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REVIEW

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Hand hygiene and hand eczema: A systematic review and meta-analysis

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Abstract

Hand eczema is a common inflammatory condition of the skin that has been linked to hand hygiene. This systematic review and meta-analysis aims to determine the risks of hand eczema associated with hand hygiene, including frequency of handwashing, wet-work and use of alcohol hand rub. A comprehensive search of MEDLINE, EMBASE and Cochrane Library was performed for cohort, case–control or cross-sectional studies that analysed the association between hand hygiene and risk of hand eczema. Results of individual studies were presented in respective forest plots and pooled summary relative risks were estimated using a random-effects model. Forty-five studies were included in analysis. Handwashing at least 8–10 times daily significantly increased risk of hand eczema (relative risk [RR] 1.51; 95% confidence interval [CI]: 1.35–1.68; $p < 0.001$). The risk was related to handwashing frequency, with higher pooled RR of 1.66 (95% CI: 1.51–1.83; $p < 0.001$) with increased handwashing at least 15–20 times daily. However, use of alcohol-based hand sanitizer was not significantly associated with risk of hand eczema. Given the widespread implementation of hand hygiene practices during the COVID-19 pandemic, there is a pertinent need to understand skin care habits specific to the hands to avoid a greater incidence of hand eczema.

KEYWORDS

contact dermatitis, epidemiology, hand eczema, hand hygiene

1 | INTRODUCTION

Hand eczema is an inflammation of the skin limited to the hands and/or wrists. It is a common condition, with lifetime prevalence reaching 14.5% in the general population.[1] The condition is often debilitating and causes marked impairment on the quality of life of patients.[2]

Risk factors for hand eczema have been extensively examined, with both endogenous and exogenous factors known to play a role.[3] The most significant risk factor has been found to be atopic dermatitis,[4–7] while exogenous factors include contact allergy[6,8,9] and exposure to irritants.[10,11] Wet work and hand washing have also been implicated as risk factors for hand eczema,[8,12] but other studies have found no association.[6] Amidst the COVID-19 pandemic, hand hygiene, which includes handwashing with soap and use of alcohol-based hand rub, has been advocated to reduce the spread of the virus. With the increased hand hygiene practices adopted by the general population, it is pertinent to evaluate its risk on hand eczema, in order to advise guidelines on handwashing and sanitizer use and avoid a concomitant rise in incidence of hand eczema.

This systematic review and meta-analysis therefore aims to present an overview of the association between hand hygiene practices (frequency of handwashing, use of alcohol hand rub, wet work) and the risk on hand eczema.

2 | METHODS

A systematic review and meta-analysis was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines.[13] A protocol outlining the aims and strategy of

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the systematic review and meta-analysis was developed and reviewed by all authors prior to the start of the study, but not registered.

2.1 | Search strategy

The comprehensive search included databases of MEDLINE via PubMed, EMBASE and Cochrane library. The search terms used were: (Eczema[MeSH Terms] OR Dermatitis, Eczematous OR Skin Diseases, Eczematous[MeSH Terms] OR Eczematous Disorders OR Eczematous Skin Diseases OR Hand Dermatoses[MeSH Terms] OR Hand Dermatosis) AND (Hand Hygiene[MeSH Terms] OR 'Hand Disinfection' or 'Hand Washing' or 'Wet Work' or 'Wet Exposure') (Table S1).

All studies published from inception to 10 April 2022 were included in the search. Additional articles were included from manual search in the reference list of articles.

All studies were then assessed based on title and abstract for relevance to hand eczema and association with hand hygiene.

2.2 | Selection of articles

Studies published in English language from all countries and evaluating all populations were considered. Cohort, case–control or cross-sectional studies that analysed the association between hand hygiene and risk of hand eczema were included. Studies had to report adequate information such as relative risks (RR), odds ratio (OR) and confidence interval (CI) in order for further meta-analysis to be performed. For studies which did not report such ratios, studies should have crude data such as total cases of hand eczema among those exposed and unexposed. The primary outcome measured in this study is the relative risk of hand eczema in the different exposure groups. Definition of hand eczema in the various studies includes physician diagnosis as well as characteristic signs and symptoms of hand eczema.

From the title and abstract, two reviewers independently selected studies for full-text review based on the inclusion criteria. The full-text articles were then evaluated independently by two reviewers to determine eligibility for inclusion, and any disagreements were resolved by consensus.

Study quality was assessed by two independent reviewers using the Newcastle–Ottawa scale (NOS)[14] for cohort and case–control studies, while cross-sectional studies were assessed using an adapted version of NOS.[15] Studies were scored in three areas: selection of study population, comparability between groups and assessment of outcome. A maximum score of 9 or 10 could be achieved for cohort studies and cross-sectional studies respectively, and NOS score of ≥7 was considered low risk of bias or high quality.

Certainty of evidence for each outcome was rated by two independent reviewers using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) assessment tool. Evidence from observational studies started at the low quality level, and was subsequently assessed across various domains including risk of bias, imprecision, inconsistency, indirectness and publication bias for downgrading or upgrading.[16,17] Any discrepancy in rating was resolved by consensus.

2.3 | Data extraction

Data were extracted from the selected studies by two reviewers independently, using a standardized data extraction form. Information extracted included: study year, country and population, study design, total number of participants, outcome and assessment of outcome, risk ratios and 95% CI for groups compared. For studies which did not report risk ratios, crude data were extracted, including total cases of hand eczema, number of cases exposed and unexposed. Studies that provided insufficient information to calculate relative risks of hand eczema or their standard errors among groups of interests were excluded. Where possible, efforts were made to contact the authors for more information.

2.4 | Meta-analysis

Selected studies were classified based on whether they analysed frequency of handwashing or use of alcohol hand rub. Studies related to handwashing were then divided into two groups based on the threshold of daily handwashing frequency that was compared: at least 8–10 times versus <8–10 times, and at least 15–20 times versus <15–20 times. Studies that investigated wet work (defined as contact with liquids >2 h/day, use of occlusive gloves >2 h/day or handwashing >20 times/day) were analysed separately. Studies related to alcohol hand rub were divided into three groups: use of alcohol hand rub versus no use of alcohol hand rub, alcohol hand rub >10 times daily versus ≤10 times daily and alcohol hand rub >20 times daily versus ≤20 times daily.

In both controlled and uncontrolled studies, most of the included studies reported odds ratios or risk ratios. They were included for meta-analysis when available; otherwise, ratios were estimated from the crude data. Pooled estimate of relative risk (RR) from selected studies was derived from these ratios, as they approximated one another mathematically under the rare disease assumption.[18] Results of individual studies were presented as a forest plot and the pooled summary relative risks was estimated using random-effects model of DerSimonian and Laird to account for variance between and within the studies. Heterogeneity between studies was assessed using χ^2 test and the I^2 statistic; values of 25, 50 and 75% were considered to be low, moderate and high heterogeneity, respectively. A funnel plot was constructed and visually inspected for asymmetry to qualitatively assess publication bias. All analyses were performed using STATA Version 13.0 (StataCorp).

3 | RESULTS

3.1 | Search results

The comprehensive search of MEDLINE, Embase and Cochrane Library yielded a total of 1020 studies, of which 256 duplicates were

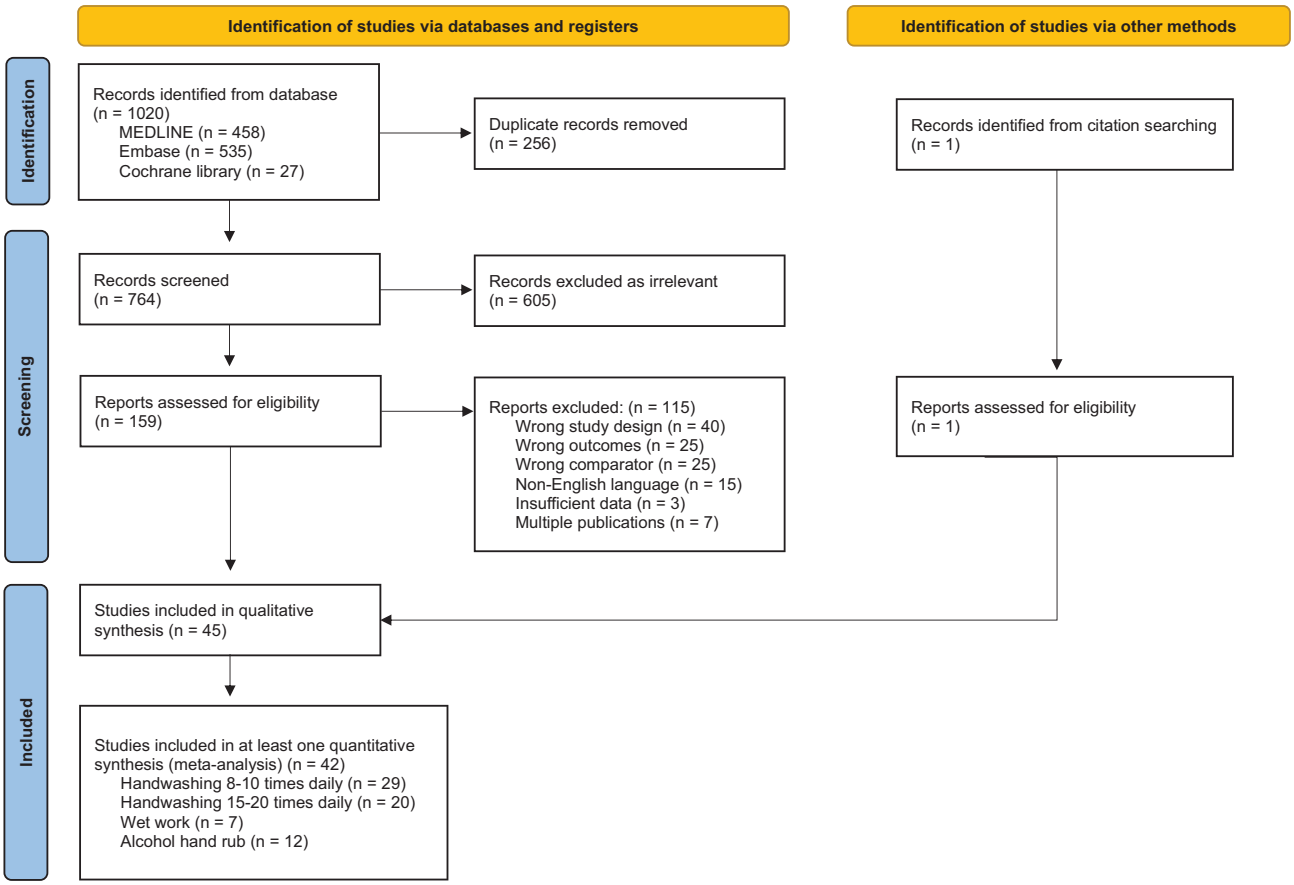

FIGURE 1 PRISMA flow diagram showing summary of the systematic review and meta-analysis

removed from further evaluation. Based on the titles and abstracts of the remaining 764 articles, 605 studies were excluded. Among the 159 full-text articles assessed, 44 studies fulfilled the inclusion criteria and the rest were excluded for reasons reported in the PRISMA flow diagram (Figure 1). An additional article was found from the citation list of another article. Finally, 45 studies were included in the systematic review, and 42 studies included in at least one meta-analysis.

3.2 | Description of included studies

Six studies utilized a cohort study design,[5,12,19–22] three studies were case–control studies,[23–25] while the other studies ($n = 36$) employed a cross-sectional study design. There were 17 studies performed in Asia, and 28 were from non-Asia countries. The majority ($n = 28$, 62.2%) of studies were performed in healthcare workers, 12 (26.7%) were in non-healthcare workers and five included the general population regardless of occupation.[23,26–29] Outcomes were assessed by self-reported questionnaire in most studies ($n = 35$), of which 12 were based on the NOSQ-2002 questionnaire,[30] and 10 studies relied on clinical examination by dermatologist or trained professional. Most of the studies were of high quality ($n = 35$), and 10 were considered lower quality (NOS < 7). The general characteristics of each study are summarized in Table 1. Further details are provided in Tables S2–S5.

3.3 | Risks of hand eczema with at least 8–10 times of daily handwashing

The meta-analysis included 29 studies that examined the risks of hand eczema with at least 8–10 times of daily handwashing versus fewer than 8–10 times (Table S2). The pooled RR of hand eczema among those who washed their hands at least 8–10 times daily was 1.51 (95% CI: 1.35–1.68; $p < 0.001$), as compared to those who washed their hands fewer times (Figure 2). There was moderate heterogeneity between studies ($I^2 = 71.0\%$, $p < 0.001$), hence a random-effects model was used. The funnel plot appeared symmetrical and did not show obvious publication bias (Figure S1).

In healthcare workers, the RR was 1.48 (95% CI: 1.30–1.67; $p < 0.001$) versus 1.62 (95% CI: 1.13–2.34; $p = 0.009$) for non-healthcare workers, and 1.45 (95% CI: 1.21–1.72; $p \leq 0.001$) for the general population. While the point estimate of hand eczema risk from handwashing of at least 8–10 times a day appeared to be higher among non-healthcare workers, the difference was not significant given their overlapping confidence intervals.

The pooled RRs were also similar across different geographical regions where the study was conducted (Figure S2). Studies performed in Asia reported a pooled RR of 1.51 (95% CI: 1.28–1.78; $p < 0.001$), while studies outside of Asia demonstrated RR 1.52 (95% CI: 1.31–1.76; $p < 0.001$).

TABLE 1 Characteristics of all selected articles and their references

Authors (start year)	Country	Population	Number of participants	Number of cases (%)	Outcome	Assessment of outcome	Study design	NOS
Alsaidan et al. (2020)[27]	Saudi Arabia	Students and employees of university	2354	821 (34.8)	Skin changes or symptoms over hands	Self-administered online questionnaire	Cross-sectional study	6
Altunisik Toplu et al. (2020)[31]	Turkey	Healthcare workers in a tertiary university hospital	276	203 (73.6)	Hand-skin-related symptoms	Self-reported via self-administered online questionnaire	Cross-sectional study	6
Anveden et al. (1996)[23]	Sweden	General population aged 20-65 years	364	182 (50)	Prevalence of hand eczema during the past 12 months	Self-reported hand eczema via self-administered postal questionnaire	Case–control study	7
Apfelbacher et al. (2005)[24]	Germany	Individuals who had been followed until the end of their apprenticeship in the original cohort study in the car industry (1990–1998)	230	110 (47.8)	Current hand eczema	Dermatological examination	Case–control study	7
Borch et al. (2020)[32]	Denmark	Children	6273	4496 (42.4)	Incidence of irritant contact dermatitis	Parental self-administered questionnaire	Cross-sectional study	6
Brands et al. (2020)[29]	Netherlands	General population aged 18 years and older	57 046	4158 (7.3)	1-year prevalence of hand eczema	Self-reported via self-administered digital questionnaire (based on NOSQ-2002)	Cross-sectional study	8
Bryld et al. (1996)[6]	Denmark	Twins	1076	449 (41.7)	Prevalence of hand eczema	Self-reported hand eczema via self-administered postal questionnaire	Cross-sectional study	8
Callahan et al. (2013)[19]	United States	Healthcare workers	90	46 (51.1)	Incidence of irritant hand dermatitis (IHD)	Assessment by dermatologist	Cohort study	8
Campion (2013)[25]	United Kingdom	Healthcare workers	2762	424 (15.3)	Prevalence of occupational skin disease	Self-reported via self-administered questionnaire (modified NOSQ-2002)	Case–control study	7
Douwes et al. (2016)[33]	New Zealand	Cleaners	425	63 (14.8)	Current hand/arm dermatitis in past 3 months	NOSQ-2002 (face to face interview)	Cross-sectional study	9
Erdem et al. (2020)[34]	Turkey	Healthcare workers working in COVID-19 patient care units of hospital	107	54 (50.5)	Prevalence of hand eczema	Examination by dermatologist using hand eczema severity index (HECSI) for standardi zation of HE severity	Cross-sectional study	7
Falay Gür et al. (2019)[35]	Turkey	Healthcare professionals working in a tertiary hospital	601	308 (51)	Lifetime prevalence of hand eczema	Self-reported via self-administered questionnaire (modified NOSQ-2002); confirmed by clinical examination	Cross-sectional study	8
Flyvholm et al. (2002)[36]	Denmark	Hospital employees	1246	256 (22.8)	Hand eczema within the past 12 months	Self-reported via self-administered questionnaire (based on NOSQ-2002)	Cross-sectional study	5

TABLE 1 (Continued)

Authors (start year)	Country	Population	Number of participants	Number of cases (%)	Outcome	Assessment of outcome	Study design	NOS
Forrester et al. (1998)[37]	United States	Healthcare professionals in ICU	126	70 (55.6)	Prevalence of occupational hand dermatitis	Self-administered questionnaire	Cross-sectional study	5
Hamnerius et al. (2014)[38]	Sweden	Healthcare workers (nurses, assistant nurses, physicians)	9051	1870 (21)	1-year prevalence of hand eczema	Self-reported questionnaire	Cross-sectional study	7
Hamnerius et al. (2020)[39]	Sweden	Healthcare workers	5094	1469 (29)	1-year prevalence of hand eczema	Self-reported (survey)	Cross-sectional study	7
Huang et al. (2019)[40]	China (Guangzhou)	Nurses, doctors	521	50 (9.6)	1-year prevalence of hand eczema	Self-report via modified NOSQ-2002 questionnaire	Cross-sectional study	9
Ibler et al. (2009)[41]	Denmark	Healthcare workers	2269	396 (17.5)	1-year prevalence of hand eczema	Self-reported hand eczema via self-administered questionnaire based on NOSQ-2002	Cross-sectional study	7
Jindal et al. (2020)[42]	India	Healthcare workers (doctors and nurses) working in designated COVID-19 hospitals	160	105 (65.6)	Point prevalence of hand eczema	Self-reported signs and symptoms of hand eczema via self-administered online questionnaire	Cross-sectional study	5
Lan et al. (2007)[43]	Taiwan	Nursing staff	140	35 (25)	Prevalence of non-atopic hand dermatitis during past 1 year	Non-atopic eczema assessed by physician according to Hanifin and Rajka criteria; hand dermatitis by self-report via validated questionnaire	Cross-sectional study	8
Lan et al. (2020)[44]	China	Physicians, nurses in tertiary hospitals	542	392 (72.3)	Prevalence of skin damage in the hands	Self-reported via self-administered online questionnaire	Cross-sectional study	6
Lee et al. (2011)[45]	Korea	Hospital nursing staff	525	397 (75.6)	Prevalence of symptom-based hand eczema in past 12 months	Questionnaire survey; self-reported hand eczema or symptom-based hand eczema	Cross-sectional study	8
Lerbaek et al. (1996)[12]	Denmark	Population-based twin cohort	4128	244 (5.9)	Incidence of hand eczema	Self-reported via question naire	Cohort study	7
Luk et al. (2009)[46]	Hong Kong	Nurses	724	160 (22.1)	Prevalence of hand eczema	Self-report questionnaire (based on NOSQ-2002)	Cross-sectional study	8
Mekonnen et al. (2018)[47]	Ethiopia	Healthcare workers	422	133 (31.5)	1-year prevalence of self-report occupational contact dermatitis	Self-report contact dermatitis via NOSQ-2002	Cross-sectional study	9
Metin et al. (2020)[48]	Turkey	Healthcare professionals (doctors, nurses)	523	379 (72.5)	Prevalence of hand eczema in the previous week, after 1 month of COVID-19 outbreak	Self-report via online questionnaire	Cross-sectional study	6
Minamoto et al. (2011)[49]	Japan	Dental workers: dentists, hygienists, technicians, assistants, receptionists	528	209 (39.6)	1-year period prevalence of chronic hand eczema	Self-administered questionnaire (NOSQ-2002)	Cross-sectional study	7

(Continues)

TABLE 1 (Continued)

Authors (start year)	Country	Population	Number of participants	Number of cases (%)	Outcome	Assessment of outcome	Study design	NOS
Mortz et al. (1995)[5]	Denmark	Unselected young adults followed from primary school	889	126 (14.2)	1-year period prevalence of hand eczema in 2010	History of HE self-reported via NOSQ 2002 questionnaire, point prevalence evaluated clinically by dermatologist	Cohort study	9
Simonsen et al. (2020)[50]	Denmark	Children attending day-care centres throughout Denmark	6858	1668 (24.3)	Incident hand eczema (in children without previous hand eczema)	Parental self-administered electronic questionnaire	Cross-sectional study	8
Smith et al. (2002)[51]	Japan	Female nurses	305	108 (35)	1-year period prevalence of hand dermatitis	Self-reported HD questionnaire	Cross-sectional study	8
Smith et al. (2004)[52]	Japan	Clinical nurses	860	458 (53.3)	1-year period prevalence of hand dermatitis	Self-report via a previously validated HD questionnaire	Cross-sectional study	8
Sørensen et al. (2012)[53]	Denmark	Individuals with work-related hand eczema	773	80 (10.3)	Severe and very severe hand eczema	Self-reported via questionnaire; severity assessed by use of validated photographic guide	Cross-sectional study	7
Steiner et al. (2007)[54]	Scotland	Bakery workers	93	15 (16)	1-year prevalence of hand dermatitis	Self-reported questionnaire	Cross-sectional study	6
Stoeva et al. (2019)[55]	Bulgaria	Dental students	467	99 (21.2)	Prevalence of work-related skin symptoms	Self-reported via online questionnaire	Cross-sectional study	8
Stoeva (2018)[56]	Bulgaria	Dentists	4675	1477 (31.6)	Point prevalence of work-related skin symptoms	Self-reported via online questionnaire	Cross-sectional study	7
Techasatian et al. (2020)[26]	Thailand	All individuals >18 years of age	805	168 (20.9)	Point prevalence of hand eczema	Self-report via questionnaire	Cross-sectional study	7
Teo et al. (2003)[57]	Singapore	Restaurant, catering and fast-food outlet staff	335	35 (10)	12-month period prevalence of contact dermatitis	Clinical examination by trained investigator	Cross-sectional study	8
Uter et al. (1992)[20]	Germany	Hairdressing apprentices	2352	1134 (55.1)	Point prevalence of skin changes (any degree)	Clinical examination	Cohort study	8
Vermeulen et al. (1997)[58]	Netherlands	Male rubber manufacturing workers	202	56 (28)	Point prevalence of minor hand dermatitis	Dermatologist assessment	Cross-sectional study	7
Visser et al. (2011)[21]	Netherlands	Apprentice nurses	533	285 (53)	Prevalence of hand eczema	Self-report then diagnosed by dermatologist	Cohort study	9
Yüksel et al. (2020)[59]	Denmark	Healthcare workers	2125	311 (14.7)	1-year period prevalence of hand eczema	Self-administered digital questionnaire based on NOSQ-2002	Cross-sectional study	7
Yüksel et al. (2020)[22]	Denmark	Healthcare workers	795	93 (11.7)	1-year prevalence of hand eczema at follow up	Self-reported via self-administered digital questionnaire based on NOSQ-2002	Prospective cohort study	7
ZahrAllayali et al. (2020)[28]	Saudi Arabia	General population	783	86 (11.0)	New onset symptoms of skin damage (for people with no history of hand eczema)	Self-administered online questionnaire (modified from previous studies), validated by 3 dermatologists before distribution	Cross-sectional study	6

TABLE 1 (Continued)

Authors (start year)	Country	Population	Number of participants	Number of cases (%)	Outcome	Assessment of outcome	Study design	NOS
Zhang et al. (2016)[60]	China	Nurses	934	183 (20)	Point prevalence of hand eczema	Self-reported questionnaire, adapted from NOSQ-2002	Cross-sectional study	9
Zhu et al. (2020)[61]	China	Doctors and nurses caring for patients with COVID-19	376	280 (74.5)	Prevalence of adverse skin reactions	Self-report via questionnaire	Cross-sectional study	7

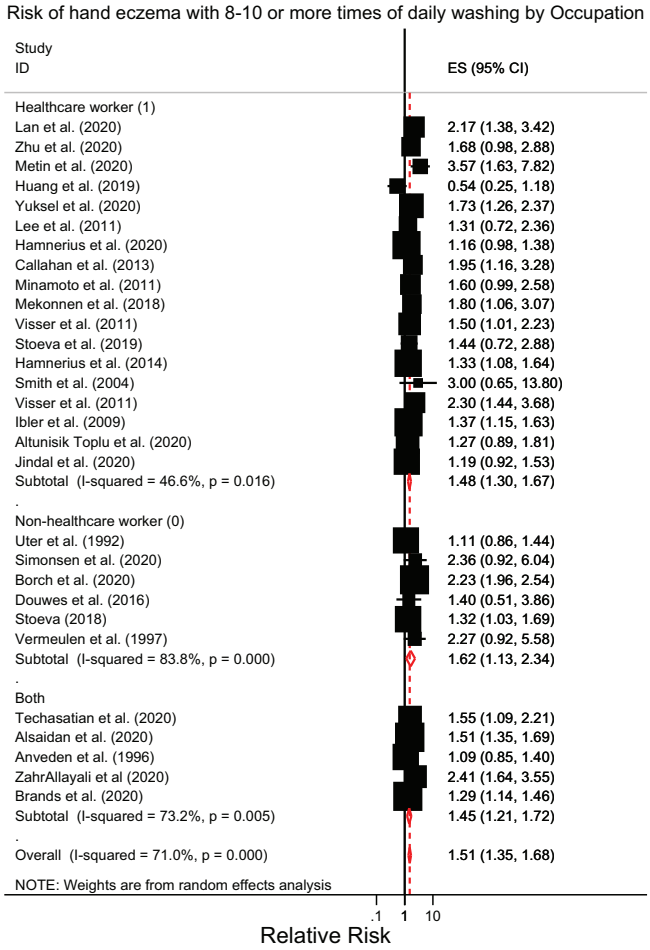

FIGURE 2 Forest plot of risks of hand eczema with at least 8–10 times of daily handwashing versus <8–10 times, with subgroup analysis by healthcare worker occupation. *CI, confidence interval; ES, effect estimate*

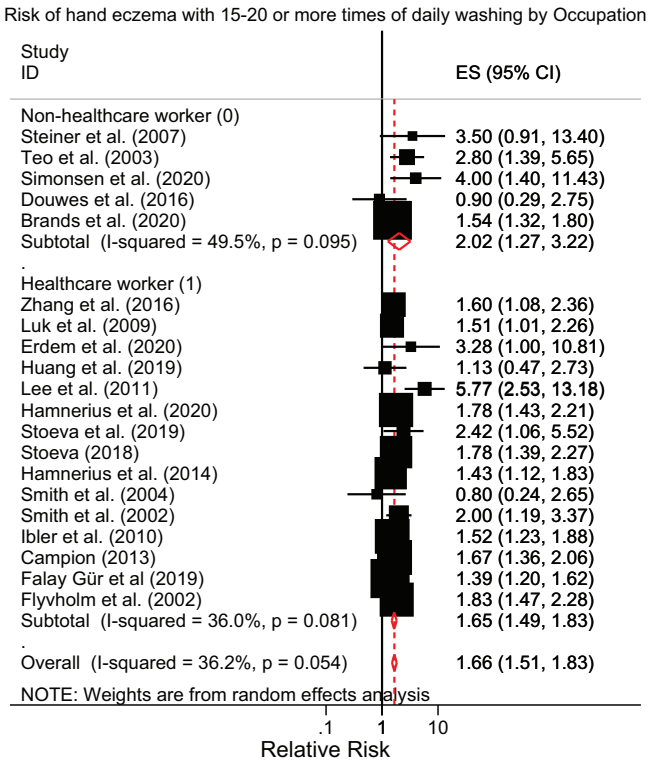

FIGURE 3 Forest plot of risks of hand eczema with at least 15–20 times of daily handwashing versus <15–20 times, with subgroup analysis by healthcare worker occupation. *CI, confidence interval; ES, effect estimate*

Studies with a lower NOS quality score reported higher risks of hand eczema from 8 to 10 or more times of daily handwashing (RR: 1.79; 95% CI: 1.41–2.27; $p < 0.001$) than studies with NOS ≥7 (RR: 1.37; 95% CI: 1.25–1.49; $p < 0.001$) (Figure S2).

3.4 | Risks of hand eczema with at least 15–20 times of daily handwashing

Twenty studies were included in meta-analysis on the risks of hand eczema with handwashing at least 15–20 times daily versus handwashing frequencies reported to be fewer than 15–20 times (Table S3a). The comparator groups in all studies had various handwashing frequencies, which may impact on the accuracy of the pooled estimate. However, despite this, there was low heterogeneity among the studies ($I^2 = 36.2\%$, $p = 0.054$). Visualization of the funnel plot did not suggest any significant publication bias (Figure S3).

The pooled RR of hand eczema among those who washed their hands at least 15–20 times daily was 1.66 (95% CI: 1.51–1.83; $p < 0.001$). As depicted in Figure 3, non-healthcare workers had higher risks of hand eczema with at least 15–20 times of daily handwashing (RR: 2.02; 95% CI: 1.27–3.22; $p = 0.003$) as compared to healthcare workers (RR: 1.65; 95% CI: 1.49–1.83; $p < 0.001$). However, this difference was not significant, as their respective interval estimates were overlapping.

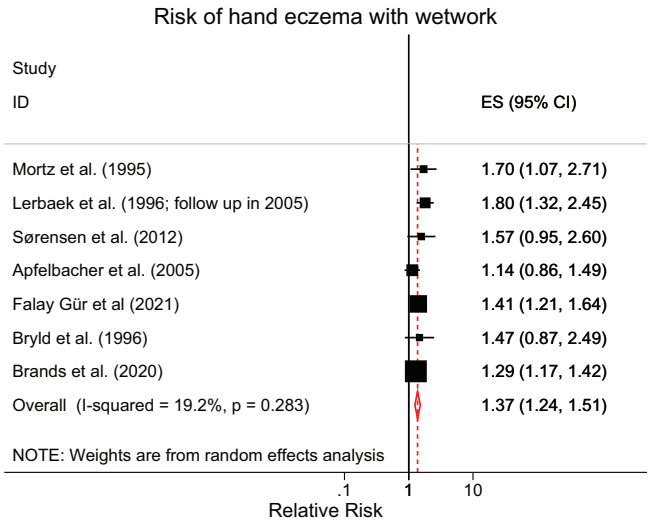

FIGURE 4 Forest plot of risks of hand eczema with wet work versus no wet work. *CI, confidence interval; ES, effect estimate*

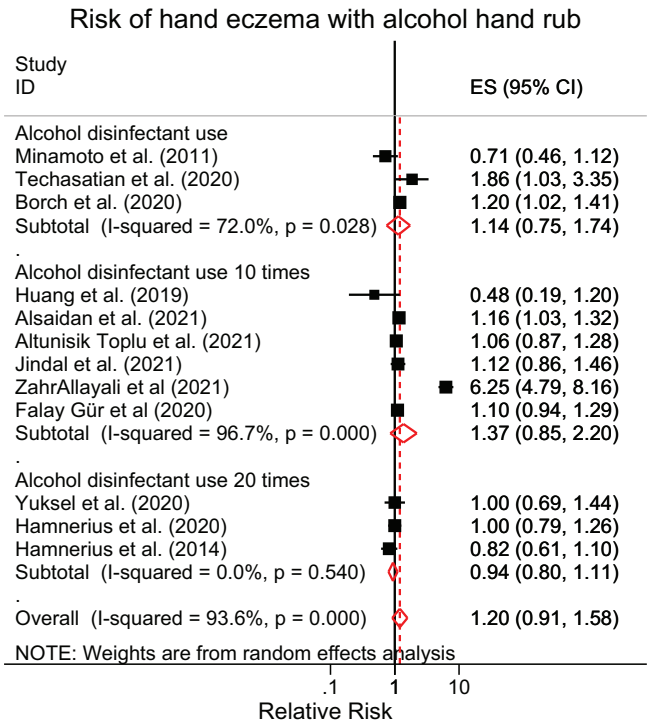

FIGURE 5 Forest plot of risks of hand eczema with use of alcohol hand rub. *CI, confidence interval; ES, effect estimate*

The pooled RR of hand eczema was 1.74 (95% CI: 1.32–2.29; $p < 0.001$) for studies conducted in Asia versus 1.65 (95% CI: 1.52–1.79; $p < 0.001$) for studies conducted in other countries (Figure S4). Geographical region did not significantly affect the association of handwashing 15–20 or more times daily with hand eczema.

The two studies with a low NOS quality score[36,54] reported a higher risk of hand eczema (RR: 1.86; 95% CI: 1.50–2.31; $p < 0.001$) compared to studies with NOS ≥7 which reported RR 1.64 (95% CI: 1.48–1.82, $p < 0.001$) (Figure S4). Additionally, Forrester and Roth,[37] which was only included in qualitative analysis, reported RR 4.13 for occupational hand dermatitis with handwashing at least 35 times per shift versus <35 times (Table S3b).

3.5 | Risks of hand eczema with wet work

Seven studies examined the risks of hand eczema with wet work versus no wet work (Table S4). As represented in Figure 4, the pooled RR of hand eczema with wet work was 1.37 (95% CI: 1.24–1.51, $p < 0.001$). There was low heterogeneity among the studies ($I^2 = 19.2\%$, $p = 0.283$) and there was no significant publication bias seen in the funnel plot (Figure S5).

3.6 | Risks of hand eczema with use of alcohol hand rub

Fourteen studies examined the risks of hand eczema with the use of alcohol hand rub; however, two studies[22,43] were not included in final meta-analysis as the frequency of alcohol hand rub reported was different from the rest of the other studies (Table S5a,b). The remaining 12 studies were analysed as three groups based on frequency of alcohol disinfectant use: use of alcohol disinfectant versus no use of alcohol disinfectant, more than 10 times daily versus ≤10 times daily and more than 20 times daily versus ≤20 times daily. There was high heterogeneity among the studies included in the meta-analysis ($I^2 = 93.6\%$, $p < 0.001$). The funnel plot appeared asymmetrical, suggesting a publication bias (Figure S6).

There was no statistically significant relationship between risks of hand eczema and use of alcohol hand rub ($p = 0.548$), alcohol hand rub more than 10 times daily ($p = 0.196$) or alcohol hand rub more than 20 times daily ($p = 0.452$), as shown in Figure 5.

In the studies that were only included in qualitative analysis, Lan et al.[43] found that there was no statistically significant risk of hand eczema with use of alcohol hand rub more than nine times within 4 h versus ≤9 times ($p = 0.2886$). A prospective cohort study by Yüksel et al.[22] described that increased use of alcohol-based hand rubs on wet skin by healthcare workers during the COVID-19 pandemic was associated with increased 1-year prevalence of hand eczema at follow up (RR: 1.78; 95% CI: 1.11–2.87).

3.7 | GRADE assessment: certainty in evidence

The GRADE certainty ratings for the following outcomes: risks of hand eczema from at least 8 to 10 times handwashing, 15 to 20 times handwashing and wet work were low. The GRADE certainty rating for risk of hand eczema from alcohol hand rub was very low (Table 2). Therefore, the overall GRADE quality rating for risks of hand eczema

TABLE 2 GRADE assessment tool: certainty in evidence for evaluated outcomes

Outcome	Quality assessments							Effect	
	Number of studies	Study design	Risk of bias	Imprecision	Inconsistency	Indirectness	Publication bias	RR (95% CI)	GRADE quality
Risks of hand eczema with at least 8–10 times of daily handwashing	29	Observational studies	Not serious	Not serious	Serious[a]	Not serious	Not serious	1.51 (1.35, 1.68)	⊕⊕◯◯ Low
Risks of hand eczema with at least 15–20 times of daily handwashing	20	Observational studies	Not serious	Not serious	Not serious	Serious[b]	Not serious	1.66 (1.51, 1.83)	⊕⊕◯◯ Low
Risks of hand eczema with wet work	7	Observational studies	Not serious	Not serious	Not serious	Serious[b]	Not serious	1.37 (1.24, 1.51)	⊕⊕◯◯ Low
Risks of hand eczema with use of alcohol hand rub	12	Observational studies	Not serious	Not serious	Serious[a]	Not serious	Serious[c]	1.20 (0.91, 1.58)	⊕◯◯◯ Very low

Note: Low quality: our confidence in the effect estimate is limited. The true effect may be markedly different from the estimate of the effect. Very low quality: we have very little confidence in the effect estimate. The true effect is likely to be markedly different from the estimate of effect.
Abbreviations: CI, confidence interval; RR, relative risk.
[a]Heterogeneity statistic I^2 was greater than 70% and these outcomes were downgraded for inconsistency.
[b]Downgraded for varied definitions of exposures in the studies.
[c]Publication bias as demonstrated by asymmetrical funnel plot.

from various hand hygiene practices, excluding alcohol hand rub use, would be considered low.

4 | DISCUSSION

This study demonstrated a significant increase in risk of hand eczema associated with frequency of handwashing and wet work, but not with use of alcohol hand rub.

Handwashing at least 8–10 times a day significantly increased the risk of hand eczema (RR: 1.51) as compared to washing hands fewer times; the risk was even higher when handwashing frequency was increased to at least 15–20 times a day (RR: 1.66). The associations between hand hygiene practices and risk of hand eczema were consistent regardless of geographical region or occupation. It is also noted that there could possibly be a dose–response relationship given that the pooled risk ratios of hand eczema were higher with more frequent handwashing. However, our meta-analysis results showed that 8–10 times of daily handwashing is enough to cause a significantly higher risk of hand eczema than someone who washes hands less frequently. On the other hand, no significant association has been established between use of alcohol hand rub and risk of hand eczema. However, healthcare workers often perceive alcohol disinfection to be more damaging to the skin than handwashing,[49,62] despite alcohol-based hand rubs being found to cause less skin irritation than handwashing in tests of skin hydration, erythema and transepidermal water loss.[63] This misconception may have stemmed from the stinging sensation when alcohol is applied to previously damaged skin.[63,64] The present study re-affirms that alcohol hand rub may be a viable substitute for handwashing with soap since it is as effective in reducing hand bacterial contamination,[65] without significant risk of hand eczema. More studies are needed to investigate the effect of alcohol hand rub on skin barrier function and irritation, to further ascertain the difference between alcohol hand rub and handwashing with soap.

In light of the associated risks of hand eczema, there is a need to advocate for appropriate hand care advice even for handwashing as low as 8–10 times daily. It is recommended that moisturizers are used, multiple times per day and particularly after handwashing, to keep the skin hydrated.[66,67]

Information on the prevalence of hand eczema is essential to guide interventions and primary prevention of the condition developing among susceptible patients. There have been various reports of a high prevalence of hand eczema associated with hand hygiene recommendations during the COVID-19 pandemic. Simonsen et al.[50] found that 28.6% of Danish children developed incident hand eczema after returning to day-care and adopting the implemented handwashing regimen. In Turkey, a cross-sectional study of healthcare professionals reported that prevalence of hand eczema increased from 23.1% before the COVID-19 outbreak, to 72.5% after 1 month of the outbreak.[48]

Besides handwashing and alcohol hand rubs, wearing of occlusive gloves is also a risk factor for hand eczema.[38,47] The gloves lead to a state of hyper-hydration causing maceration of the skin, enhancing the penetration of soaps and alcohol sanitizers.[68] This meta-analysis included studies on wet work which encompassed the use of occlusive gloves, but did not examine the independent role of gloves in increasing the risk of hand eczema. Although glove use is less common among the general population, it is a factor that should also be considered in future studies in the context of healthcare workers who routinely use gloves at work.

This review has several limitations. First, the data were gathered from observational studies that were prone to the effects of

various confounding factors. This study lacked adequate information on prior atopy, prior skin diseases and lifestyle information such as smoking habits and hobbies to adjust for confounding. Observational studies (e.g., cross-sectional studies) are susceptible to reverse causation bias and therefore no conclusion regarding direction of the found association can be drawn. For example, hand washing increases risk of hand eczema; however, people with hand eczema might avoid hand washing. This can cause an underestimation of the true effect. There is a dearth of cohort studies that analyse hand hygiene practices as risk factors in the incidence of hand eczema.

Second, information such as duration of handwashing and type of soap use, as well as current prevailing hand care habits, was not available in the various studies included. Thus, the effectiveness of modifications to handwashing practices, or the use of hand care, in preventing hand eczema could not be evaluated. This study highlighted the need for intervention studies to prevent the incidence of hand eczema by encouraging hand care and use of alcohol hand rubs.

Finally, the studies used different methods for assessment of hand eczema. The most reliable assessment of hand eczema is clinical diagnosis by a physician. Most studies used questionnaires to determine prevalence of hand eczema. While some studies employed the Nordic Occupational Skin Questionnaire (NOSQ-2002)[30] for screening of hand eczema and exposures, others relied on self-reported questionnaires that may not have been validated in detecting hand eczema accurately. Self-reported questionnaires have been found to demonstrate high specificity of over 90%, but sensitivity is less than 70%, and hence tend to underestimate the true prevalence of hand eczema.[30]

In conclusion, this meta-analysis highlights the significant risk of hand eczema associated with handwashing, but not the use of alcohol hand rubs. This risk is observed regardless of geographical region or population. The burden of hand eczema is especially significant amidst the current COVID-19 pandemic, when a higher frequency of hand hygiene has been recommended for the general public. Knowledge of this risk is valuable in underscoring the need to encourage hand care to reduce the incidence of hand eczema.

AUTHOR CONTRIBUTIONS

Enver De Wei Loh: Conceptualization (equal); data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); resources (equal); software (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal). **Yik Weng Yew:** Conceptualization (equal); data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); resources (equal); software (equal); supervision (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal).

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are provided in supplementary tables. These data were derived from resources available in the public domain and have been referenced.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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Figure S1. Funnel plot of studies evaluating risks of hand eczema with at least 8-10 times of daily handwashing.

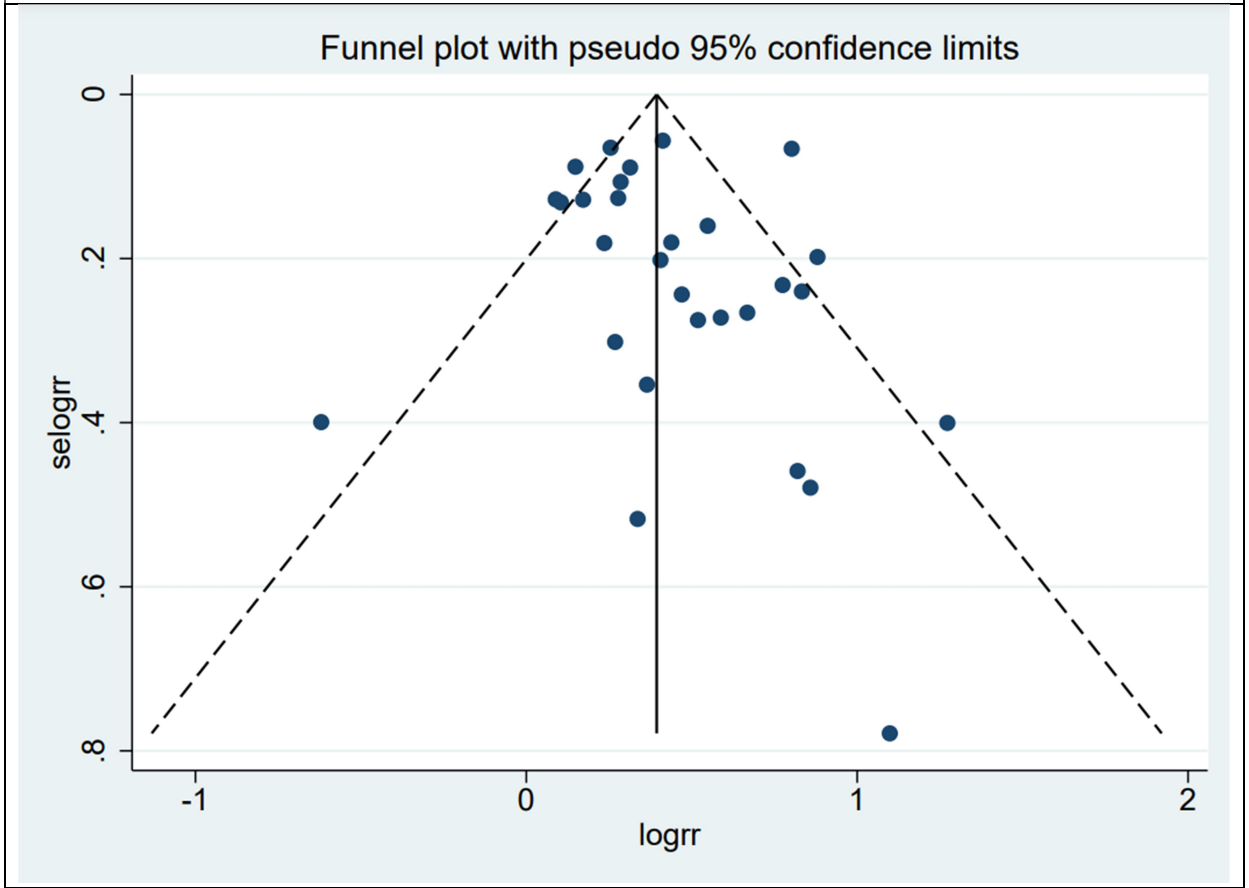
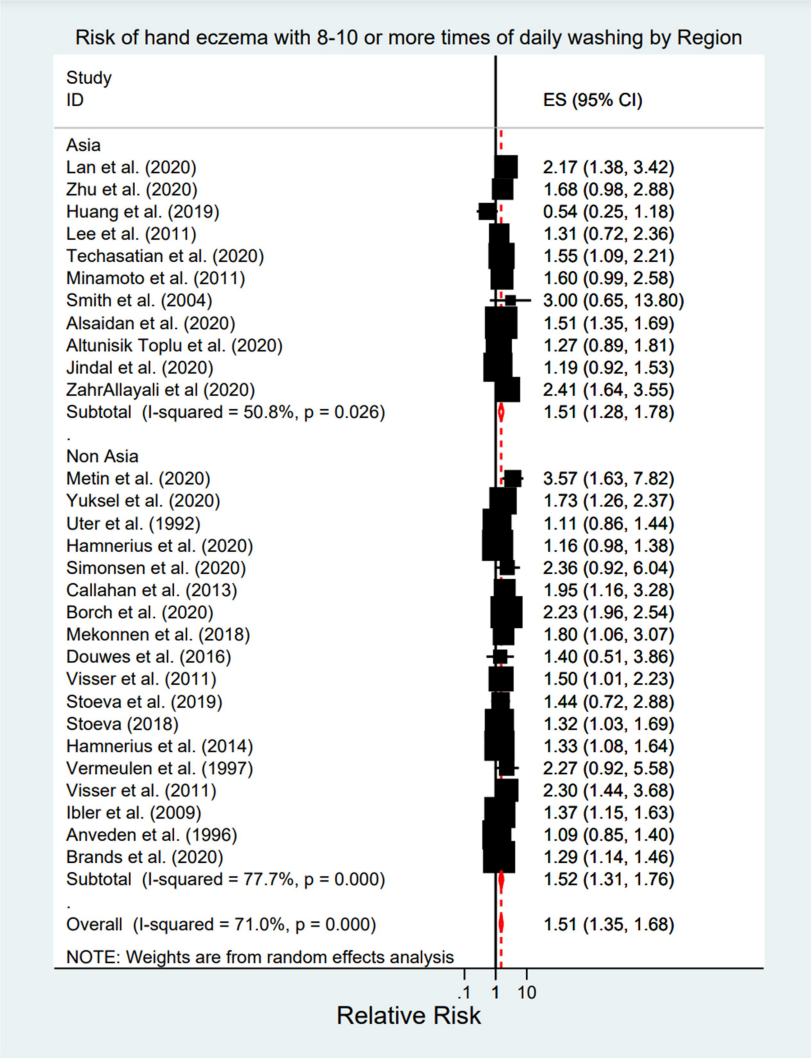


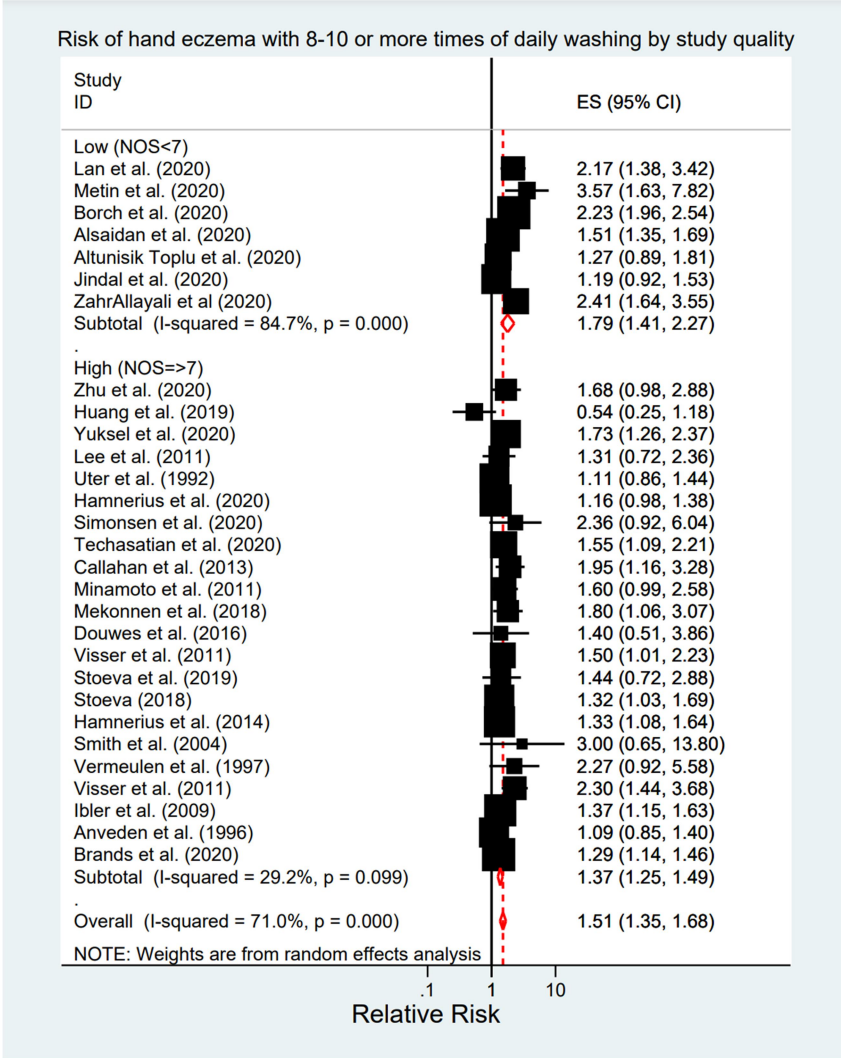
Figure S2. Forest plots of subgroup analyses of risks of hand eczema with at least 8-10 times of daily handwashing versus < 8-10 times.

(a) Geographical region (Asia vs Non-Asia); (b) Quality of study (NOS ≥ 7)

(a)



(b)



ES, effect estimate; CI, confidence interval

Figure S3. Funnel plot of studies evaluating risks of hand eczema with at least 15-20 times of daily handwashing.

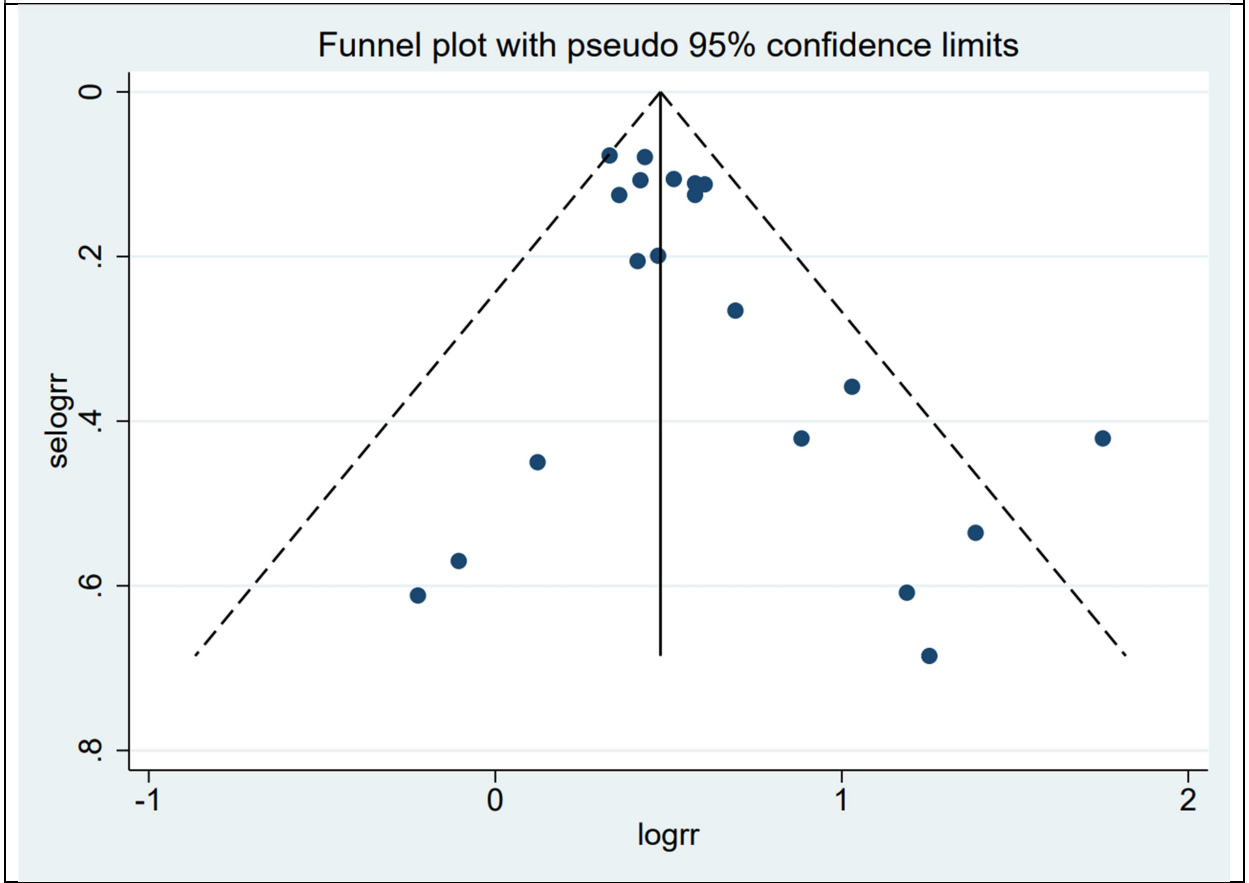
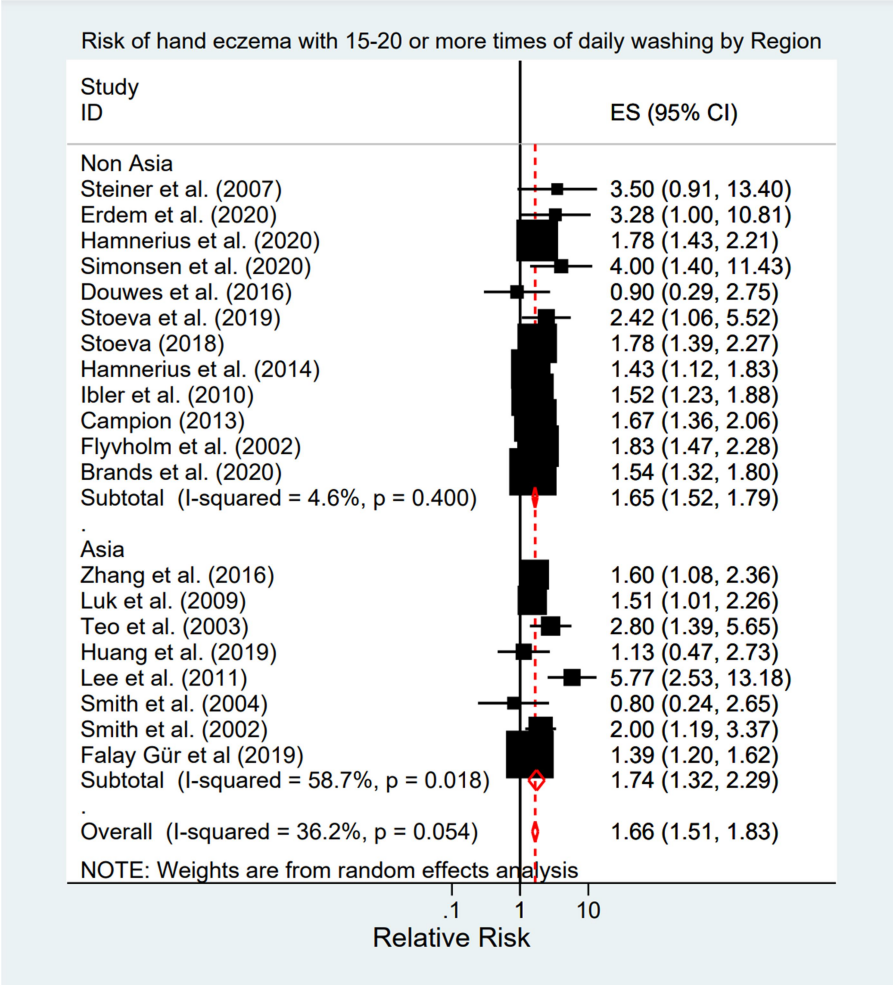


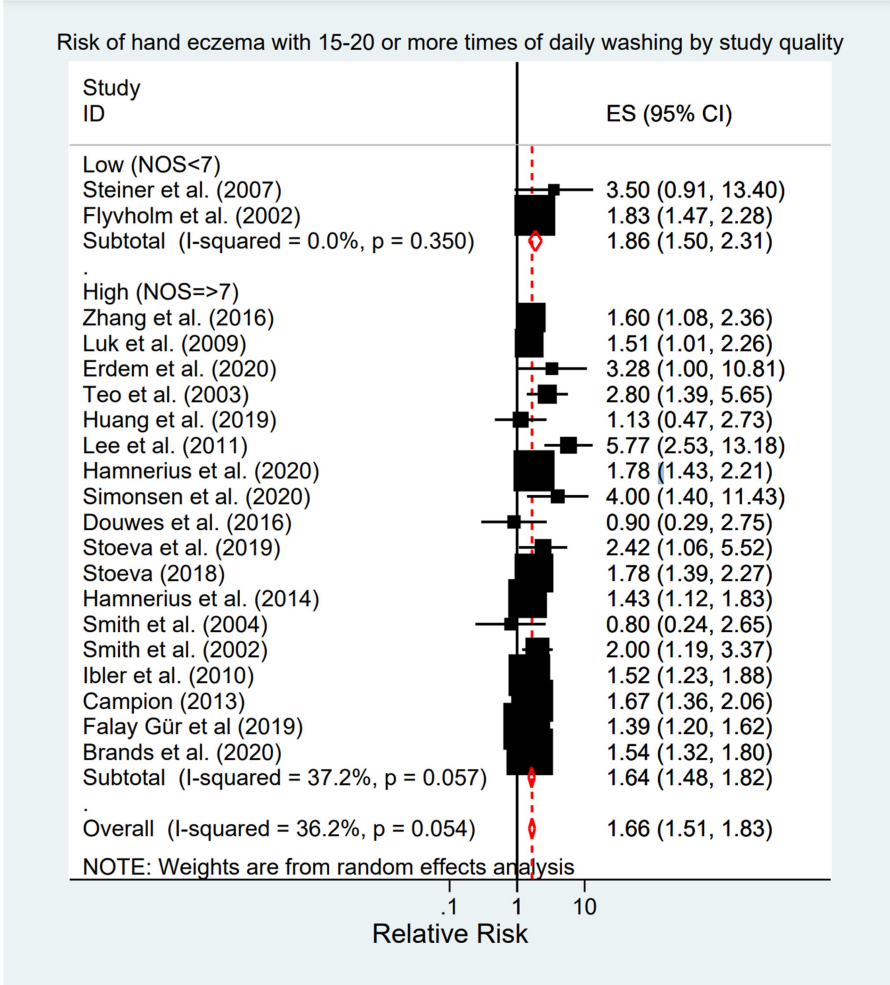
Figure S4. Forest plots of subgroup analyses of risks of hand eczema with at least 15-20 times of daily handwashing versus < 15-20 times.

(a) Geographical region (Asia vs Non-Asia); (b) Quality of study (NOS ≥ 7)

(a)



(b)



ES, effect estimate; CI, confidence interval

Figure S5. Funnel plot of studies evaluating risks of hand eczema with wet work.

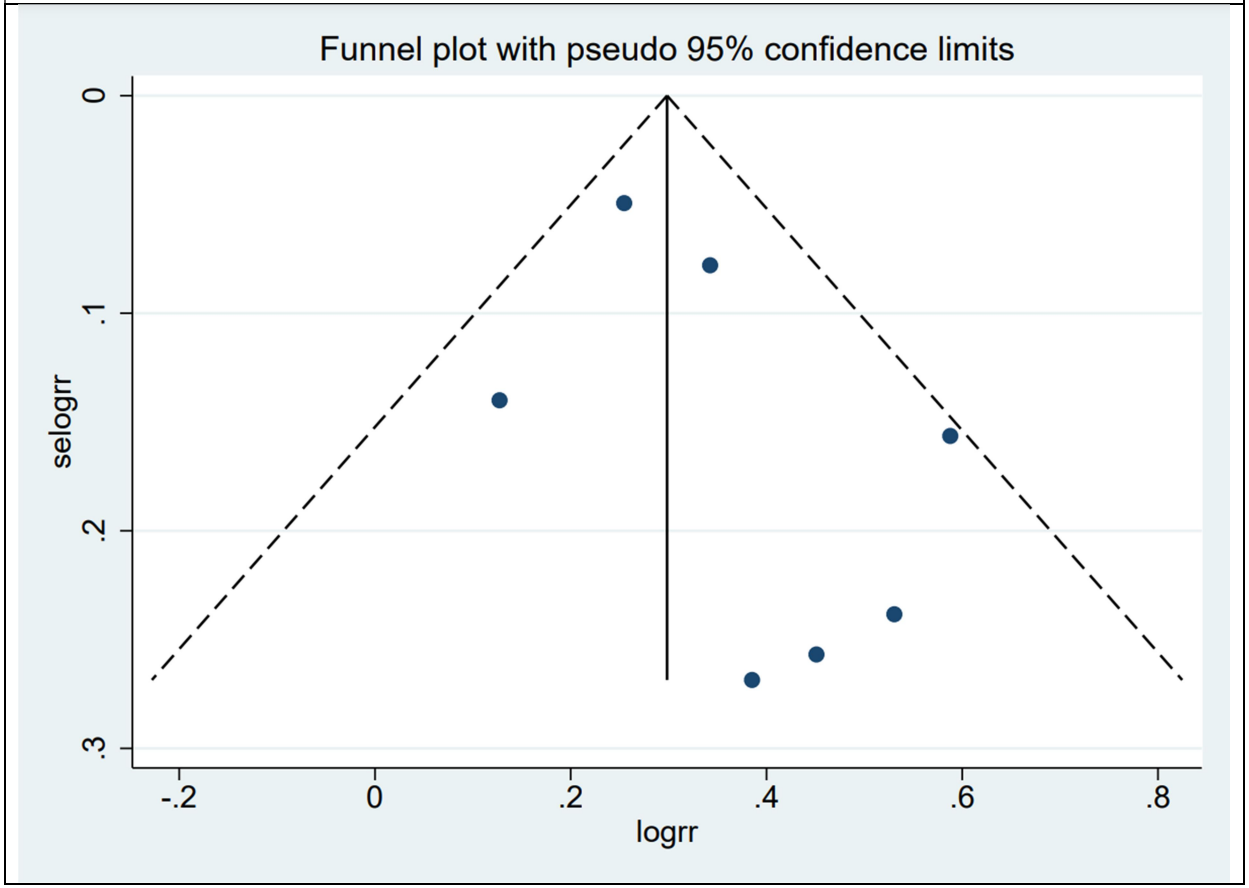


Figure S6. Funnel plot of studies evaluating risks of hand eczema with alcohol hand rub.

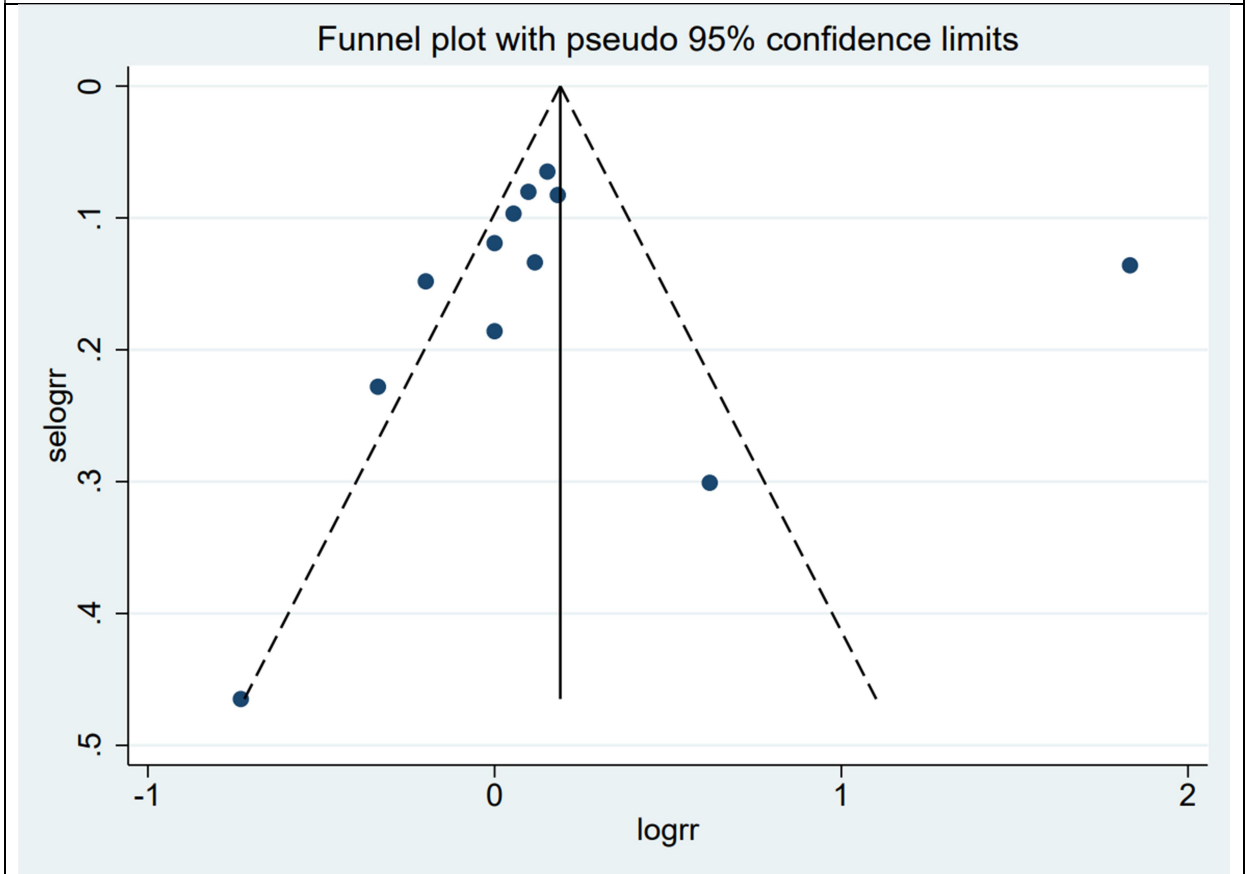


Table S1. Search strategies for MEDLINE via PubMed, EMBASE and Cochrane library.		
MEDLINE via PubMed	1981 – 10 April 2022	(Eczema[MeSH Terms] OR Dermatitis, Eczematous OR Skin Diseases, Eczematous[MeSH Terms] OR Eczematous Disorders OR Eczematous Skin Diseases OR Hand Dermatoses[MeSH Terms] OR Hand Dermatosis) AND (Hand Hygiene[MeSH Terms] OR "Hand Disinfection" or "Hand Washing" or "Wet Work" or "Wet Exposure")
EMBASE	1974 – 8 April 2022	(eczema.mp. or exp eczema/ or exp hand eczema/) AND (hand hygiene.mp. or exp hand washing/ OR wet work.mp.)
Cochrane	*EBM Reviews - Cochrane Central Register of Controlled Trials* – January 2022 *EBM Reviews - Cochrane Database of Systematic Reviews* - 2005 to April 6, 2022 *EBM Reviews - Cochrane Clinical Answers* – March 2022 *EBM Reviews - Cochrane Methodology Register* - 3rd Quarter 2012	(eczema and (hand hygiene or wet work)).mp. [mp=ti, ot, ab, sh, hw, kw, tx, ct]