outcomes for stress and hand eczema (prevalence and severity, n=12).

	Representativeness of the sample (selection)	Sample size (selection)	Non-respondents (selection)	Ascertainment of the exposure (selection)	Comparability (sex)	Comparability (age)	Assessment of the outcome	Statistical test (outcome)
Anveden 2011 stress prevalence	+	+	+	+	+	+	+	+
Böhm 2014 stress severity	+	+	+	+	+	+	+	+
Falay Gür 2021 stress prevalence	+	+	+	+	+	+	+	+
Falay Gür 2021 stress severity	+	+	+	+	+	+	+	+
Hafsia 2019 stress severity	+	+	+	+	+	+	+	+
Hamnerius 2017 stress prevalence	+	+	+	+	+	+	+	+
Janardhanan 2020 stress severity	+	+	+	+	+	+	+	+
Lodi 1992 stress severity	+	+	+	+	+	+	+	+
Magnavita 2011 stress prevalence	+	+	+	+	+	+	+	+
Sørensen 2016 stress severity	+	+	+	+	+	+	+	+
Veien 2008 stress severity	+	+	+	+	+	+	+	+
Wrängsjö 2015 stress prevalence	+	+	+	+	+	+	+	+

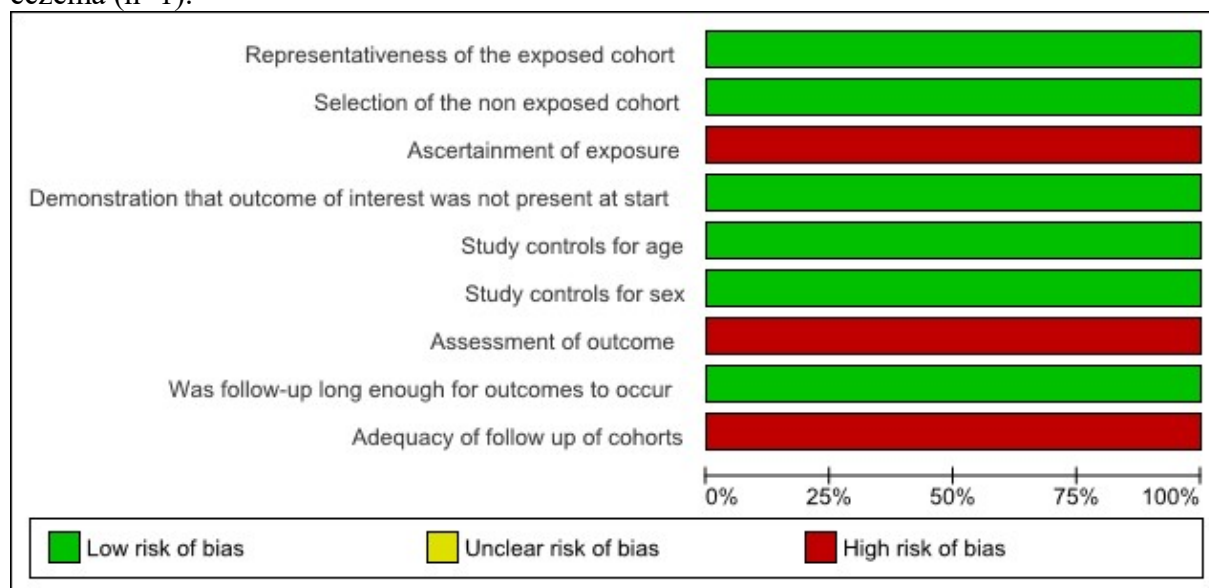
Risk of bias graph 5: review authors' judgements about each risk of bias item presented as percentages for the included case-control study outcome for stress and prevalence of hand eczema (n=1).



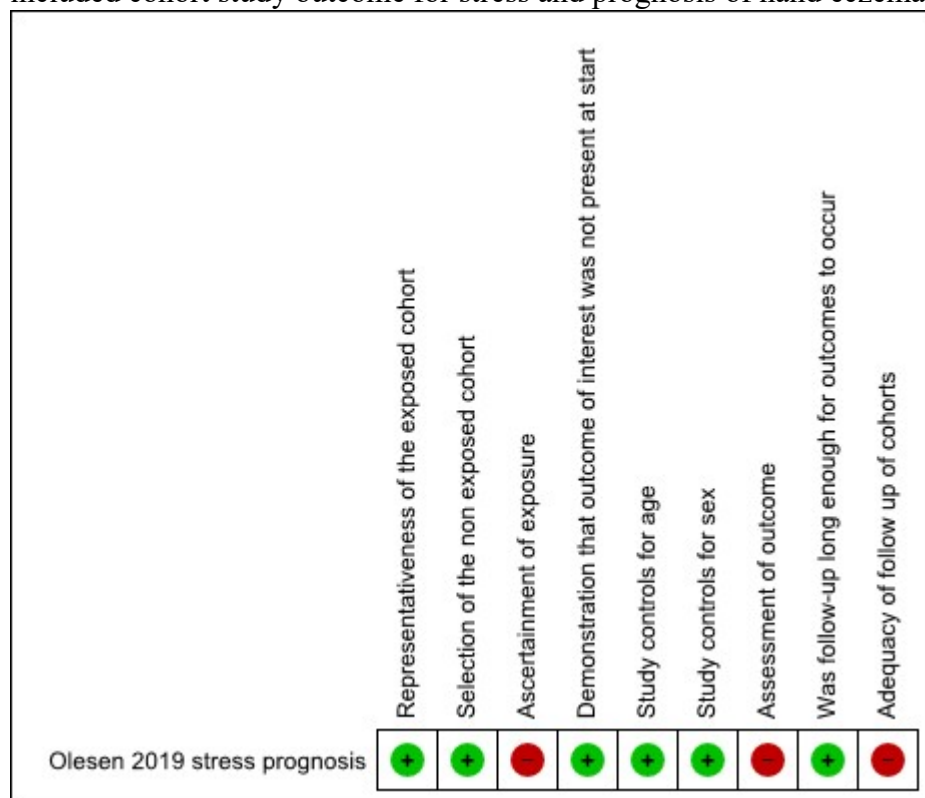
Risk of bias summary 5: review authors' judgements about each risk of bias item for the included case-control study outcome for stress and prevalence of hand eczema (n=1).



Risk of bias graph 6: review authors' judgments about each risk of bias item presented as percentages across the included cohort study outcome for stress and prognosis of hand eczema (n=1).

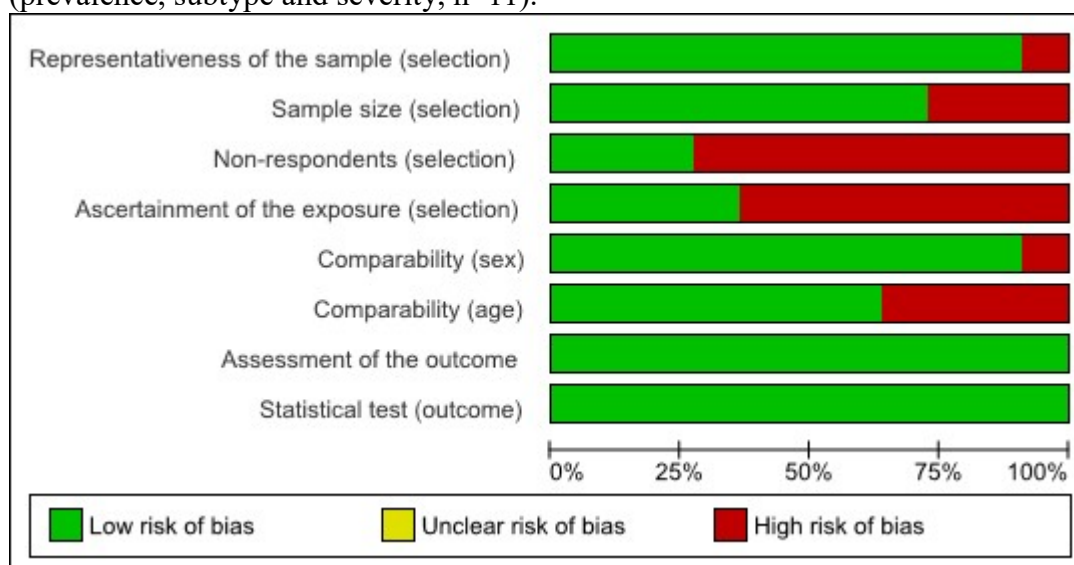


Risk of bias summary 6: review authors' judgments about each risk of bias item for the included cohort study outcome for stress and prognosis of hand eczema.



Body Mass Index (BMI)

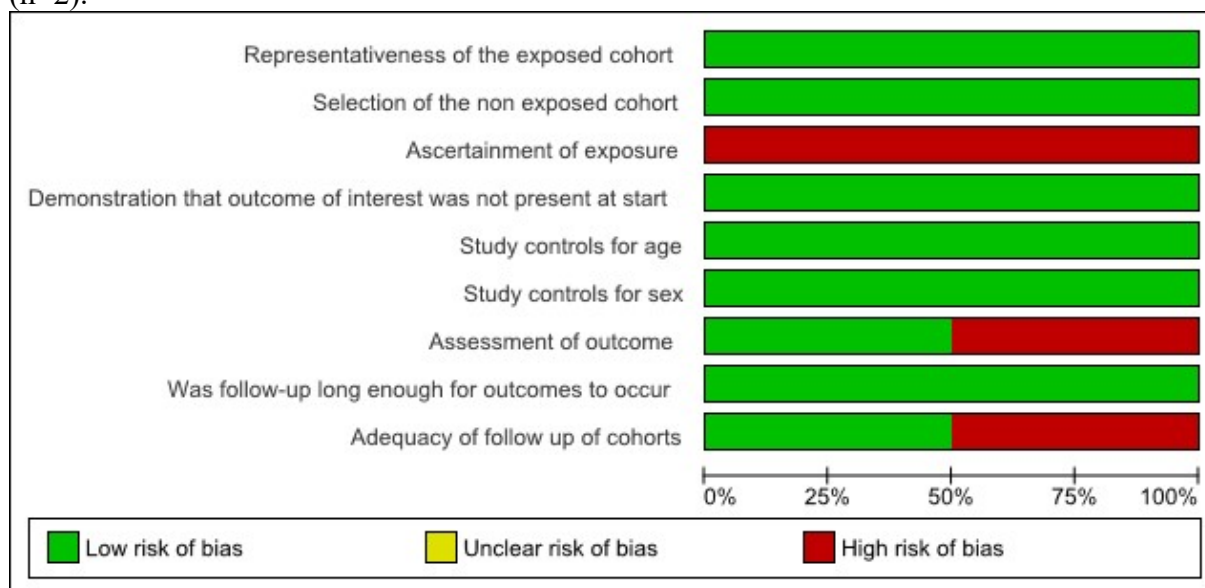
Risk of bias graph 7: review authors' judgments about each risk of bias item presented as percentages across all included cross-sectional study outcomes for BMI and hand eczema (prevalence, subtype and severity, n=11).



Risk of bias summary 7: review authors' judgments about each risk of bias item for each included cross-sectional study outcome for BMI and hand eczema (prevalence, subtype and severity, n=11).

	Representativeness of the sample (selection)	Sample size (selection)	Non-respondents (selection)	Ascertainment of the exposure (selection)	Comparability (sex)	Comparability (age)	Assessment of the outcome	Statistical test (outcome)
Anveden 2011 BMI prevalence	+	+	+	+	+	+	+	+
Cazzaniga 2016 BMI severity	+	+	+	+	+	+	+	+
Cazzaniga 2018 BMI severity	+	+	+	+	+	+	+	+
Cazzaniga 2018 BMI subtype	+	+	+	+	+	+	+	+
Hafsia 2019 BMI severity	+	+	+	+	+	+	+	+
Hamnerius 2017 BMI prevalence	+	+	+	+	+	+	+	+
Lai 2016 BMI prevalence	+	+	+	+	+	+	+	+
Sørensen 2016 BMI severity	+	+	+	+	+	+	+	+
van der Heiden 2018 BMI subtype	+	+	+	+	+	+	+	+
Vindenes 2017 BMI prevalence	+	+	+	+	+	+	+	+
Wrangsjö 2015 BMI prevalence	+	+	+	+	+	+	+	+

Risk of bias graph 8: review authors' judgments about each risk of bias item presented as percentages across the included cohort study outcome for BMI and prognosis of hand eczema (n=2).

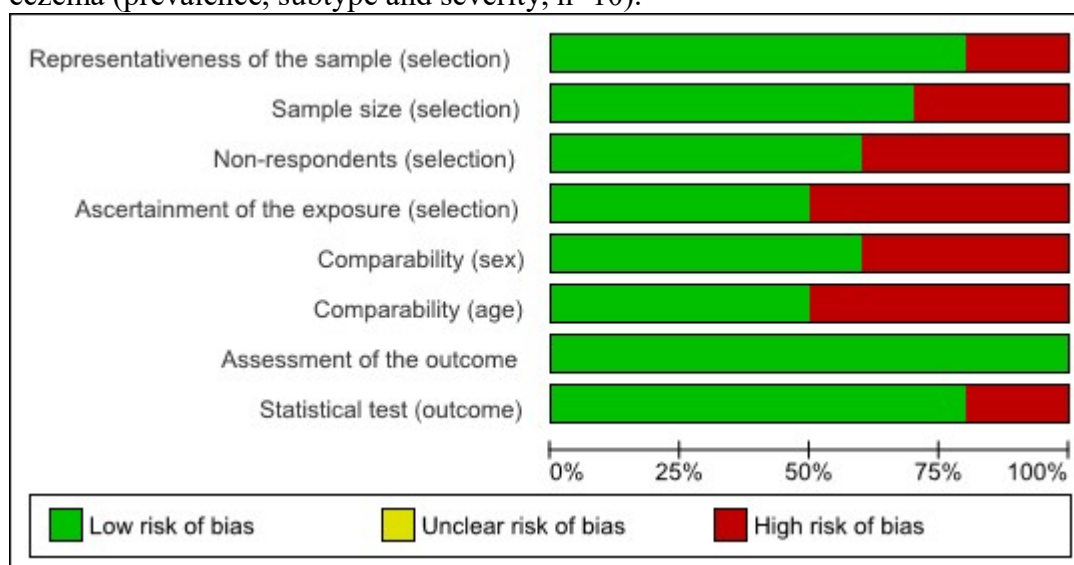


Risk of bias summary 8: review authors' judgments about each risk of bias item for the included cohort study outcome for BMI and prognosis of hand eczema (n=2).

	Representativeness of the exposed cohort	Selection of the non exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start	Study controls for age	Study controls for sex	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow up of cohorts
Cazzaniga 2018 BMI prognosis	+	+	-	+	+	+	+	+	+
Olesen 2019 BMI prognosis	+	+	-	+	+	+	-	+	-

Physical activity

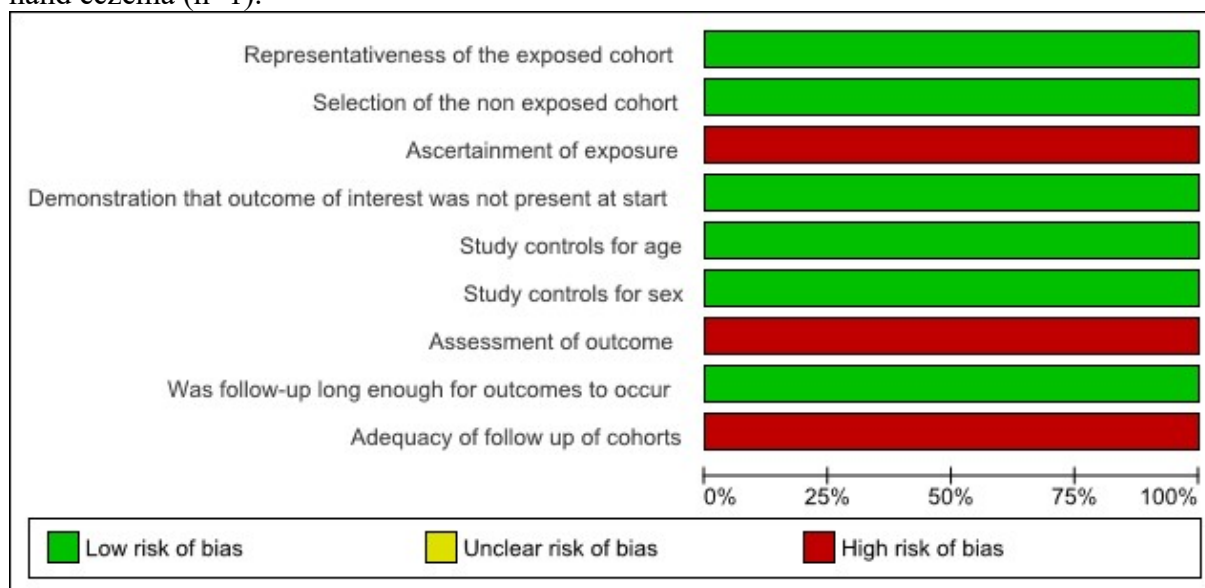
Risk of bias graph 9: review authors' judgements about each risk of bias item presented as percentages across all included cross-sectional study outcomes for physical activity and hand eczema (prevalence, subtype and severity, n=10).



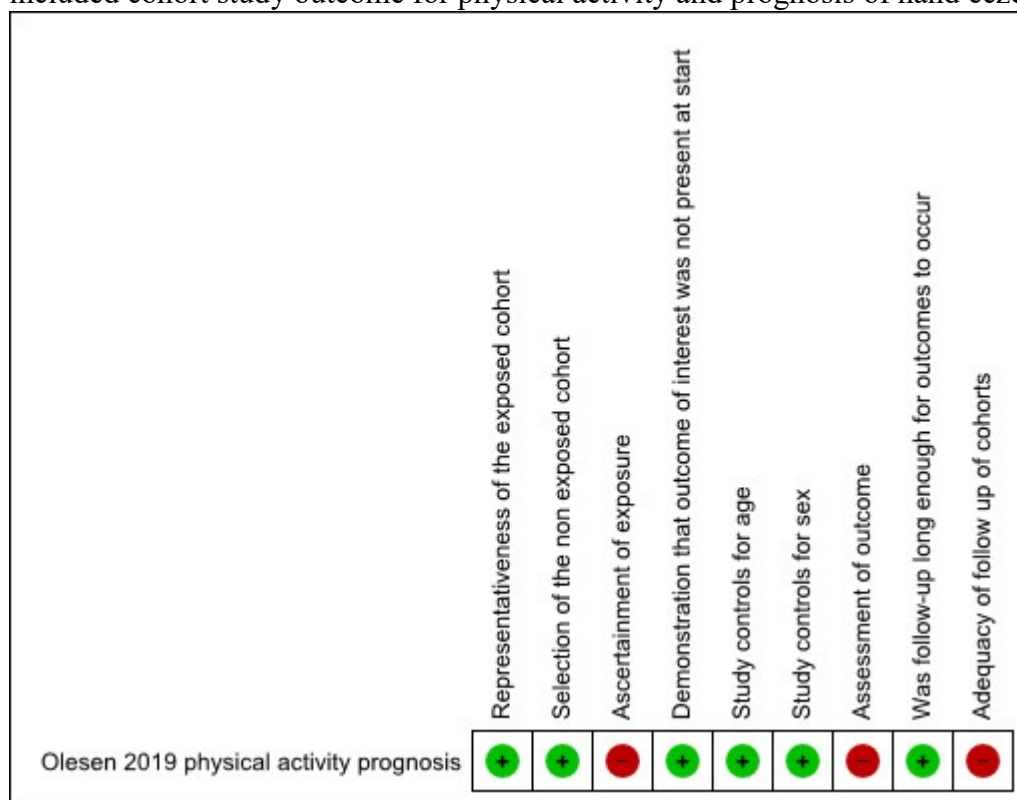
Risk of bias summary 9: review authors' judgements about each risk of bias item for each included cross-sectional study outcome for physical activity and hand eczema (prevalence, subtype and severity, n=10).

	Representativeness of the sample (selection)	Sample size (selection)	Non-respondents (selection)	Ascertainment of the exposure (selection)	Comparability (sex)	Comparability (age)	Assessment of the outcome	Statistical test (outcome)
Anveden 2011 physical prevalence	+	+	+	+	+	+	+	+
Hafsia 2019 physical activity severity	+	+	+	+	+	+	+	+
Ibler 2012 physical activity prevalence	+	+	+	+	+	+	+	+
Ibler 2012 physical activity severity	+	+	+	+	+	+	+	+
Jing 2020 physical activity prevalence	+	+	+	+	+	+	+	+
Johannisson 2013 physical activity prevalence	+	+	+	+	+	+	+	+
Kavli 1984 physical activity prevalence	+	+	+	+	+	+	+	+
Lai 2015 physical activity prevalence	+	+	+	+	+	+	+	+
van der Heiden 2018 physical activity subtype	+	+	+	+	+	+	+	+
Wrangsjö 2015 physical activity prevalence	+	+	+	+	+	+	+	+

Risk of bias graph 10: review authors' judgements about each risk of bias item presented as percentages across the included cohort study outcome for physical activity and prognosis of hand eczema (n=1).

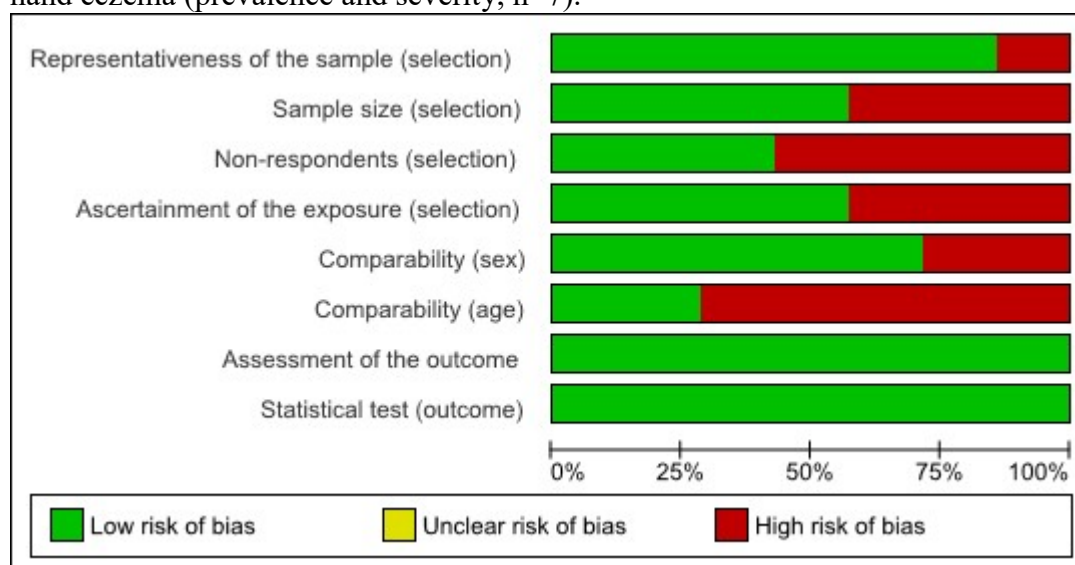


Risk of bias summary 10: review authors' judgements about each risk of bias item for the included cohort study outcome for physical activity and prognosis of hand eczema (n=1).



Alcohol consumption

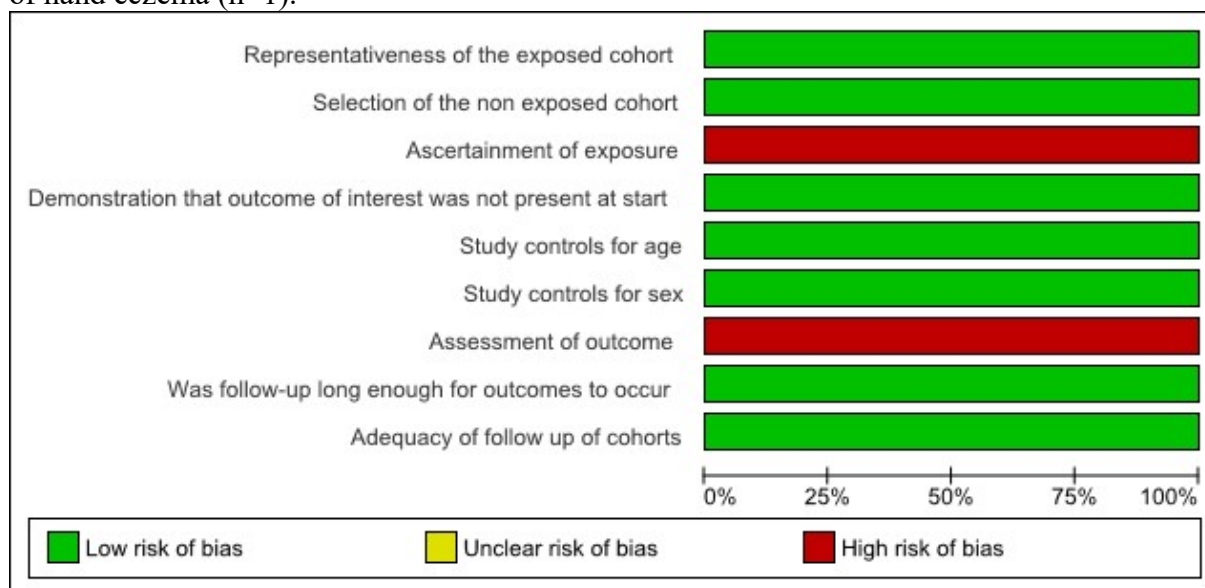
Risk of bias graph 11: review authors' judgements about each risk of bias item presented as percentages across all included cross-sectional study outcomes for alcohol consumption and hand eczema (prevalence and severity, n=7).



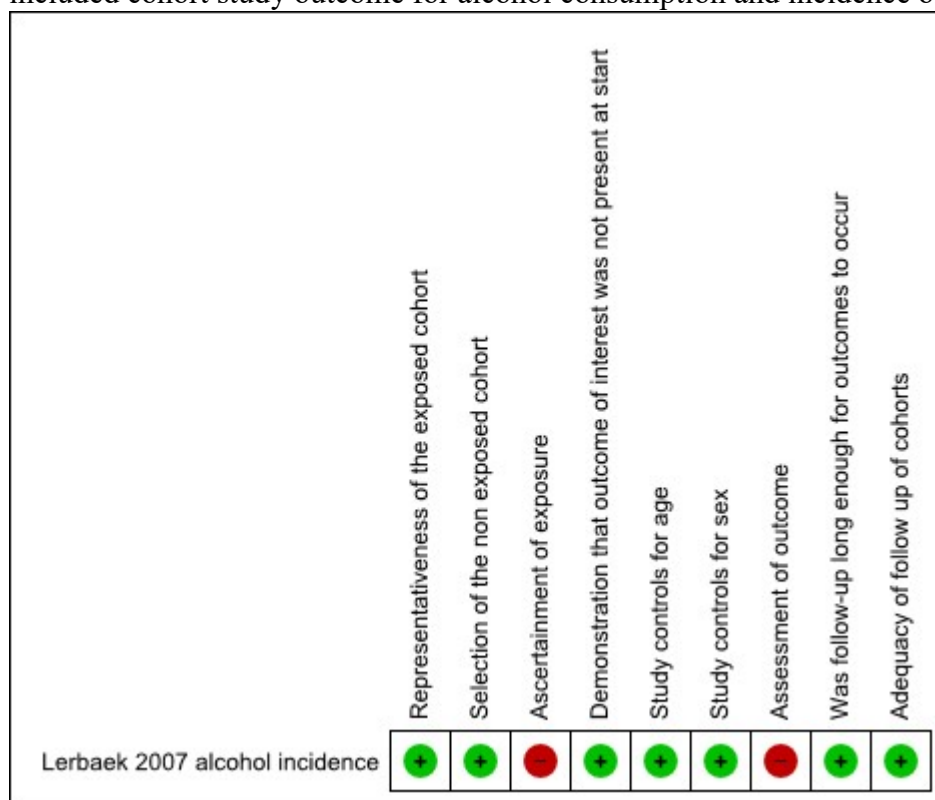
Risk of bias summary 11: review authors' judgements about each risk of bias item for each included cross-sectional study outcomes for alcohol consumption and hand eczema (prevalence and severity, n=7).

	Representativeness of the sample (selection)	Sample size (selection)	Non-respondents (selection)	Ascertainment of the exposure (selection)	Comparability (sex)	Comparability (age)	Assessment of the outcome	Statistical test (outcome)
Anveden 2011 alcohol prevalence	+	+	+	+	+	-	+	+
Bo 2008 alcohol prevalence	+	+	-	+	+	-	+	+
Hafsia 2019 alcohol severity	+	-	-	-	-	-	+	+
Jing 2020 alcohol prevalence	+	+	+	-	+	+	+	+
Lai 2016 alcohol prevalence	+	-	-	+	+	-	+	+
Smith 2005 alcohol prevalence	-	-	+	-	-	-	+	+
Thyssen 2009 alcohol prevalence	+	+	-	+	+	+	+	+

Risk of bias graph 12: review authors' judgements about each risk of bias item presented as percentages across the included cohort study outcome for alcohol consumption and incidence of hand eczema (n=1).

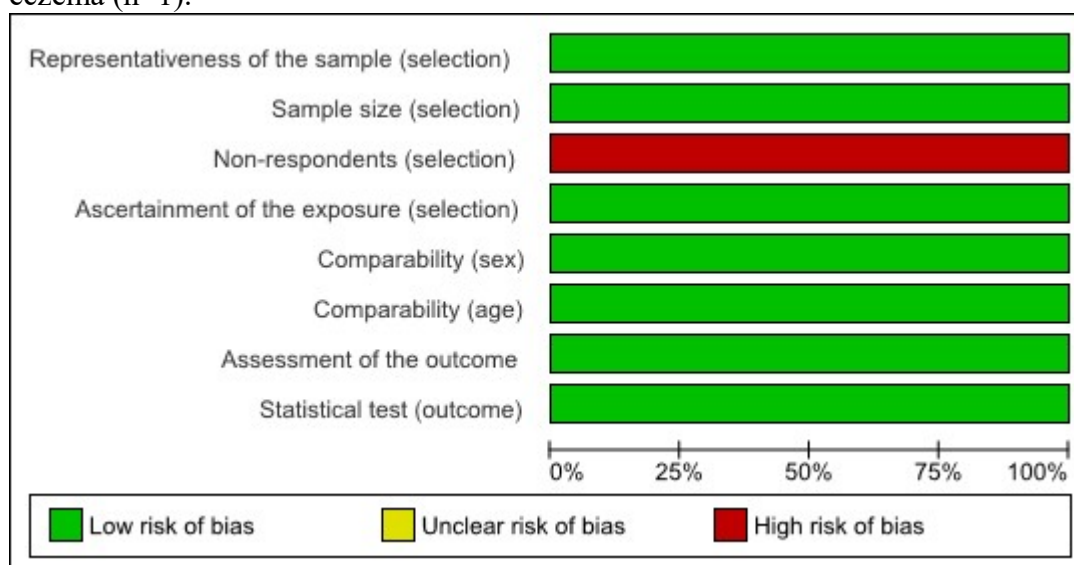


Risk of bias summary 12: review authors' judgements about each risk of bias item for the included cohort study outcome for alcohol consumption and incidence of hand eczema (n=1).

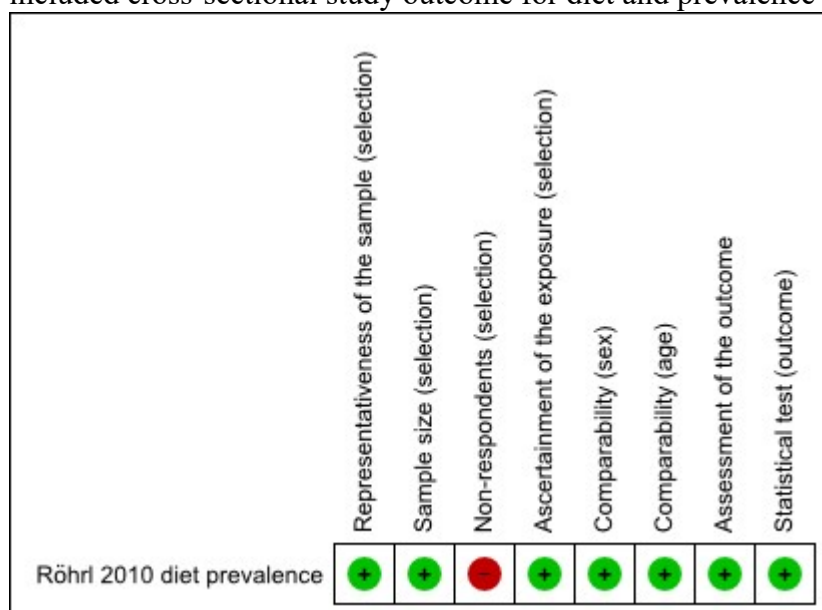


Diet

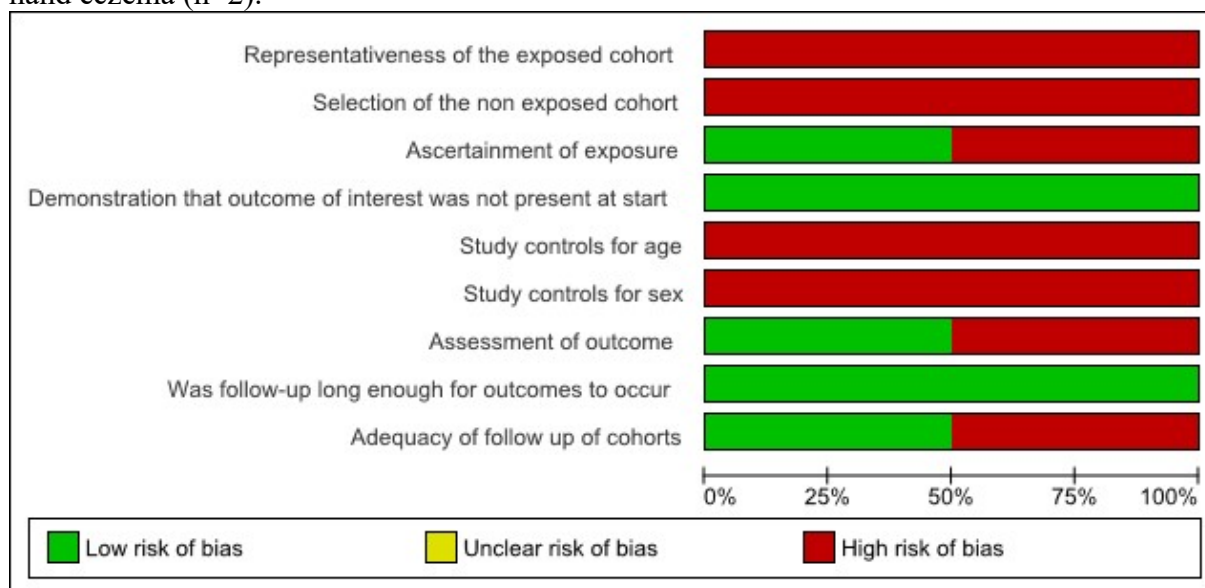
Risk of bias graph 13: review authors' judgements about each risk of bias item presented as percentages across the included cross-sectional study outcome for diet and prevalence of hand eczema (n=1).



Risk of bias summary 13: review authors' judgements about each risk of bias item for the included cross-sectional study outcome for diet and prevalence of hand eczema (n=1).



Risk of bias graph 14: review authors' judgements about each risk of bias item presented as percentages across the included cohort study outcome for diet and severity and prognosis of hand eczema (n=2).



Risk of bias summary 14: review authors' judgements about each risk of bias item for the included cohort study outcome for diet and severity and prognosis of hand eczema (n=2).

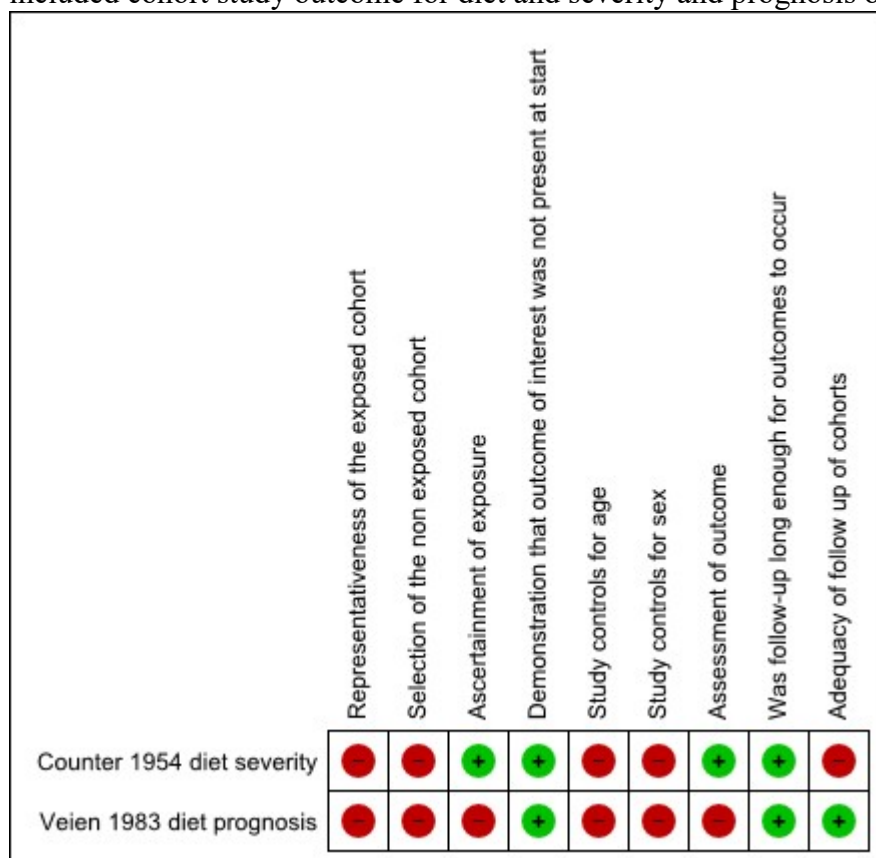
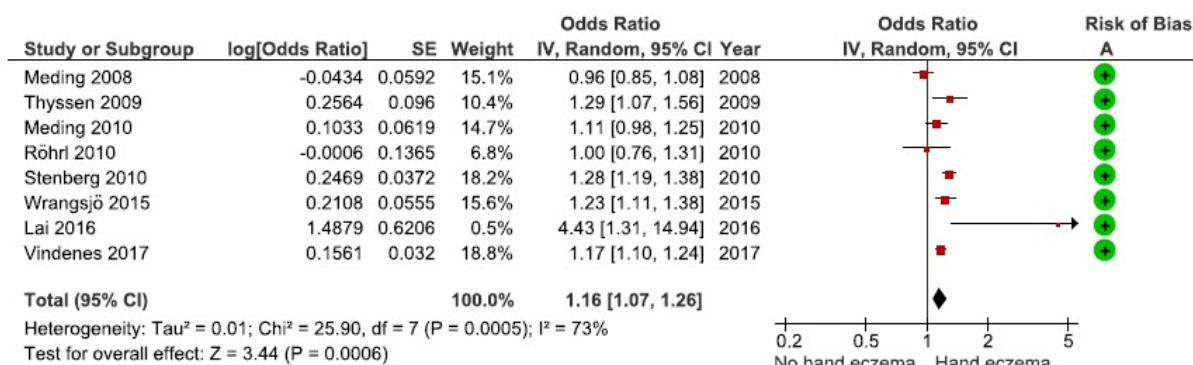


Figure S4: Forest plot smoking and prevalence of hand eczema, sub-analysis only including study outcomes with a risk of bias score ≥ 7 .



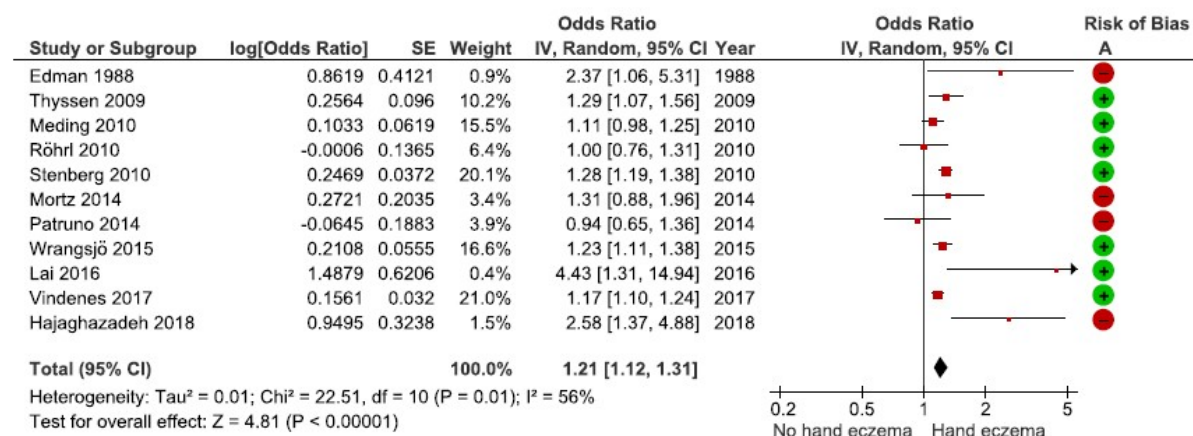
Risk of bias legend

(A) red, low quality study; green, high quality study

Legend: Cohort and case-control study outcomes with ≥ 6 points on the NOS, and cross-sectional study outcomes with ≥ 7 points, were considered low risk of bias.

Abbreviations: CI, confidence interval; df, degrees of freedom.

Figure S5: Forest plot smoking and occurrence of hand eczema, only including study outcomes in a non-occupational setting.



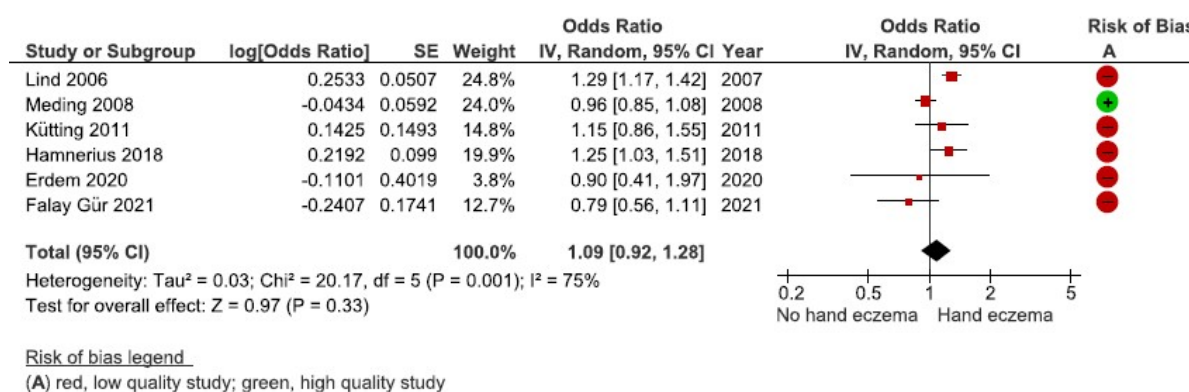
Risk of bias legend

(A) red, low quality study; green, high quality study

Legend: Cohort and case-control study outcomes with ≥ 6 points on the NOS, and cross-sectional study outcomes with ≥ 7 points, were considered low risk of bias.

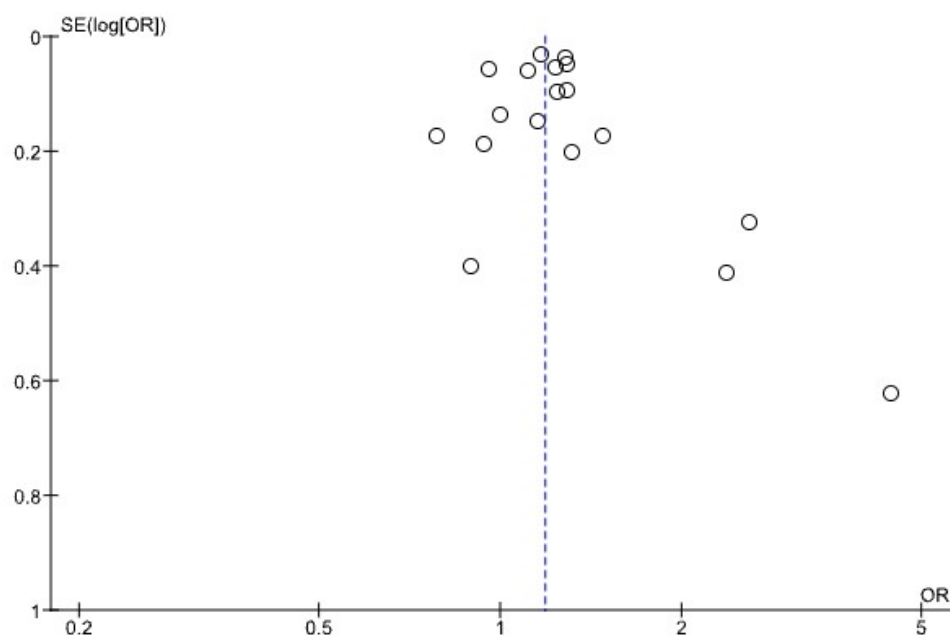
Abbreviations: CI, confidence interval; df, degrees of freedom.

Figure S6: Forest plot smoking and occurrence of hand eczema, subanalysis only including study outcomes in an occupational setting.



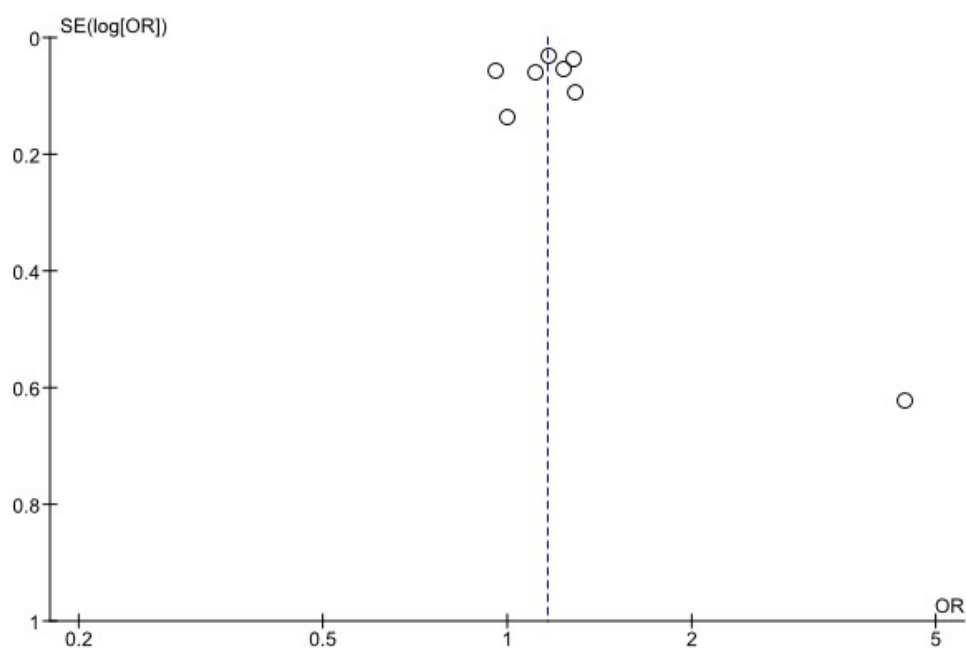
Legend: Cohort and case-control study outcomes with ≥ 6 points on the NOS, and cross-sectional study outcomes with ≥ 7 points, were considered low risk of bias.
Abbreviations: CI, confidence interval; df, degrees of freedom.

Figure S7: Funnel plot smoking and prevalence of hand eczema. Including all studies from the meta-analysis.



Abbreviations: OR, odds ratio; SE, standard error.

Figure S8: Funnel plot smoking and prevalence of hand eczema. Including all studies from the sub-analysis of study outcomes with a risk of bias score ≥ 7 .



Abbreviations: OR, odds ratio; SE, standard error.

References of excluded studies (from Table S2)

1. Agner, T. *et al.* Contact sensitisation in hand eczema patients-relation to subdiagnosis, severity and quality of life: a multi-centre study. *Contact Dermatitis* **61**, 291–296 (2009).
2. Agner, T. [Hand eczema--a diagnostic and therapeutic challenge]. *Ugeskr. Laeger* **162**, 6850–6852 (2000).
3. Ahmed, A., Shah, R., Papadopoulos, L. & Bewley, A. An ethnographic study into the psychological impact and adaptive mechanisms of living with hand eczema. *Clin. Exp. Dermatol.* **40**, 495–501 (2015).
4. Ahmed, A. S. & Eldahshan, R. M. Occupational dermatoses: knowledge, attitudes and perceptions among motor vehicle repair workers. *Int. J. Occup. Saf. Ergon.* 1–7 (2021). doi:10.1080/10803548.2021.1962640
5. Ali, R., Aldraibi, M. & Abdulghani, M. M. Determination of the most frequent dermatosis and its associated risk factors in our society. *J. Dermatol. Nurses. Assoc.* **12**, (2020).
6. Alluhayyan, O. B. *et al.* Occupational-Related Contact Dermatitis: Prevalence and Risk Factors Among Healthcare Workers in the Al'Qassim Region, Saudi Arabia During the COVID-19 Pandemic. *Cureus* **12**, e10975 (2020).
7. Alsaidan, M. S. *et al.* The Prevalence and Determinants of Hand and Face Dermatitis during COVID-19 Pandemic: A Population-Based Survey. *Dermatol. Res. Pract.* **2020**, 6627472 (2020).
8. Apfelbacher, C. *et al.* Self-assessed disease severity is a powerful predictor of health-related quality of life in chronic hand eczema. *Exp. Dermatol.* **22**, e23 (2013).
9. Apfelbacher, C. *et al.* Patient-assessed disease severity is a strong determinant of health-related quality of life in chronic hand eczema. *J. Invest. Dermatol.* **133**, S101 (2013).
10. Arrandale, V. H., Kudla, I. & Holness, D. L. Smoking and allergic contact dermatitis: Causation or correlation? *Occup. Environ. Med.* **71**, A112 (2014).
11. Attwa, E. & el-Laithy, N. Contact dermatitis in car repair workers. *J. Eur. Acad. Dermatol. Venereol.* **23**, 138–145 (2009).
12. Aydin, A. İ., Atak, M., Özyazicioğlu, N. & Dalkizan, V. Determining the Frequency of and Factors in Hand Dermatitis among Nurses during the COVID-19 Pandemic. *Adv. Skin Wound Care* (2021). doi:10.1097/01.ASW.0000765916.20726.41
13. Babić, Ž., Samardžić, T. & Macan, J. Comparison of beautician and hairdressing apprentices with regard to skin health and skin barrier function. *Arh. Hig. Rada Toksikol.* **71**, 190–196 (2020).
14. Becker, J. Increased incidence of dermatoses in nicotine and alcohol abuse. *Hautartz* **46**, 735 (1995).
15. Bewley, A. & Walker, S. An ethnographic insight into the psychological impact of hand eczema. *J. Am. Acad. Dermatol.* **68**, AB74 (2013).
16. Koscec Bjelajac, A., Franic Zrinka, Ticic, M., Beuk, P. & Macan, J. Changes in sleep patterns in relation to hand eczema and atopy symptoms during the first year of hairdressing apprentices' education. *J. Sleep Res.* 278–278 (2020).

17. Boehm, D. *et al.* Anxiety, depression and impaired health-related quality of life in patients with occupational hand eczema. *Contact Dermatitis* **67**, 184–192 (2012).
18. Brans, R. & John, S. M. Individual risk factors for occupational hand eczema. *Aktuelle Derm.* **41**, 20–24 (2015).
19. Brans, R., Hübner, A., Gediga, G. & John, S. M. Prevalence of foot eczema and associated occupational and non-occupational factors in patients with hand eczema. *Contact Dermatitis* **73**, 100–107 (2015).
20. Celik, V. & Ozkars, M. Y. An overlooked risk for healthcare workers amid COVID-19: Occupational hand eczema. *North. Clin. Istanbul* **7**, 527–533 (2020).
21. Chen, C.-J. *et al.* The total body burden of chromium associated with skin disease and smoking among cement workers. *Sci. Total Environ.* **391**, 76–81 (2008).
22. Chen, Y.-X., Cheng, H.-Y. & Li, L.-F. Prevalence and risk factors of contact dermatitis among clothing manufacturing employees in Beijing: A cross-sectional study. *Medicine (Baltimore)*. **96**, e6356 (2017).
23. Cheon, J. J. *et al.* Evaluation of the dermatologic life quality among cleanroom workers in a secondary battery factory. *Ann. Occup. Environ. Med.* **28**, 39 (2016).
24. Chiriac, A. E. M., Matei, M., Stefanescu, C., Taranu, T. & Azoicai, D. Epidemiological study: Self-reported (work-related and occupational) hand eczema. *Allergy Eur. J. Allergy Clin. Immunol.* **75**, 466 (2020).
25. Chirico, F., Menchinelli, C., Giannandrea, F., Mazzarella, D. & Brandi, G. Stress-strain at work in hairdressers suffering from allergies and irritative diseases. *G. Ital. Med. Lav. Ergon.* **26**, 194–195 (2004).
26. Chou, T.-C., Wang, P.-C., Wu, J.-D. & Sheu, S.-C. Chromium-induced skin damage among Taiwanese cement workers. *Toxicol. Ind. Health* **32**, 1745–1751 (2016).
27. Collier, H. Pompholyx and dietary deficiency. *Lancet* **268**, 200–201 (1956).
28. Cvetkovski, R. S. *et al.* Quality of life and depression in a population of occupational hand eczema patients. *Contact Dermatitis* **54**, 106–111 (2006).
29. Dalgard, F. J. *et al.* The psychological burden of skin diseases: a cross-sectional multicenter study among dermatological out-patients in 13 European countries. *J. Invest. Dermatol.* **135**, 984–991 (2015).
30. Devold, J. A. & Furberg, A.-S. Atopic disease in relation to *Staphylococcus aureus* carriage and spa type distribution in a subarctic adult population. *Nor. Epidemiol.* **28**, 26 (2019).
31. Dietz, J. B. *et al.* Incidence rates of occupational contact dermatitis in Denmark between 2007 and 2018: A population-based study. *Contact Dermatitis* **85**, 421–428 (2021).
32. Doğan, E. İ. & Kurt, B. Ö. New-onset or Exacerbated Occupational Hand Eczema among Healthcare Workers During the COVID-19 Pandemic: A Growing Health Problem. *Acta Dermatovenereol. Croat.* **291**, 21–29 (2021).
33. Dotterud, L. K. & Smith-Sivertsen, T. Allergic contact sensitization in the general adult population: a population-based study from Northern Norway. *Contact Dermatitis* **56**, 10–15 (2007).
34. Drewitz, K. P., Stark, K. J., Zimmermann, M. E., Heid, I. M. & Apfelbacher, C. J.

- Frequency of hand eczema in the elderly: Cross-sectional findings from the German AugUR study. *Contact Dermatitis* **85**, 489–493 (2021).
35. Fei, F. *et al.* The present situation investigation and possible factors of skin diseases in Southern Theater Command. *Med. J. Chinese People's Lib. Army* **44**, 701–705 (2019).
 36. Fors, R. *et al.* Lifestyle and nickel allergy in a Swedish adolescent population: effects of piercing, tattooing and orthodontic appliances. *Acta Derm. Venereol.* **92**, 664–668 (2012).
 37. Gallicchio, L., Miller, S. R., Greene, T., Zacur, H. & Flaws, J. A. Adverse health outcomes among cosmetologists and noncosmetologists in the Reproductive Outcomes of Salon Employees (ROSE) study. *J. Toxicol. Environ. Health. A* **74**, 52–61 (2011).
 38. Grabenhenrich, L. *et al.* Eczema in the first 20 years of life: Results from the multicenter allergy study-90 birth cohort. *Allergy Eur. J. Allergy Clin. Immunol.* **66**, 18 (2011).
 39. Holm, J. G., Agner, T., Clausen, M.-L. & Thomsen, S. F. Quality of life and disease severity in patients with atopic dermatitis. *J. Eur. Acad. Dermatol. Venereol.* **30**, 1760–1767 (2016).
 40. Hougaard, M. G., Winther, L., Zachariae, C., Søsted, H. & Johansen, J. D. Development of skin diseases in Danish hairdressing apprentices. *Contact Dermatitis* **70**, 61 (2014).
 41. Huang, D. *et al.* Hand eczema among healthcare workers in Guangzhou City: a cross-sectional study. *Ann. Transl. Med.* **8**, 1664 (2020).
 42. Kashyap, G., Singh, S. K. & Chauhan, B. Prevalence and Risk Factor of Occupational Skin Complaints among Male Tannery Workers of Kanpur, India. *Indian J. Dermatol.* **66**, 347–351 (2021).
 43. Kendziora, B. *et al.* Evaluation of hand hygiene and onset of hand eczema after the outbreak of SARS-CoV-2 in Munich. *Eur. J. Dermatol.* **30**, 668–673 (2020).
 44. Khalili, M. I., Dhaise, B. A., Abbassi, M. M. & Alwash, R. H. Contact dermatitis in auto repair workers. *Saudi Med. J.* **20**, 236–240 (1999).
 45. Lee, C. H. *et al.* Lifetime exposure to cigarette smoking and the development of adult-onset atopic dermatitis. *Br. J. Dermatol.* **164**, 483–489 (2011).
 46. Liang, Y., Zhang, X., Zhu, J., Ali, F. & Mo, H. Analysis of patch testing in patients with hand eczema at Shenzhen from 2016 to 2019. *Postep. dermatologii i Alergol.* **38**, 170–172 (2021).
 47. Linnainmaa, M., Susitaival, P., Mäkelä, P. & Sjöblom, T. Respiratory symptoms and dermatoses among grinders and brazers of hard metal and stellite blades. *Occup. Med. (Chic. Ill.)* **47**, 33–39 (1997).
 48. Lysdal, S. H., Mosbech, H., Johansen, J. D. & Søsted, H. Asthma and respiratory symptoms among hairdressers in Denmark: results from a register based questionnaire study. *Am. J. Ind. Med.* **57**, 1368–1376 (2014).
 49. Maarouf, M., Tran, K., Hendricks, A. J. & Shi, V. Pain burden in atopic dermatitis. *J. Invest. Dermatol.* **138**, S49 (2018).
 50. McArthur, G. & Firkin, B. G. Smoking--another cause of palmar erythema? *The Medical journal of Australia* **156**, 71 (1992).

51. Metin, N., Turan, Ç. & Utlu, Z. Changes in dermatological complaints among healthcare professionals during the COVID-19 outbreak in Turkey. *Acta dermatovenerologica Alpina, Pannonica, Adriat.* **29**, 115–122 (2020).
52. Moldovan, H. R. *et al.* Prevention of Hand Eczema among Nurse Apprentice (PREVEDERM): An Interventional Study. *Ann. Work Expo. Heal.* **65**, 167–175 (2021).
53. Mortz, C. G., Bindslev-Jensen, C. & Andersen, K. E. Contact allergy and hand eczema in the TOACS cohort. *Contact Dermatitis* **70**, 35 (2014).
54. Murota, H., Kijima, A., Takihara, K. & Katayama, I. Research on the actual therapeutic situation in Japanese university students with atopic dermatitis. *J. Dermatol.* **39**, 16 (2012).
55. Nakamoto, M. *et al.* Soy product and isoflavone intake associations with allergic diseases in Japanese workers: rhinitis, dermatitis and asthma. *Asia Pac. J. Clin. Nutr.* **27**, 1277–1285 (2018).
56. Niemeier, V., Nippesen, M., Kupfer, J., Schill, W.-B. & Gieler, U. Psychological factors associated with hand dermatoses: which subgroup needs additional psychological care? *Br. J. Dermatol.* **146**, 1031–1037 (2002).
57. Nørreslet, L. B. *et al.* Impact of hand eczema on quality of life: metropolitan versus non-metropolitan areas. *Contact Dermatitis* **78**, 348–354 (2018).
58. O'Neill, H. *et al.* Occupational dermatoses during the COVID-19 pandemic: a multicentre audit in the UK and Ireland. *The British journal of dermatology* **184**, 575–577 (2021).
59. Patruno, C., Nisticò, S. P., Fabbrocini, G. & Napolitano, M. COVID-19, quarantine, and atopic dermatitis. *Medical hypotheses* **143**, 109852 (2020).
60. Pourani, M. R. & Abdollahimajd, F. Assessment of the psychosocial effects of hand dermatitis among healthcare workers during the COVID-19 pandemic. *Iran. J. Dermatology* **24**, 127–131 (2021).
61. Pourani, M. R. *et al.* Self-Reported Hand Eczema: Assessment of Prevalence and Risk Factors in Health Care Versus Non-Health Care Workers During the COVID-19 Pandemic. *Dermat. contact, atopic, Occup. drug* **32**, e19–e21 (2021).
62. Riala, R., Heikkilä, P. & Kanerva, L. A questionnaire study of road pavers' and roofers' work-related skin symptoms and bitumen exposure. *Int. J. Dermatol.* **37**, 27–30 (1998).
63. Rizzi, A. *et al.* Occupational hand dermatitis web survey in a university hospital during COVID-19 pandemic: the SHIELD study. *Med. Lav.* **112**, 320–326 (2021).
64. Rönmark, E. P. *et al.* Eczema among adults: Prevalence, risk factors and relation to airway diseases. Results from a large-scale population survey in Sweden. *Br. J. Dermatol.* **166**, 1301–1308 (2012).
65. Rosén, K. Pustulosis palmoplantaris and chronic eczematous hand dermatitis. Treatment, epidermal Langerhans cells and association with thyroid disease. *Acta Derm. Venereol. Suppl. (Stockh).* **137**, 1–52 (1988).
66. Rystedt, I. & Nilsson, E. [Hazardous work and predictors of hand eczema--vocational guidance of patients with atopic allergy]. *Lakartidningen* **86**, 714–717 (1989).

67. Saha, M., Podder, I. & Das, A. Skin Damage Induced by Enhanced Protective Measures in Frontline Doctors During Covid-19 Pandemic: A Web-Based Descriptive Study. *Indian J. Dermatol.* **66**, 145–150 (2021).
68. Sato, K., Kusaka, Y., Suganuma, N., Nagasawa, S. & Deguchi, Y. Occupational allergy in medical doctors. *J. Occup. Health* **46**, 165–170 (2004).
69. Silverberg, J. I. & Greenland, P. Eczema and cardiovascular risk factors in 2 US adult population studies. *J. Allergy Clin. Immunol.* **135**, 721–728.e6 (2015).
70. Silverberg, J. I. *et al.* Phenotypical Differences of Childhood- and Adult-Onset Atopic Dermatitis. *J. Allergy Clin. Immunol. Pract.* **6**, 1306–1312 (2018).
71. Simonsen, A. B. *et al.* Increased occurrence of hand eczema in young children following the Danish hand hygiene recommendations during the COVID-19 pandemic. *Contact Dermatitis* **84**, 144–152 (2021).
72. Singh, M. *et al.* Occupational dermatoses in healthcare workers deployed in COVID-19 centres. *Dermatitis* **32**, e48 (2021).
73. Singh, R.; Prabhu, S. S.; Balachandran, C.; Pai, K. Acquired palmoplantar keratodermas : A study of clinical, histopathological and patch test findings. *J. Pakistan Assoc. Dermatologists* **30**, 388–395 (2020).
74. Smith, D. R., Ohmura, K. & Yamagata, Z. Prevalence and correlates of hand dermatitis among nurses in a Japanese teaching hospital. *J. Epidemiol.* **13**, 157–161 (2003).
75. Smith, D. R., Smyth, W., Leggat, P. A. & Wang, R.-S. Prevalence of hand dermatitis among hospital nurses working in a tropical environment. *Aust. J. Adv. Nurs. a Q. Publ. R. Aust. Nurs. Fed.* **22**, 28–32 (2005).
76. Smith, D. R. *et al.* Hand dermatitis among Korean nursing students. *Int. J. Nurs. Pract.* **12**, 160–165 (2006).
77. Son, J. H., Chung, B. Y., Kim, H. O. & Park, C. W. Clinical Features of Atopic Dermatitis in Adults Are Different according to Onset. *J. Korean Med. Sci.* **32**, 1360–1366 (2017).
78. Svensson, A. C. *et al.* Cohort profile: The Stockholm Public Health Cohort. *Int. J. Epidemiol.* **42**, 1263–1272 (2013).
79. Szepletowski, J. C., Salomon, J., Nowicka, D., Soter, K. & Horanin, M. Psychological Distress in Hospital Staff with Self-Reported Hand Dermatitis. *Dermatology Psychosom. / Dermatologie und Psychosom.* **3**, 180–182 (2002).
80. Techasatian, L. *et al.* Hand Hygiene Habits and Prevalence of Hand Eczema During the COVID-19 Pandemic. *J. Prim. Care Community Health* **12**, 21501327211018012 (2021).
81. Thuesen, B. H. *et al.* Cohort Profile: the Health2006 cohort, research centre for prevention and health. *Int. J. Epidemiol.* **43**, 568–575 (2014).
82. Veien, N. K., Hattel, T., Justesen, O. & Nørholm, N. Oral challenge with balsam of Peru. *Contact Dermatitis* **12**, 104–107 (1985).
83. Veien, N. K., Hattel, T., Justesen, O. & Nørholm, A. Dermatitis induced or aggravated by selected foodstuffs. *Acta Derm. Venereol.* **67**, 133–138 (1987).
84. Veien, N. K., Hattel, T., Justesen, O. & Nørholm, A. Dietary restrictions in the treatment of adult patients with eczema. *Contact Dermatitis* **17**, 223–228 (1987).

85. Veien, N. K., Hattel, T., Justesen, O. & Nørholm, A. Oral challenge with metal salts. (II). Various types of eczema. *Contact Dermatitis* **9**, 407–410 (1983).
86. Veien, N. K., Hattel, T., Justesen, O. & Nørholm, A. Dermatoses in coffee drinkers. *Cutis* **40**, 421–422 (1987).
87. von Manteuffel, L. [Hand eczema is preventable. A ‘thicker skin’ helps to achieve healthy skin]. *Kinderkrankenschwester Organ der Sek. Kinderkrankenpf.* **24**, 514–515 (2005).
88. Weistenhöfer, W., Uter, W., Bernet, F. & Drexler, H. The tissue viability imaging system-Suitable method for discovering minimal skin changes in occupational screenings? Results of a cross-sectional field study. *Ski. Res. Technol. Off. J. Int. Soc. Bioeng. Ski. [and] Int. Soc. Digit. Imaging Ski. [and] Int. Soc. Ski. Imaging* **25**, 553–563 (2019).
89. Xerfan, E. M. S. *et al.* Hand eczema, obsessive compulsive disorder and the role of sleep: a triad of associated factors and the influence of the current pandemic. *Sleep medicine* **79**, 164–165 (2021).
90. Yuan, Y. *et al.* Behavior of Nutritional Supplements Use in Association With Inflammatory Skin Diseases in Chinese College Students. *Front. Nutr.* **8**, 615462 (2021).
91. Zeerak, S. *et al.* Clinical Pattern and Patch Test Profile of Hand Eczema in Hospital Employees in a Tertiary Care Hospital of North India. *Indian Dermatol. Online J.* **12**, 72–77 (2021).