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PREVALENCE AND MICROBIOLOGICAL PROFILE OF CONTACT DERMATITIS AMONG HEALTHCARE WORKERS USING PERSONAL PROTECTIVE EQUIPMENT

Original Article

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Abstract

Background: Contact dermatitis is a frequent occupational skin disease among healthcare workers using personal protective equipment (PPE). Prolonged use during long shifts disrupts the skin barrier, causing dermatitis and increasing the risk of secondary microbial infections, an aspect poorly documented in regional settings.

Objective: To evaluate the prevalence and severity of contact dermatitis among healthcare workers using PPE during long shifts and to identify the associated microbial flora on affected skin.

Methods: A cross-sectional study was conducted over four months with 240 healthcare workers. Data were collected via questionnaires and clinical examination. Skin swabs from lesions were cultured for bacteria and fungi, with isolates identified using standard methods and antibiotic susceptibility testing.

Results: The prevalence of contact dermatitis was 38.8%, being highest among nurses (45.7%) and female staff (44.1%). Gloves (74.2%) and masks (51.6%) were the most common causes. Longer PPE use correlated with greater severity ($r=0.34$, $p<0.001$). Microbiological analysis identified *Staphylococcus aureus* in 48.4% of lesions, with 33.3% of these being Methicillin-resistant (MRSA). *Candida* species were isolated in 12.9% of cases.

Conclusion: Contact dermatitis is highly prevalent and is compounded by frequent colonization with resistant pathogens like MRSA. This underscores the need for a dual-focused intervention: preventive skin care and targeted management of microbial complications to safeguard healthcare workers and patients.

Keywords: Contact Dermatitis, Cross-Sectional Studies, Face Masks, Gloves, Healthcare Workers, Occupational Diseases, Personal Protective Equipment

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Introduction

Contact dermatitis is a common occupational skin disease that affects individuals exposed to irritants and allergens in their working environment. Healthcare workers, because of their constant exposure to gloves, disinfectants, and protective clothing, are particularly vulnerable to this condition (1). The increasing reliance on personal protective equipment (PPE) during long clinical shifts, especially in the context of infectious disease outbreaks such as COVID-19, has intensified this problem, making contact dermatitis an emerging occupational health concern in modern healthcare (2). The skin, serving as the first line of defense, is often compromised by repeated friction, occlusion, moisture accumulation, and exposure to harsh cleaning agents, all of which contribute to irritation and barrier dysfunction (3). When combined with the prolonged and frequent use of PPE, the risk of developing contact dermatitis rises considerably (4). The pathophysiology of contact dermatitis in healthcare settings can be attributed to both irritant and allergic mechanisms. Irritant contact dermatitis results from direct chemical or physical damage to the skin barrier, often caused by alcohol-based hand rubs, frequent washing, or occlusion under gloves and masks (5). Allergic contact dermatitis, on the other hand, is mediated by delayed-type hypersensitivity to allergens such as rubber accelerators in gloves, preservatives in sanitizers, or adhesives used in medical tapes and masks (6). The clinical manifestations range from dryness and erythema to painful fissures and vesicular eruptions, which may impair the ability of healthcare workers to perform essential tasks efficiently (7). Importantly, these conditions are not only physically distressing but also psychologically burdensome, as they may reduce compliance with PPE use, increase absenteeism, and negatively affect patient safety.

Several studies have highlighted the heightened prevalence of occupational contact dermatitis among healthcare professionals. Reports from the COVID-19 pandemic revealed that between 20% and 50% of healthcare workers experienced some form of skin reaction attributed to PPE use (8). Gloves and face masks were the most frequently implicated items, with reactions ranging from mild irritation to more severe dermatitis requiring medical intervention (9). In particular, long working hours, continuous use of N95 respirators, and double-gloving practices were strongly associated with skin barrier breakdown. Although these studies brought global attention to the issue, the prevalence and determinants of PPE-related dermatitis may vary considerably across regions, institutions, and work practices. The occupational implications of contact dermatitis in healthcare cannot be underestimated (10). Compromised skin integrity increases the risk of secondary infections, reduces manual dexterity, and may compel healthcare workers to modify or abandon protective measures. This in turn raises concerns not only for individual health but also for occupational safety and infection control. While institutional guidelines often emphasize hand hygiene and protective equipment, relatively less attention has been paid to skin health and prevention of dermatitis. Moisturizers, protective barrier creams, and rotation of PPE materials are among the measures shown to reduce incidence, yet compliance remains inconsistent (11).

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Identifying the magnitude of the problem within a specific population of healthcare workers is therefore crucial for informing preventive strategies and occupational health policies.

Despite the growing awareness of PPE-related dermatitis, there remains a gap in systematic, region-specific data that quantifies its prevalence among healthcare professionals. Many studies have been conducted in high-income countries during pandemic surges, but there is limited literature focusing on low- and middle-income healthcare settings where resource limitations, high patient loads, and extended working hours may exacerbate risks. Furthermore, the majority of studies emphasize anecdotal or hospital-based observations rather than structured prevalence studies with defined methodologies. This gap highlights the need for robust epidemiological research to provide evidence-based insights into the burden of contact dermatitis among frontline healthcare staff. The present study was designed to address this gap by evaluating the prevalence of contact dermatitis among healthcare workers frequently using PPE during long shifts. By adopting a cross-sectional design, the study aims to capture both the magnitude of the problem and its association with the intensity and duration of PPE use. The objective is to provide empirical data that can inform occupational health interventions, encourage preventive practices, and support the development of evidence-based policies to safeguard the dermatological health of healthcare workers.

While the clinical and epidemiological aspects of PPE-related dermatitis are increasingly documented, there is a significant lack of data on the microbiological profile of these skin lesions. The compromised skin barrier creates a potential entry point for pathogenic bacteria and fungi, increasing the risk of secondary infections which can exacerbate the condition, lead to absenteeism, and complicate treatment. Therefore, understanding the spectrum of microorganisms colonizing or infecting these sites is crucial from both a clinical and public health perspective. This study aims to bridge this gap by investigating not only the prevalence but also the microbiological characteristics of contact dermatitis among healthcare workers.

Methods

The study protocol was reviewed and approved by the KUST Ethical Committee (Approval No. KUST/Ethical Committee/2020). All procedures were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments. *Written informed consent was obtained from all participants prior to enrolment, and confidentiality of personal data was maintained throughout the study.* The study employed a cross-sectional design to evaluate the prevalence of contact dermatitis among healthcare workers who regularly used personal protective equipment (PPE) during long shifts. The research was carried out in KP, Pakistan, over a period of four months. The target population included doctors, nurses, paramedics, and ancillary staff directly engaged in patient care in hospitals and healthcare facilities where continuous PPE use was mandatory. A sample size of 240 participants was calculated using the World Health Organization sample size calculator, assuming an expected

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prevalence of 25%, a 95% confidence level, and a 5% margin of error. This sample size was further adjusted to account for a possible non-response rate of 10%, ensuring adequate statistical power. Participants were recruited through stratified random sampling to ensure representation across different cadres of healthcare workers. Inclusion criteria comprised individuals aged 20 to 60 years who had been using PPE for at least six hours per shift and for a minimum of three months prior to the study. Exclusion criteria included healthcare workers with a prior diagnosis of chronic dermatological conditions unrelated to occupational exposure, those on systemic corticosteroids or immunosuppressive therapy, and individuals unwilling to provide informed consent.

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The Thesis/Synopsis: PREVALENCE AND MICROBIOLOGICAL PROFILE OF CONTACT DERMATITIS AMONG HEALTHCARE WORKERS USING PERSONAL PROTECTION EQUIPMENTS

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Through: PROF. DR. MUHAMMAD QASIM, CHAIRMAN, DEPARTMENT OF MICROBIOLOGY, KUST
(Chairman/Director)

After fulfilling the required documents, the KUST ethical Committee, hereby approved the above tittle.

KUST Ethical Committee

Data collection was conducted using a structured, pretested questionnaire that captured demographic information, occupational details, type and duration of PPE use, and self-reported dermatological symptoms. To enhance validity, clinical examination of reported skin lesions was performed by a dermatologist to confirm the presence of contact dermatitis. The diagnosis was based on standard clinical criteria including erythema, pruritus, dryness, fissuring, and vesiculation localized to PPE contact areas. Following the clinical examination, sterile cotton swabs moistened with sterile saline were used to collect samples from the most severely affected area of the dermatitis. A control swab was also taken from a healthy, non-affected area of the skin on the same participant. The severity of dermatitis was graded using the validated Hand Eczema Severity Index (HECSI) and a Visual Analog Scale (VAS) for symptom burden, both of which have been widely used in occupational dermatology studies. The swabs were immediately transported to the laboratory for microbiological processing. They were inoculated onto Blood Agar, MacConkey Agar, and Sabouraud Dextrose Agar (SDA). The bacterial culture plates were incubated aerobically at 37°C for 24-48 hours, while fungal cultures on SDA were maintained at 25-30°C for up to one week. Bacterial isolates were identified using standard microbiological techniques including Gram staining, catalase, coagulase, and other relevant biochemical tests. Fungal isolates were identified based on colonial morphology and microscopic characteristics observed using lactophenol cotton blue stain. For significant bacterial pathogens, antibiotic susceptibility testing was performed on Mueller-Hinton agar using the Kirby-Bauer disk diffusion method as per the Clinical and Laboratory Standards Institute (CLSI) guidelines.

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The primary outcome of interest was the prevalence of contact dermatitis among healthcare workers, expressed as a proportion of the study population. Secondary outcomes included the association between dermatitis and variables such as duration of daily PPE use, type of PPE most commonly worn, frequency of hand hygiene practices, and the spectrum of associated microbial flora. Data were entered and analyzed using SPSS version 26. Continuous variables such as age, working hours, and HECSI scores were presented as means with standard deviations. Categorical variables such as gender, occupation, type of PPE used, and dermatitis prevalence were summarized using frequencies and percentages.

To evaluate associations between categorical variables, the chi-square test was applied. Independent sample t-tests and one-way ANOVA were used to compare mean HECSI scores across groups defined by hours of PPE use and type of PPE worn, as the data were normally distributed. Pearson correlation coefficients were calculated to assess the relationship between daily PPE use duration and dermatitis severity scores. A p-value of less than 0.05 was considered statistically significant. Participants with severe dermatitis were counseled and referred for dermatological care in accordance with ethical principles of beneficence and nonmaleficence. The methodological rigor of this study lay in the combination of self-reported data with clinical confirmation and microbiological analysis, thereby minimizing misclassification bias and providing a more comprehensive etiological profile. The use of standardized severity indices and laboratory protocols allowed for objective quantification of outcomes, while stratified sampling improved representativeness of different healthcare groups. The statistical approach was selected to align with the study's objective of assessing prevalence, determining associations, and characterizing microbial involvement, thus providing robust and reproducible findings.

Results

The study enrolled 240 healthcare workers from tertiary care hospitals in KP, achieving a response rate of 95.4%. The participant cohort had a mean age of 32.8 ± 7.1 years and was composed of 52.9% females and 47.1% males, with nurses representing the largest occupational group (39.2%). The analysis revealed a substantial burden of contact dermatitis, with an overall prevalence of 38.8% (n=93). This condition was more common among female staff (44.1%) and nursing personnel (45.7%), and a clear trend was observed where a longer daily duration of PPE use was associated with a higher likelihood of developing dermatitis.

An examination of the specific PPE items implicated showed that gloves were the most frequent cause, linked to 74.2% of cases, primarily affecting the hands. This was followed by masks and respirators, which were associated with 51.6% of cases, often involving facial skin. In terms of clinical impact, the majority of dermatitis cases were mild (62.4%), though a considerable proportion were moderate (28.0%) or severe (9.6%). Statistical analysis further solidified the relationship between exposure and outcome, demonstrating a significant positive correlation between the number of hours spent in PPE and the severity of the skin condition.

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Beyond the clinical presentation, microbiological analysis of the skin lesions provided crucial insights into the potential for secondary complications. Culturing of skin swabs from the affected participants revealed a diverse microbial profile. *Staphylococcus aureus* emerged as the predominant bacterium, isolated from nearly half (48.4%) of the lesions. Of significant concern, a third of these *S. aureus* isolates were identified as Methicillin-resistant (MRSA). Furthermore, fungi, predominantly *Candida* species, were present in 12.9% of the samples, highlighting the range of microorganisms colonizing the compromised skin.

In summary, these results paint a comprehensive picture of the occupational risk faced by healthcare workers. The high prevalence of contact dermatitis, its association with prolonged glove and mask use, and the frequent colonization of lesions with resistant bacteria like MRSA collectively underscore a significant threat to both workforce well-being and infection control protocols.

Table 1. Demographic characteristics of participants (n = 240)

Variable	Mean ± SD / n (%)
Age (years)	32.8 ± 7.1
Gender (Male/Female)	113 (47.1%) / 127 (52.9%)
Occupation (Doctor/Nurse/Paramedic/Ancillary)	81 (33.8%) / 94 (39.2%) / 43 (17.9%) / 22 (9.1%)
Working hours/day	9.6 ± 2.4

Table 2. Prevalence of contact dermatitis by gender and occupation

Variable	n	Prevalence (%)
Male	113	32.7
Female	127	44.1
Doctors	81	37.0
Nurses	94	45.7
Paramedics	43	34.9

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Ancillary	22	27.3

Table 3. PPE type and distribution of dermatitis (n = 93 affected)

PPE Type	Frequency (n)	Percentage (%)
Gloves (hands)	69	74.2
Masks/Respirators	48	51.6
Gowns/Aprons	18	19.4

Table 4. Severity of dermatitis among affected participants (n = 93)

Severity (HECSI classification)	Frequency (n)	Percentage (%)
Mild	58	62.4
Moderate	26	28.0
Severe	9	9.6
Mean HECSI ± SD	23.5 ± 8.4	
Mean VAS ± SD	5.6 ± 1.7	

Table 5: **Microbial Isolates from Skin Lesions of Affected Participants (n=93)**

Microbial Isolate	Frequency (n)	Percentage (%)	Notes (e.g., MRSA)
Staphylococcus aureus	45	48.4%	15 (33.3%) were MRSA
Coagulase-Negative Staphylococci	28	30.1%	
Escherichia coli	8	8.6%	
Candida spp.	12	12.9%	
Mixed Growth	22	23.7%	
No Growth	15	16.1%	

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Microbiological analysis of skin swabs from the 93 affected participants revealed a diverse microbial profile. As shown in Table 5, *Staphylococcus aureus* was the most frequently isolated bacterium, found in 48.4% of cases. Notably, a significant proportion (33.3%) of these *S. aureus* isolates were identified as Methicillin-resistant *Staphylococcus aureus* (MRSA). Fungal elements, primarily *Candida species*, were identified in 12.9% of the samples.

Figure 1. Prevalence of Contact Dermatitis by Occupation

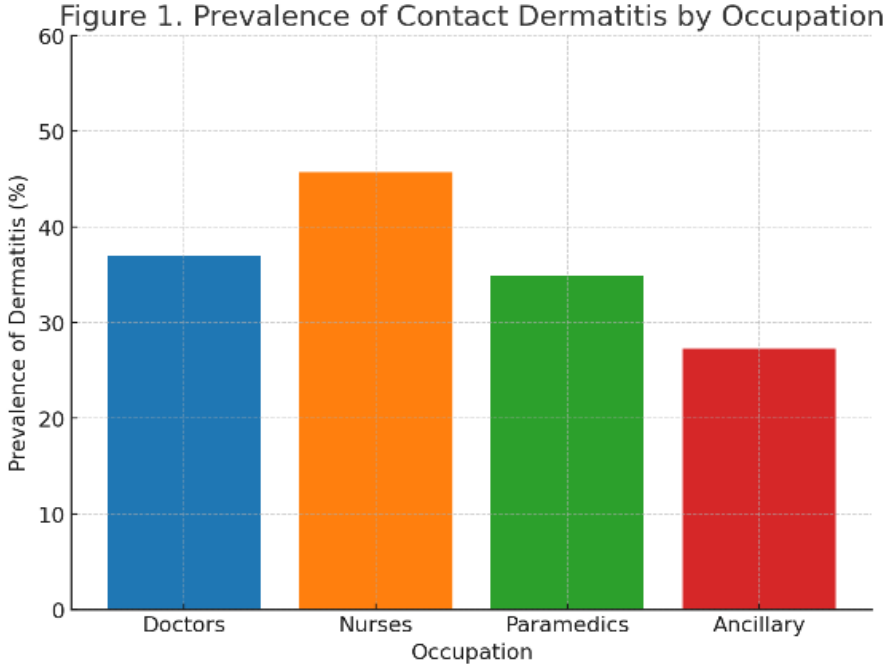
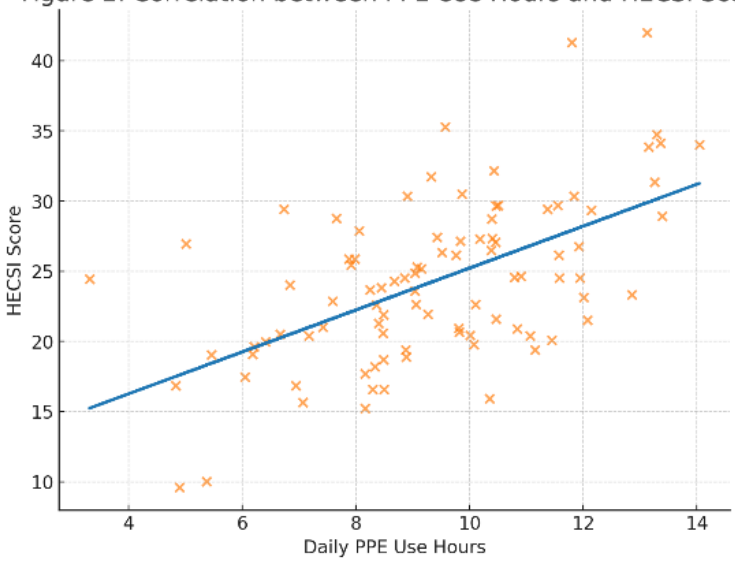


Figure 2. Correlation between PPE Use Hours and HECSI Score



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Discussion

The findings of this study demonstrated that nearly two out of five healthcare workers developed contact dermatitis associated with the prolonged use of personal protective equipment during long clinical shifts. The prevalence observed aligns with international reports, particularly those emerging during the COVID-19 pandemic, where similar rates ranging from 30% to 50% were recorded among frontline medical staff (12). The higher prevalence among nurses compared to other healthcare groups was consistent with prior evidence, as nursing staff often engage in prolonged patient contact, more frequent glove use, and repeated hand hygiene, all of which compromise the skin barrier (13). The gender difference, with females more frequently affected, also mirrored findings from occupational dermatology literature, where hormonal influences, differences in skin sensitivity, and PPE fit have been implicated as contributing factors (14).

The predominance of glove-related dermatitis underscores the impact of occlusion, sweating, and exposure to glove materials, including latex and rubber accelerators, which have long been recognized as occupational sensitizers (15). Similar observations have been documented in European and Asian cohorts, reinforcing the universal burden of hand dermatitis among healthcare workers. Facial dermatitis associated with mask and respirator use was also notable, reflecting increased friction, pressure, and moisture retention, particularly with N95 respirators (16). Comparable findings have been reported in studies from China and Italy, where prolonged mask wear correlated with facial erythema and erosions. These similarities across diverse healthcare systems highlight that PPE-related skin damage is not confined to a single geographic or institutional setting but represents a broader occupational health challenge (17). The analysis of severity revealed that while most cases were mild, a significant proportion of moderate and severe cases was present, which is clinically important as these levels of dermatitis can impair work performance, reduce compliance with PPE protocols, and increase the risk of secondary infections (18). The positive correlation between PPE use duration and severity of dermatitis provided robust evidence that cumulative exposure is a central determinant of skin barrier breakdown (19). This relationship has been repeatedly highlighted in occupational dermatology studies, and the present findings confirm its applicability in the local healthcare context.

The implications of these findings extend beyond individual health. Contact dermatitis among healthcare workers compromises occupational efficiency, increases absenteeism, and can indirectly impact patient safety by reducing compliance with infection control protocols (20). Preventive strategies, such as rotation of PPE materials, scheduled breaks, use of barrier creams, and provision of skin-friendly gloves, therefore assume critical importance. Institutional policies should integrate dermatological health into broader occupational safety frameworks, especially in contexts of high patient load and extended working hours (21). The strengths of this study include its structured cross-sectional design, the use of standardized clinical tools such as the HECSI and VAS, and the combination of self-reported symptoms with clinical confirmation, which minimized misclassification bias. The stratified sampling approach ensured representation across

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occupational categories, adding to the reliability of prevalence estimates (22). The study also provided locally relevant data, addressing the gap in literature from low- and middle-income healthcare settings. Nevertheless, certain limitations must be acknowledged (23). Being cross-sectional, the study captured prevalence at a single point in time and could not establish causality. Recall bias may have influenced self-reported data on PPE use duration and hand hygiene frequency. Additionally, patch testing was not performed, limiting differentiation between irritant and allergic contact dermatitis. The study was confined to healthcare facilities in KP, Pakistan, which may restrict generalizability to other regions with differing resources and work conditions. Despite these limitations, the study contributes valuable evidence that can guide both local occupational health interventions and broader comparative research. Future research should adopt longitudinal designs to capture the incidence and persistence of dermatitis over time, as well as intervention-based studies evaluating the effectiveness of preventive measures such as barrier creams, PPE modifications, and skin health education programs. Expanding research to include biochemical assessments of skin barrier function and patch testing could help clarify the relative contribution of irritant versus allergic mechanisms. Multicenter studies across different regions and healthcare systems would also strengthen external validity and provide a more comprehensive understanding of the occupational burden of PPE-related dermatitis.

Beyond confirming the high prevalence of PPE-related dermatitis, our study provides critical insights into its microbiological dimension. The high rate of *S. aureus* isolation, including MRSA, is a major concern. *S. aureus* is a known skin pathogen that can exacerbate inflammation, delay healing, and lead to more serious soft tissue infections. Its presence, especially in MRSA form, poses a significant occupational risk to the healthcare workers themselves and a potential cross-contamination risk for patients. The isolation of fungi like *Candida* aligns with the moist, occluded environment created by prolonged PPE use. These findings underscore that PPE-related dermatitis is not merely a comfort issue but a significant microbiological hazard that warrants inclusion in occupational health protocols.

Conclusion

This study established that prolonged PPE use significantly contributes to contact dermatitis among healthcare workers. Furthermore, the frequent isolation of pathogenic bacteria like *S. aureus* and fungi from these lesions highlights a substantial risk for secondary infection. Addressing this issue requires a dual approach: institutional policies for skin-friendly PPE and preventive care, coupled with awareness and guidance on the management of microbiological complications to protect both workforce well-being and patient safety.

Author Contributions

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1st Author: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Project Administration.

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