Facial dermatoses induced by face masks: A systematic review and meta-analysis of observational studies

Lim Yi Shen Justin\(^1,2\)  |  Yik Weng Yew\(^1,3\)

\(^1\)Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore  
\(^2\)Tan Tock Seng Hospital, Singapore  
\(^3\)National Skin Centre, Singapore

Correspondence  
Yik Weng Yew, National Skin Centre, 1 Mandalay Road, Singapore 308205.  
Email: yikweng.yew@gmail.com

Abstract  
The use of masks for infection control was common in the COVID-19 pandemic. As numerous cross-sectional studies have suggested a link between the use of such masks and various facial dermatoses, a systematic review and meta-analysis of published studies was conducted to evaluate this association, as well as potential risk factors for the development of such facial dermatoses. Observational studies were searched for in MEDLINE, EMBASE and the Cochrane Central Register. Thirty-seven observational studies with a total of 29,557 study participants were identified. This study was performed according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 checklist and quality was assessed via the Newcastle-Ottawa Quality Assessment Scale. Overall prevalence of facial dermatoses was 55%. Individually, acne, facial dermatitis, itch and pressure injuries were consistently reported as facial dermatoses, with a pooled prevalence of 31%, 24%, 30% and 31%, respectively. Duration of mask-wear was the most significant risk factor for the development of facial dermatoses (95% CI: 1.31–1.54, \(p < 0.001\)). Overall, facial dermatoses associated with mask wear are common, and consist of distinct entities. They are related to duration of use. Appropriate and tailored treatment is important to improve the outcomes for these affected patients.

KEYWORDS  
acne, face mask, facial eczema, itch, meta-analysis, systemic review

1 | BACKGROUND

The COVID-19 global pandemic has plagued us for over 2 years now,\(^1\) and has dramatically altered many of our ways of life.\(^2\) Among other things, due to the high infectivity and virulence of this respiratory pathogen,\(^3\) the use of facial masks as an effective way to limit its spread\(^4\) has become commonplace, not only in high-risk healthcare settings among healthcare workers (HCWs) who must wear personal protective equipment (PPE) to protect themselves and their patients from the virus, but even in the community setting, due to fears of contracting this disease, social responsibility and sometimes government mandate. With the increased adoption of face masks worldwide, there have been numerous complaints of various facial dermatoses attributed to the prolonged use of facial masks; terms such as ‘maskne’ have even been coined to describe acne mechanica from prolonged mask-wear. Over these past 2 years, many small cross-sectional studies on this phenomenon have been performed. However, their findings are distinct, and do not always correlate. While we hypothesize that facial dermatoses induced by face masks are extremely prevalent, and that possible risk factors could include duration of mask wear, type of mask worn, the climate in which the study is performed and the occupation of the target group, among others, currently, updated epidemiological data to statistically quantify this phenomenon and elucidate the actual effect of these hypothesized risk factors is lacking. Hence, to better understand the various adverse skin pathologies induced by face masks, to quantify the extent and the severity of this
problem and to determine the risks factors for facial dermatoses induced by masks, we performed a large-scale systematic review and meta-analysis to quantitatively evaluate the problem of skin issues arising from protective mask wearing.

2 | METHODS

The Preferred Reporting Items for Systematic reviews and Meta-Analyses 2020 27-item checklist⁵ was followed in conducting this study. A systematic and quantitative synthesis of all studies that evaluated the relationship between the use of facial masks and the prevalence or incidence of various dermatological conditions and symptoms affecting the face was planned a priori.

2.1 | Search strategy

A comprehensive database search was performed using Medline, EMBASE and the Cochrane Central Register. Our search strategy is detailed in Table S1. A protocol was not registered for this meta-analysis but the methodology was determined a priori.

The search was limited to English language studies published from inception to March 20, 2022. All abstracts were evaluated based on the inclusion criteria to determine eligibility for meta-analysis. Additional studies were identified from manual searches of references in retrieved articles. Unpublished data was not included in this meta-analysis.

2.2 | Selection of articles

The following inclusion criteria were used to select original studies for the analysis: cross-sectional, case-control or cohort study design; analysis of the prevalence of signs and symptoms of facial dermatoses after the use of facial masks. Studies would need to provide sufficient information, such as the sample size, the pooled prevalence of facial dermatoses and/or the prevalence of individual facial dermatoses including acne, facial dermatitis, itch and/or pressure injury in the study population, so that the corresponding standard errors could be calculated. Studies which did not specify the location of dermatitis or itch were excluded as some of these studies merged the statistics for facial dermatitis and hand dermatitis induced by hand washing or alcohol scrubs. Studies which included only patients with existing facial dermatoses or only patients who visited specialized clinics that exclusively evaluated occupational dermatoses were excluded, as these populations were considered to be non-representative.

Two reviewers (L.Y.S.J., Y.Y.W.) independently reviewed the titles and abstracts of these articles. Based on the inclusion criteria and information from abstracts, eligible articles were identified for full-text review. Full-length articles were then reviewed independently to determine their eligibility for inclusion in the meta-analysis. Any disagreements were resolved by consensus.

2.3 | Data extraction

Reviewers independently extracted the data from selected studies using a standardized data extraction form. Relevant information extracted, if available, included the year of publication, country of study, study design, sample size, characteristics of the study population, age of participants, the pooled prevalence of facial dermatoses, the prevalence of acne, dermatitis, itch or pressure injury in the study population, the method used to evaluate these facial dermatoses, the duration for which masks were worn and the type of mask worn. Exposure in terms of use of facial masks was based on self-reported use of any type of mask (cloth, surgical, N95, etc.) on a regular basis.

The quality of the studies was assessed via the Newcastle-Ottawa Quality Assessment Scale,⁶ adapted for cross-sectional studies. Three main categories are included in this scale: selection of sample, comparability of samples and assessment of outcome. Within the ‘selection of sample’ category, values of 0 or 1 were assigned to the four following sub-categories: representativeness of the sample, sample size, non-respondents and ascertainment of the exposure, for a maximum score of 4 points. Within the ‘comparability of samples’ category, values of 0, 1 or 2 were assigned based on whether the study controlled for duration of mask wear, which was deemed to be the most important factor, and on whether the study controlled for any other important factor, such as occupation or type of mask, for a maximum score of 2 points. Within the ‘assessment of outcomes’ category, values of 1 or 2 were assigned based on whether the outcome was ascertained via self-report or via professional assessment respectively, and an additional value of 0 or 1 was assigned based on whether statistical analysis was adequately performed, for a maximum score of 3 points. Studies with a total quality score of 0–6 were considered lower quality, while those with a score of 7–9 were considered higher quality. Any differences in scores were adjudicated by consensus.

Subsequently, the GRADE system⁷ was used to assess the confidence in risk estimates as high, moderate, low or very low, based on explicit criteria, including study design, risk of bias, imprecision, inconsistency and magnitude of effect. Two reviewers (L.Y.S.J., Y.Y.W.) independently reviewed the risk of bias in these articles. Any disagreements were resolved by consensus.

2.4 | Meta-analysis

Few studies provided 95% confidence intervals (CIs) for prevalence. Standard error was calculated for each study by assuming prevalence as a Bernoulli random variable \( p \), with variance being equal to \( p(1 – p) \). Random-effects models of DerSimonian and Laird were used to estimate pooled prevalences of facial dermatoses related to the use of face masks, owing to heterogeneity between studies \( \left( I^2 > 25\% \right) \). Prevalences and 95% CIs were presented in forest plots. Random-effects meta-regression and stratified meta-analysis were further performed to determine the relative risk of facial dermatoses related to mask wear based on the duration of mask wear and the type of mask worn.
The prevalences of facial dermatoses related to mask wear were also calculated, and stratified based on occupation and region, to assess the burden of skin problems due to mask-wearing during the pandemic. These additional sub-analyses were also planned a priori, and performed if there were three or more studies from which data could be extracted. A two-sided $p$ value less than 0.05 was considered statistically significant. Statistical analyses were performed using STATA software (version 13.0, StataCorp).

3 | RESULTS

3.1 | Search results

A search using Medline, EMBASE and the Cochrane Central Register yielded a total of 2061 articles, as shown in Figure 1. Of the 1775 articles (after removing duplicate studies) initially identified, 55 studies were selected, after reviewing both the titles and abstracts, based on the prescribed inclusion criteria. Two more articles were identified via relevant citations from some of the full-text articles. After assessing full-length articles, 20 studies were excluded for the following reasons: did not provide usable statistics8–10 ($n = 3$), characterized the dermatoses poorly or did not specify location of lesions ($n = 14$), only included patients presenting to dermatological clinic for mask-related complaints ($n = 1$), all patients had pre-existing facial dermatoses26,27 ($n = 2$). After these exclusions, 37 published studies were included in the meta-analysis.28–64

3.2 | Study characteristics

The 37 observational studies were published from 2004 to 2022, with the majority being published in 2020 after the onset of the global pandemic, and one being published in 2004 during the SARS pandemic39 during which HCWs had similar PPE requirements. Of these 37 studies, all were cross-sectional studies.
| Study | Year | Country | Study design | Study participants (n) | Mean age (years) | Main facial dermatoses reported | Assessment of mask usage | Assessment of facial dermatoses | Occupation | Other comparisons made | Quality score | Quality assessment |
|-------|------|---------|-------------|------------------------|----------------|-------------------------------|--------------------------|-----------------------------|------------|----------------------|--------------|-------------------|
| Aloweni et al. | 2022 | Singapore | Cross-Sectional | 592 | 35.4 | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | Type of mask | 7 | High quality |
| Altun and Topaloglu | 2021 | Turkey | Cross-Sectional | 101 | 30 | Acne | Self-reported questionnaire | Dermatological consultation | HCWs | Type of mask | 8 | High quality |
| Battista et al. | 2020 | Italy | Cross-Sectional | 381 | 35 | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | Overall Population | Duration of mask wear (6 h), type of mask | 6 | Low quality |
| Caglar et al. | 2020 | Turkey | Cross-Sectional | 315 | 31.6 | Dermatitis | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Chaiyabutr et al. | 2020 | Thailand | Cross-Sectional | 1231 | Not given | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Dermatological consultation | Overall Population | Duration of mask wear (4 h), type of mask | 6 | Low quality |
| Christopher et al. | 2020 | Indonesia | Cross-Sectional | 200 | 27 | Acne, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Cilibier et al. | 2021 | Europe | Cross-Sectional | 8077 | 32 | Itch | Self-reported questionnaire | Self-reported questionnaire | Overall Population | 5 | Low quality |
| Daye et al. | 2020 | Turkey | Cross-Sectional | 440 | 33.5 | Acne | Self-reported questionnaire | Self-reported questionnaire | HCWs | 6 | Low quality |
| Deshpande et al. | 2020 | India | Cross-Sectional | 230 | Not given | Itch | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Devi et al. | 2021 | India | Cross-Sectional | 220 | 34.6 | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | Type of mask | 7 | High quality |
| Foo et al. | 2004 | Singapore | Cross-Sectional | 307 | 32.4 | Acne, dermatitis, itch | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Gao et al. | 2021 | UK | Cross-Sectional | 805 | 35.3 | Acne, dermatitis, pressure injury | Self-reported questionnaire | Dermatological consultation | HCWs | 5 | Low quality |
| Gurlek et al. | 2022 | Turkey | Cross-Sectional | 297 | Not given | Acne, dermatitis, itch | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Harnnrius et al. | 2021 | Sweden | Cross-Sectional | 751 | 46 | Acne, dermatitis, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 6 | Low quality |
| Hu et al. | 2020 | China | Cross-Sectional | 61 | 33.2 | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Inan Doğan and Kaya | 2020 | Turkey | Cross-Sectional | 150 | 28.6 | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Dermatological consultation | Overall Population | Duration of mask wear (4 h), type of mask | 5 | Low quality |
| Jiang et al. | 2020 | China | Cross-Sectional | 4306 | 32.5 | Pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 8 | High quality |
| Jose et al. | 2021 | India | Cross-Sectional | 137 | 30.4 | Dermatitis, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 8 | High quality |
| Krajewska et al. | 2020 | Poland | Cross-Sectional | 1156 | 40.5 | Itch | Self-reported questionnaire | Self-reported questionnaire | Overall Population | Duration of mask wear (4 h), type of mask | 7 | High quality |
| Kumar and Singh | 2020 | India | Cross-Sectional | 423 | 29 | Acne | Self-reported questionnaire | Self-reported questionnaire | HCWs | 5 | Low quality |
| Lai et al. | 2020 | China | Cross-Sectional | 542 | Not given | Dermatoses in general | Self-reported questionnaire | Self-reported questionnaire | HCWs | Duration of mask wear (6 h) | 8 | High quality |
| Marraha et al. | 2021 | Morocco | Cross-Sectional | 273 | 34 | Dermatitis, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs | 7 | High quality |
| Metin et al. | 2020 | Turkey | Cross-Sectional | 526 | 34 | Acne, dermatitis | Self-reported questionnaire | Self-reported questionnaire | HCWs | 5 | Low quality |
| Study | Year  | Country       | Study design        | Study participants (n) | Mean age (years) | Main facial dermatoses reported | Assessment of mask usage | Assessment of facial dermatoses | Occupation | Other comparisons made | Duration of mask wear (h), type of mask | Quality score | Quality assessment |
|-------|-------|---------------|---------------------|------------------------|------------------|-------------------------------|------------------------|-------------------------------|------------|-----------------------|----------------------------------------|--------------|----------------------|
| Niesert et al. | 2021 | Germany       | Cross-Sectional 550 | 550                    | 46               | Dermatitis, itch               | Self-reported questionnaire | Self-reported questionnaire | Overall Population          |           | 5                    | Low quality                           |
| Park et al.    | 2021 | Korea         | Cross-Sectional 303 | Not given              | Acne, dermatitis, itch | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Type of mask               | High quality                          | 7            |                       |
| Purushot et al. | 2020 | India         | Cross-Sectional 250 | 25.8                   | Acne, dermatitis | Self-reported questionnaire | Self-reported questionnaire | HCWs             |                       | High quality                          | 7            |                       |
| Resuello and Puyat | 2022 | Philippines   | Cross-Sectional 313 | 35.9                   | Acne, dermatitis, itch | Self-reported questionnaire | Dermatological consultation | Overall Population |           |                       | High quality                          | 7            |                       |
| Santoro et al. | 2022 | Italy         | Cross-Sectional 1184 | 43.4                   | Dermatoses in general | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Duration of mask wear (6 h), type of mask | High quality                          | 8            |                       |
| Singh et al.   | 2020 | India         | Cross-Sectional 43  | 32.8                   | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Dermatological consultation | HCWs             | Duration of mask wear (4 h), type of mask | Low quality                           | 6            |                       |
| Skriveren et al. | 2022 | Denmark       | Cross-Sectional 751 | 44.8                   | Acne, dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Duration of mask wear (6 h), type of mask | High quality                          | 7            |                       |
| Szepietowski et al. | 2020 | Poland        | Cross-Sectional 2307 | 20.2                   | Itch             | Self-reported questionnaire | Self-reported questionnaire | Overall Population |                       | Duration of mask wear (4 h), type of mask | High quality                          | 7            |                       |
| Techasatian et al. | 2020 | Thailand      | Cross-Sectional 833 | 32                     | Acne, dermatitis, itch | Self-reported questionnaire | Self-reported questionnaire | Overall Population | Duration of mask wear (4 h), type of mask | Low quality                           | 5            |                       |
| Yaqoob et al.  | 2021 | India         | Cross-Sectional 193 | 27.5                   | Acne             | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Duration of mask wear (8 h), type of mask | High quality                          | 8            |                       |
| Yuan et al.    | 2021 | China         | Cross-Sectional 275 | 30.7                   | Dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Duration of mask wear (6 h), type of mask | High quality                          | 7            |                       |
| Zaib et al.    | 2020 | Pakistan      | Cross-Sectional 300 | Not given              | Acne, dermatitis, itch | Self-reported questionnaire | Dermatological consultation | HCWs             | Type of mask               | High quality                          | 8            |                       |
| Zuo et al.     | 2020 | China         | Cross-Sectional 404 | Not given              | Dermatitis, itch, pressure injury | Self-reported questionnaire | Self-reported questionnaire | HCWs             | Duration of mask wear (4 h), type of mask | Low quality                           | 6            |                       |

Abbreviation: HCW, healthcare worker.
The 37 studies were conducted across 17 countries, including 16 in Europe (43.2%), eight in India/Pakistan (21.6%), six in South East Asia (16.2%), five in China (13.5%) and two in Korea (5.4%). All 37 studies were conducted in the adult population. Within these 37 studies, 19 (51.4%) included the pooled prevalence of any facial dermatosis, while 24 (64.9%) surveyed respondents on the presence of acne specifically, 25 (67.6%) surveyed respondents on the presence of facial dermatitis specifically, 22 (59.4%) surveyed respondents on the presence of itch or pruritus specifically and 18 (48.6%) surveyed respondents on the presence of pressure injury. Other skin changes that were infrequently reported included dry, greasy or peeling skin, hyperhidrosis, dyspigmentation, wheals and aphthous stomatitis, as well as the subjective sensations of burning and pain; statistical analysis was not performed for these complaints due to the small number of studies.

The usage of masks, type of mask worn and duration of mask-wear was self-reported in all studies. Of these, 14 studies (37.8%) further provided separated statistics for one or more facial dermatoses based on participants’ duration of mask wear and compared the prevalence of facial dermatoses between sub-populations, while 17 studies (45.9%) did the same based on the type of masks (surgical masks or respirators, e.g., N95, FFP2, FFP2, FFP3, etc.) worn by the respondents. The presence of these facial dermatoses was self-reported in 30 studies (81.1%), and diagnosed by trained dermatologists in seven studies (18.9%).

Among these studies, 27 (73.0%) focused solely on healthcare workers (HCWs), while 10 (27.0%) focused on the overall population, and included participants from the general public. However, it was noted that a few of these studies still included responses from healthcare professionals, perhaps due to convenient sampling.

The quality of the studies was also assessed via the Newcastle-Ottawa Quality Assessment Scale. Among the studies, 14 (37.8%) were rated as low quality (score of 0–6) and 23 (62.2%) were rated as high quality (score of 7–9).

Table 1 summarizes the study population characteristics and the characteristics of the studies performed.

### 3.3 Pooled prevalence of facial dermatoses associated with mask wear

Pooled meta-analysis of the prevalence of facial dermatoses associated with mask wear was determined by using random-effects weighting owing to heterogeneity ($I^2 = 96.7\%–99.1\%$). Among the 19 studies that reported the overall prevalence of any facial dermatoses, the pooled prevalence of facial dermatoses as a whole was 55% (95% CI, 46%–63%).

Subsequently, the overall prevalence of individual facial dermatoses was calculated. The facial dermatoses focused on in this meta-analysis were acne, dermatitis, pruritus and pressure injury since they were the most consistently reported facial dermatoses among the studies that met the inclusion criteria.

In the 24 studies that included acne, the pooled prevalence of acne was 31% (95% CI: 26%–37%). In the 25 studies that included facial dermatitis, the pooled prevalence of facial dermatitis was 24% (95% CI: 20%–29%). In the 22 studies that included itch, the pooled prevalence of itch was 30% (95% CI: 26%–34%). Finally, in the 18 studies that included pressure injuries, the pooled prevalence of pressure injuries was 31% (95% CI: 26%–37%). Figure 2 summarizes the above results.

### 3.4 Risk factors for developing facial dermatoses

Subsequently, the relative risk of developing various facial dermatoses due to duration of mask wear and type of mask worn was calculated, as these were commonly reported risk factors for facial dermatoses in the studies which were found to be eligible for this meta-analysis. Studies were also stratified according to the different characteristics of their study populations, to ascertain the stratifying factors affecting the prevalence of facial dermatoses in different sub-groups. These sub-groups were divided based on occupation and the region in which the study was conducted.

#### 3.4.1 Duration of mask wear

The pooled prevalence of facial dermatoses and the prevalence of acne, dermatitis and itch was compared between different sub-groups of respondents with different durations of mask exposure. For this comparison, only studies that provided data on the prevalence of these dermatoses for both the sub-group that wore masks for less than 4–6 h and the sub-group that wore masks for more than 4–6 h were included, such that the relative risk could be calculated within the study. There was insufficient data for analysis of the prevalence of pressure injury between different duration of mask wearing.

![Figure 2](image-url) Prevalence of facial dermatoses in general, and individual facial dermatoses that are attributed to the use of face masks
Pooled analysis of eight studies showed that the overall relative risk of developing any facial dermatosis in the population which used face masks for above 4 to 6 h was significantly higher at 1.42 (95% CI: 1.31–1.54, \(p < 0.001\)), compared to the population which used face masks for less than four to six hours.

Subsequently, the relative risk of developing individual facial dermatoses in the population which used face masks for above four to six hours was calculated. Pooled analysis of four studies revealed that the relative risk of developing acne in the population which used face masks for above four to six hours was 1.27 (95% CI: 0.79–2.04, \(p = 0.329\)). Pooled analysis of three studies showed that the relative risk of developing dermatitis in the population which used face masks for above four to six hours was 1.47 (95% CI: 1.05–1.69, \(p = 0.254\)). Finally, pooled analysis of four studies revealed that the relative risk of developing facial itch in the population which used face masks for above four to six hours was 1.38 (95% CI: 1.01–1.89, \(p = 0.041\)). Figure summarizes the above results.

### 3.4.2 Type of mask worn

Subsequently, the pooled prevalence of facial dermatoses and the prevalence of acne, dermatitis and itch was compared between different populations which used different types of mask. Surgical masks and respirators were the focus of this comparison, as they were the more commonly used types of mask within the papers analysed. For this comparison, only studies that provided data on the prevalence of these dermatoses for both the sub-group that wore respirators and the sub-group that wore surgical masks were included, such that the relative risk could be calculated within the study. There was insufficient data for analysis of the prevalence of pressure injury between different duration of mask wearing.

Seventeen studies provided sufficient data for pooled analysis of the relative risks of developing any facial dermatoses, and acne, facial dermatitis or itch individually from wearing respirators compared to surgical masks (Figure 4). Statistical analysis showed no significant differences (\(p > 0.05\)) in the relative risks of developing any facial dermatoses in patients who used surgical masks compared to respirators.

### 3.4.3 Occupation

Subsequently, the prevalences of facial dermatoses as a whole, or acne, dermatitis or itch in studies that only included healthcare workers were
| Outcome                  | Quality assessments | Number of studies | Study design | Risk of bias | Inconsistency | Indirectness | Imprecision | Number of patients with respective dermatoses | Effect | Relative risk (95% CI) | Quality |
|-------------------------|--------------------|------------------|--------------|--------------|---------------|--------------|-------------|-------------------------------------------|--------|------------------|---------|
| Pooled facial dermatoses | 8                  | Observational    | Serious      | Serious      | Not serious   | Not serious  | 6433/9567 (67.2%) | 2537/5402 (46.7%) | 1.42 (1.31–1.54) | Low    |
| Acne                    | 4                  | Observational    | Serious      | Serious      | Not serious   | Serious      | 255474 (53.8%) | 161431 (37.4%) | 1.27 (0.79–2.04) | Very low|
| Dermatitis              | 3                  | Observational    | Serious      | Not serious  | Serious       | Serious      | 161419 (38.4%) | 101403 (25.1%) | 1.47 (1.05–1.69) | Very low|
| Itch                    | 4                  | Observational    | Serious      | Not serious  | Not serious   | 4831265 (38.2%) | 6222901 (21.4%) | 1.38 (1.01–1.89) | Low    |
and that there is great value in undertaking further studies conducted in Asian countries. There were no significant differences in the stratified prevalence of facial dermatoses as a whole, and acne, dermatitis, facial itch and pressure injuries individually, between studies conducted in different regions (Figure S2).

3.4.5 | Quality

The proportion of the various facial dermatoses was also compared between the studies we rated as low quality and the studies we rated as high quality. Overall, the prevalence of facial dermatoses as a whole, and acne, dermatitis, facial itch and pressure injuries individually, were similar between both categories (Figure S3).

3.4.6 | Grade assessment

The confidence in the estimates for the risk of facial dermatoses due to prolonged mask-wear and the type of mask were assessed in accordance with the criteria outlined in the GRADE system. All studies were cross-sectional studies, which start as low confidence. The risk of bias was assessed to be serious as due to the potential for responder bias in any survey which participants could voluntarily participate in, which is how most studies included in this meta-analysis were conducted. There was also inconsistency in the findings, in that there was perceptible heterogeneity on visual inspection. The risk of imprecision was also rated as serious in studies involving acne or dermatitis, as the facial dermatoses were not professionally diagnosed in most studies, and were deemed to be morphologically similar and hence easily confused by the layperson. The overall grade assessment of duration of mask wear and the type of masks as risk factors for facial dermatoses is hence ‘Low’ for the relationship between the duration of mask wear and the development of facial dermatoses in general or itch, and ‘Very Low’ for the other relationships. These assessments are summarized in Table 2.

4 | DISCUSSION

This meta-analysis quantitatively evaluate the prevalence of the various distinct adverse skin reactions associated with the usage of face masks. Our study, after analysing data from these 37 reports with a total of 29 557 subjects, has found that the prevalence of facial dermatoses that could be attributed to mask-wear was common, affecting over half of this large study population. Moreover, the individual facial dermatoses, including acne, facial dermatitis, itch and pressure injury are all relatively prevalent in people who use face masks, each affecting almost a third of their respective study population. The prevalence of face-mask-induced facial dermatoses in our meta-analysis suggests that this problem is likely to be under-reported, and that there is great value in undertaking further research in this area.

This meta-analysis revealed that a prolonged duration of mask wear was the main statistically significant risk factor for the development of all facial dermatoses, including acne, dermatitis and itch. This finding is not surprising, since prolonged exposure to any irritant would likely cause an increase in the prevalence of symptoms. However, our meta-analysis shows that even exposure to face masks for as short as 4 h a day can lead to facial dermatoses; this level of exposure would be far below the average duration that people wear masks in countries where mask-wearing is mandated. This finding also suggests that in professions that require prolonged mask-wear, especially healthcare, there is a role in instituting regular breaks to temporarily remove PPE, to reduce the time spent using facial PPE in a single stretch and hence reducing their risk of developing facial dermatoses.

On the other hand, there was insufficient evidence to show that respirators, such as N95 masks, cause a statistically significant increased risk for developing any facial dermatoses, as compared to surgical masks. This suggests that although using N95 masks is, anecdotally, significantly less comfortable than using surgical masks, the extent of facial dermatoses caused by surgical masks cannot be belittled. It has been shown the materials in surgical masks can cause contact dermatitis. Surgical masks can also cause the accumulation of moisture, which predisposes wearers to skin breakdown and the penetration of irritants and allergens, and is also comedogenic. Moreover, surgical masks can also cause contact dermatitis. However, it is also worth noting that there was only a single study by Skiveren et al., but with an extremely large sample size of 10 287 respondents, which suggested that surgical masks cause a higher prevalence of facial dermatoses than respirators; this may have skewed the results.

Inter-study comparisons also did not show any differences in the prevalence of any facial dermatoses that can be attributed to occupation or region. This suggests that even outside of high risk settings such as healthcare, individuals in the general population are still using face masks for prolonged periods, which are sufficient to cause a significant amount of dermatological morbidity. Moreover, it appears that face masks inducing facial dermatoses is a global problem, and is not isolated to a single region with a unique climate.

This meta-analysis has some limitations. First, most studies rely on self-reporting of both the symptoms of facial dermatoses and the duration of mask wear. Hence, the results may be confounded by the inability of respondents to accurately diagnose their dermatological conditions, and are also subject to recall bias. Second, the results of this meta-analysis may have been influenced by publication bias.
(Figure S4). For instance, studies with small sample size and low prevalence if facial dermatoses from mask-wearing may not have been published. Hence, the actual burden of facial dermatoses could potentially be misrepresented. Moreover, this analysis was limited to only studies published in the English language, and did not include unpublished studies. Third, few studies in the meta-analysis had a control group for comparison. This is understandable since many countries, as mentioned earlier, strongly encourage the use of masks, and it would be unethical to expose a control group to a higher risk of contracting COVID-19; nevertheless, this decreases the statistical power of aggregated intra-study comparisons. Finally, although type of mask, occupation and region were not shown to influence the prevalence of facial dermatoses, there could still be further confounding variables that could account for the gross heterogeneity between the studies in this meta-analysis. Hence, there is definitely a role for additional interventional studies to determine, for example, if the types of masks worn or any adjunctive measures are useful in mitigating the risk of facial dermatoses.

Additionally, while conducting this meta-analysis, it was noted that some studies did not further characterize mask-related facial dermatoses into specific dermatological diagnoses. Instead, these studies employed umbrella terms such as ‘mask-related skin conditions’, especially while elucidating risk factors for these facial dermatoses. However, acne, facial dermatitis, itch and pressure injuries are all distinct identities that are all commonly reported in the literature included in this meta-analysis, and there are yet other less-reported facial dermatoses related to the usage of masks. These multitudinous facial dermatoses have distinct pathophysiological mechanisms, and are hence also likely to have unique risk factors. Hence, these discrete dermatological diagnoses should be better distinguished, and more information should be elucidated in further studies to ascertain the risk factors for each of these unique dermatological conditions.

Moreover, formal dermatological review of reported facial dermatoses secondary to mask use was uncommon among studies conducted. Clinical information on the exact facial dermatoses induced by face masks may hence be inaccurate, since these pathologies may all appear similar to the layperson. As discussed previously, the specific dermatological pathologies that can result from the use of face masks are varied and distinct. Thus, targeted recommendations for reducing the prevalence of specific face-mask-related facial dermatoses are needed, especially since there might be interactions between management of co-existing facial dermatoses. During this COVID-19 pandemic, telemedicine might be an especially valuable tool to provide accurate diagnoses while minimizing the need for interpersonal interaction and the resultant spread of this virus; in dermatology, it has already been shown to be a reliable consultation tool.

In summary, while the pandemic seems to be improving and there has been gradual easing of mask wearing requirements across the globe, face masks will likely continue to be part of our daily lives for some time to come as part of personal protection. Our meta-analysis has shown that several distinct facial dermatoses can be induced by the use of masks, some of which are prevalent, and could potentially be under-reported. Moreover, these dermatoses likely affect not only healthcare workers, but also the general public. Hence, there could be value in conducting further research to better understand these distinct clinical entities that comprise ‘mask-induced facial dermatoses’, and provide recommendations for some of these clinical entities. This way, we can continue to be protected by face masks as part of infection control, while mitigating their deleterious effects on the skin underneath.

**AUTHOR CONTRIBUTIONS**

Lim Yi Shen Justin: Conceptualization; methodology; data curation; software; formal analysis; investigation; validation; writing – original draft; writing – review and editing. Yik Weng Yew: Conceptualization; investigation; methodology; validation; software; formal analysis; data curation; supervision; writing – review and editing; writing – original draft.

**CONFLICT OF INTEREST**

The authors declare no conflict of interest.

**DATA AVAILABILITY STATEMENT**

The data that support the findings of this study are openly available in PubMed at https://pubmed.ncbi.nlm.nih.gov/.

**ORCID**

Lim Yi Shen Justin: https://orcid.org/0000-0003-3919-4343

**REFERENCES**

1. WHO Director-General’s Opening Remarks at the Media Briefing on COVID-19. World Health Organization. 2021. Accessed July 8, 2021. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020

2. 2019 Novel Coronavirus Prevention & Treatment. Centre for Disease Control and Prevention. 2021. Accessed July 8, 2021. https://www.cdc.gov/coronavirus/2019-ncov/about/prevention-treatment.html.

3. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. Lancet. 2020;395(10223):470-473. doi:10.1016/S0140-6736(20)30185-9

4. Ju JTJ, Boisvert LN, Zuo YY. Face masks against COVID-19: standards, efficacy, testing and decontamination methods. Adv Colloid Interface Sci. 2021;292:102435. doi:10.1016/j.cis.2021.102435

5. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Bmj. 2021;372:n71. doi:10.1136/bmj.n71

6. Wells GA, Shea B, O’Connell D, et al. The Newcastle-Ottawa Scale (NOS) for Assessing the Quality if Nonrandomized Studies in Meta-Analyses. https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed May 11, 2022.

7. Meader N, King K, Llewellyn A, et al. A checklist designed to aid consistency and reproducibility of GRADE assessments: development and pilot validation. Syst Rev. 2014;3(1):82. doi:10.1186/2046-4053-3-82

8. Eslanadi R, Casale F, Nourmohammadi N, et al. 28575 caring for skin during a pandemic: acute facial skin changes following mask-wearing. J Am Acad Dermatol. 2021;85(3 suppl)AB199. doi:10.1016/j.jaad.2021.06.808

9. Trepanowski N, Larson AR, Evers-Meltzer R. Occupational dermatoses among front-line health care workers during the COVID-19 pandemic: a cross-sectional survey. J Am Acad Dermatol. 2021;84(1):223-225. doi:10.1016/j.jaad.2020.08.126
24. Peres DRV, Monteiro J, Boleo-Tome JP. Medical masks’ and respirators’ pattern of use, adverse effects and errors among Portuguese health care professionals during the COVID-19 pandemic: a cross-sectional study. Am J Infect Control. 2022;50(6):618-623. doi:10.1016/j.ajic.2021.10.002

25. Uthayakumar AK, Panagou E, Manam S, et al. PPE-associated dermatoses: effect on work and wellbeing. Future Healthcare J. 2021;8(1):E67-E69. doi:10.7861/fhj.2020-0210
during the COVID-19 pandemic: a online survey study. J Tissue Viability. 2022;31(1):112-118. doi: 10.1016/j.jtv.2022.01.003

42. Hamnerius N, Ponten A, Bergendorff O, Bruze M, Bjork J, Svedman C. Skin exposures, hand eczema and facial skin disease in healthcare workers during the covid-19 pandemic: a cross-sectional study. Acta Derm Venereol. 2021;101(9):adv00543. doi: 10.2340/00015555-3904

43. Hu K, Fan J, Li X, Gou X, Li Z, Zhou X. The adverse skin reactions of health care workers using personal protective equipment for COVID-19. Medicine. 2020;99(24):e20630.

44. Inan Dogan E, Kaya F. Dermatological findings in patients admitting to dermatology clinic after using face masks during Covid-19 pandemia: a new health problem. Dermatol Ther. 2021;34:e14934.

45. Jiang Q, Liu Y, Wei W, et al. The prevalence, characteristics, and impact of dermatological complaints from 550 health care and non-health care workers in Germany. Contact Dermatitis. 2022;86(4):266-275. doi: 10.1111/cod.14022

46. Jose S, Cyriac MC, Dhandapani M. Health problems and skin damages caused by personal protective equipment: experience of frontline nurses caring for critical COVID-19 patients in intensive care units. Indian J Crit Care Med. 2021;25(2):134-139. doi: 10.5005/jp-journals-10071-23713

47. Krajewski PK, Matusiak Ł, Szepietowska M, Białynicki-Birula R, Szepietowski JC. Increased prevalence of face mask-induced itch in health care workers. Biology. 2020;9(12):451.

48. Kumar S, Singh A. Prolonged use of N95 mask a boon or bane to skin? Indian J Otolaryngol Head Neck Surg. 2021;1:4.

49. Lam J, Song Z, Xiao X, et al. Skin damage among health care workers managing coronavirus disease-2019. J Am Acad Dermatol. 2020;82(5):1215-1216. doi: 10.1016/j.jaad.2020.03.014

50. Marraha F, Al Faker I, Charif F, et al. Skin reactions to personal protective equipment among first-line COVID-19 healthcare workers: a survey in northern Morocco. Ann Work Expo Health. 2021;65(8):998-1003. doi: 10.1093/annweh/wxa018

51. Metin N, Turan Č, Utlu Z. Changes in dermatological complaints among healthcare professionals during the COVID-19 outbreak in Turkey. Acta Dermatovenerologica Adriat. 2020;29(3):115-122.

52. Niesert AC, Oppel EM, Nellesen T, et al. “Face mask dermatitis” due to compulsory facial masks during the SARS-CoV-2 pandemic: data from 550 health care and non-health care workers in Germany. Eur J Dermatol. 2021;31(2):199-204. doi: 10.1684/ejd.2021.4007

53. Park SJ, Han HS, Shin SH, et al. Adverse skin reactions due to use of face masks: a prospective survey during the COVID-19 pandemic in Korea. J Eur Acad Dermatol Venereol. 2021;35(10):e628-e630. doi: 10.1111/jdv.17447

54. Purushothaman PK, Priyanga E, Vaidhyaswaran R. Effects of prolonged use of facemask on healthcare Workers in Tertiary Care Hospital during COVID-19 pandemic. Indian J Otolaryngol Head Neck Surg. 2021;73(1):1-7.

55. Resuello TEM, Puyat MCA. Mask-induced facial dermatoses during the COVID-19 pandemic: a cross-sectional study in a tertiary medical center in The Philippines. JAAD Int. 2022;7:121-123. doi: 10.1016/j.jidt.2022.03.002

56. Santoro PE, Borrelli I, Gualano MR, et al. The dermatological effects and occupational impacts of personal protective equipment on a large sample of healthcare workers during the COVID-19 pandemic. Front Public Health. 2021;9:815415. doi: 10.3389/fpubh.2021.815415

57. Singh M, Pawar M, Bothra A, et al. Personal protective equipment induced facial dermatoses in healthcare workers managing coronavirus disease 2019. J Eur Acad Dermatol Venereol. 2020;34(8):e378-e380. doi: 10.1111/jdv.16628

58. Skiveren JG, Ryborg MF, Nilaussen B, Bermark S, Philipson PA. Adverse skin reactions among health care workers using face personal protective equipment during the coronavirus disease 2019 pandemic: a cross-sectional survey of six hospitals in Denmark. Contact Dermatitis. 2022;86(4):266-275. doi: 10.1111/cod.14022

59. Szepietowski JC, Matusiak Ł, Szepietowska M, Krajewski PK, Błażynicki-Birula R. Face mask-induced itch: a self-questionnaire study of 2,315 responders during the COVID-19 pandemic. Acta Derm Venereol. 2020;100(10):adv00152.

60. Techasatian L, Lebsing S, Uppala R, et al. The effects of the face mask on the skin underline: a prospective study during the COVID-19 pandemic. J Prim Care Commun Health. 2020;11:2150132720966167.

61. Yaqoob S, Saleem A, Jarulall FA, Asif A, Essar MY, Emad S. Association of acne with face mask in healthcare workers amidst the covid-19 outbreak in Karachi, Pakistan. Clin, Cosm, Investig Dermatol. 2021;14:1427-1433. doi: 10.2147/CCID.S333221

62. Yuan X, Xi H, Le Y, et al. Online survey on healthcare skin reactions for wearing medical-grade protective equipment against COVID-19 in Hubei Province, China. PLoS ONE. 2021;16:e0250869. doi: 10.1371/journal.pone.0250869

63. Naqvi ZF, Inayat S, Yaqoob N, Tahir K, Sarwar U, Muhammad F. Cutaneous impact of surgical mask versus N 95 mask during covid-19 pandemic: incidence of dermatological side effects and response of topical methylprednisolone aceponate (MTPA) treatment to associated contact dermatitis. J Pakistan Assoc Dermatol. 2020;30(4):650-655.

64. Zuo Y, Hua W, Luo Y, Li L. Skin reactions of N95 masks and medical masks among health-care personnel: a self-report questionnaire survey in China. Contact Dermatitis. 2020;83(2):145-147.

65. Yuan N, Yang WX, Lu J, Lv ZH. Investigation of adverse reactions in healthcare personnel working in level 3 barrier protection PPE to treat COVID-19. Postgrad Med J. 2021;97(1148):351-354. doi: 10.1136/postgradmedj-2020-137854

66. Diepgen TLSA. Are the incidence and prevalence of occupational skin diseases underestimated? Arbeitsmedizin Sozialmedizin Umweltmedizin. 2002;37(10):477-480.

67. Lee HC, Goh CL. Occupational dermatoses from personal protective equipment during the COVID-19 pandemic in the tropics - a review. J Eur Acad Dermatol Venereol. 2021;35(3):509-596. doi: 10.1111/jdv.16925.

68. Desai SR, Kovarič B, Brod B, et al. COVID-19 and personal protective equipment: treatment and prevention of skin conditions related to the occupational use of personal protective equipment. J Am Acad Dermatol. 2020;83(2):675-677. doi: 10.1016/j.jaad.2020.05.032

69. Trettel A, Eissing L, Augustin M. Telemedicine in dermatology: findings and experiences worldwide - a systematic literature review. J Eur Acad Dermatol Venereol. 2018;32(2):215-224. doi: 10.1111/jdv.14341

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Justin LYS, Yew YW. Facial dermatoses induced by face masks: A systematic review and meta-analysis of observational studies. Contact Dermatitis. 2022;87(6):473-484. doi: 10.1111/cod.14203