

Assessment of Personal Protective Equipment usage and Compliance to prevent Infectious Disease spread in a Tertiary Care Hospital setting

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Abstract

Background: Healthcare workers (HCWs) face occupational infection risks, especially in high-risk environments, necessitating strict adherence to personal protective equipment (PPE) protocols to prevent transmission.

Objective: To assess the usage and compliance with Personal Protective Equipment among healthcare workers in a tertiary care hospital.

Methodology: This cross-sectional study enrolled 310 HCWs (doctors, nurses, allied health, and janitorial staff) via stratified sampling from July to December 2024. Inclusion criteria: HCWs ≥ 18 years old, employed for ≥ 6 months in clinical/support roles. Data collection included KAP surveys, direct observation of PPE practices, and compliance metrics. Independent variables were PPE type, frequency, and protocol adherence; compliance scores served as dependent variables. Statistical analysis used chi-square tests and logistic regression. SPSS version 26.0 was used for data analysis.

Results: PPE compliance rates for masks were 255 (82.3%), gloves 242 (78.1%) and gowns 203 (65.5%). Doctors demonstrated the highest compliance at 80 (80%). Availability of PPE was strongly associated with compliance ($p < 0.001$). PPE availability significantly boosted compliance (adjusted OR 4.2; 95% CI 2.8–6.3), alongside training (OR 3.1; 95% CI 1.9–5.1) and high-risk departments (OR 2.5; 95% CI 1.6–3.9). High workload inversely related (OR 0.6; 95% CI 0.4–0.9). Barriers were discomfort/poor fit (45.2%), shortages (38.1%), inadequate training (28.1%), and low-risk perception (21.9%).

Conclusion: PPE compliance among HCWs is suboptimal, influenced by resource availability, training, workload, and departmental risk. Prioritizing consistent PPE supply, training, and workload management is critical to reducing preventable infections and protecting HCWs.

Keywords: Healthcare workers, Infection control, Personal protective equipment, Occupational safety, Tertiary healthcare

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Introduction

Personal Protective Equipment (PPE) plays a critical role in reducing the transmission of infectious diseases in healthcare settings.¹ PPE, including masks, gloves, gowns, and face shields, serves as a physical barrier to prevent the spread of pathogens between healthcare workers (HCWs) and patients.^{1,2} The importance of PPE has been underscored by global outbreaks such as the COVID-19 pandemic, where improper or inconsistent use of PPE contributed significantly to the spread of the virus among HCWs and patients.² Healthcare-associated infections (HAIs), which affect millions of patients annually, are another major concern that can be mitigated through proper PPE usage.³ HAIs not only increase morbidity and mortality but also impose a substantial economic burden on healthcare systems worldwide.⁴

Tertiary care hospitals, characterized by their complex patient cases and high volumes of critically ill patients, are particularly high-risk environments for infectious disease transmission. Frequent interactions between HCWs, patients, and visitors, coupled with the presence of immunocompromised individuals, create an environment conducive to the rapid spread of infections.⁵ Additionally, tertiary care hospitals often serve as referral centers for complicated cases, increasing the likelihood of encountering multidrug-resistant organisms (MDROs) and other highly transmissible pathogens.⁶ Despite the well-documented benefits of PPE, challenges persist in its effective implementation. These include shortages during pandemics, improper donning and doffing techniques, discomfort leading to non-compliance, and insufficient training on PPE protocols.⁷ Such gaps highlight

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the need for comprehensive assessments of PPE usage and compliance in tertiary care settings. While PPE is a cornerstone of infection prevention and control, there remain significant gaps in knowledge and practice regarding its usage in tertiary care hospitals. Studies have shown that compliance with PPE guidelines varies widely across different departments and roles, with factors such as workload, availability of supplies, and perceived risk influencing adherence.^{8,9} Furthermore, the lack of standardized training programs and ongoing monitoring of PPE practices exacerbates these issues.¹⁰ During the COVID-19 pandemic, many healthcare facilities faced severe PPE shortages, forcing HCWs to reuse or improperly use equipment, thereby compromising safety.¹⁰ These challenges necessitate the need for a detailed evaluation of PPE usage patterns and their effectiveness in preventing infectious disease transmission. Understanding the barriers to optimal PPE use and identifying strategies to address them is essential for enhancing infection control measures in tertiary care settings. The objective of the study was to assess the usage and compliance with Personal Protective Equipment among healthcare workers (HCWs) in a tertiary care hospital.

Methodology

A cross-sectional study was conducted to assess the usage and compliance with personal protective equipment (PPE) among healthcare workers (HCWs) in Dera Ghazi Khan Medical College, Dera Ghazi Khan, from July to December 2024. The study population included Doctors, Nurses, Allied health professionals (e.g., physiotherapists, radiographers), and Janitorial staff who were directly involved in patient care or hospital cleaning activities. Calculated sample size for study at confidence level 95%, estimated prevalence (proportion) of PPE compliance 72%¹¹, and margin of error 5% was 310. Inclusion criteria comprised HCWs aged 18 years or older, employed at the hospital for at least six months, and actively engaged in clinical or support services. Exclusion criteria included administrative staff not involved in direct patient care, temporary or visiting personnel, and those unwilling to provide informed consent. Data collection involved three primary

approaches: structured surveys, direct observations, and analysis of infection-related metrics. Structured questionnaires were used to evaluate HCWs' knowledge, attitudes, and practices (KAP) regarding PPE. The questionnaire included sections on perceived barriers to PPE use, availability of supplies, and adherence to protocols. Observers recorded compliance with donning and doffing procedures, appropriateness of PPE selection, and frequency of use. The study variables were categorized as: independent variables included the type of PPE used (e.g., masks, gloves, gowns), frequency of use, and adherence to established protocols; dependent variables included rate compliance scores derived from both surveys and observations. Confounding variables, such as staff workload, availability of PPE, and levels of training, were controlled for through stratified analyses.

Ethical approval for the study was obtained from the Institutional Review Committee (Ref. No. 00416/MED/DGKMC Dated: 27-05-2024). Written informed consent was obtained from all participants prior to their enrolment in the study, and confidentiality was maintained throughout the research process. Statistical analysis was performed using SPSS version 26.0. Descriptive statistics were used to summarize demographic characteristics and baseline data. Chi-square test was applied to identify associations between categorical variables such as department type and PPE compliance rates. Logistic regression analysis was conducted to determine predictors of PPE adherence while controlling for confounders. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 310 healthcare workers (HCWs) were included in the study. The majority of participants were female, 215 (69.4%), and males, comprising 95 (30.6%). The age distribution showed that most participants were within the 31-45 years age group, 135 (43.5%), followed by those aged 18-30 years, 120 (38.7%), and a smaller proportion aged above 45 years, 55 (17.8%). In terms of professional roles, Nurses represented the largest group, accounting for 150 (48.4%) of participants, followed by Doctors 65 (21%), Allied health professionals 60 (19.4%), and Janitorial staff 35 (11.2%). Participants were taken from five major hospital departments. Emergency department had the highest representation, 80

(25.8%), followed by Internal Medicine, 70 (22.6%), Obstetrics and Gynecology, 60 (19.4%), Surgery, 55 (17.7%), and Pediatrics, 45 (14.5%).

The compliance rates for various types of personal protective equipment (PPE) among the 310 healthcare workers (HCWs) surveyed. The highest compliance was observed for mask use, with 255 (82.3%) of participants reporting consistent adherence. Gloves followed closely with a compliance rate of 242 (78.1%). However, compliance with gown usage was notably lower, reported by only 203 (65.5%) of respondents. (Table-I)

Table-I: Compliance rates for different types of Personal Protective Equipment (n=310)

Type of PPE	Compliance Rate (%)
Masks	255 (82.3%)
Gloves	242 (78.1%)
Gowns	203 (65.5%)

The association between PPE compliance and selected professional and workplace-related variables among healthcare workers (HCWs) showed that profession was significantly associated with PPE compliance ($p<0.001$). Doctors demonstrated the highest compliance at 80 (80%), followed by Nurses 92 (76.7%), Allied health workers 82 (68.3%), and Janitorial staff 40 (57.1%). Department-wise analysis revealed that Emergency department personnel had the highest compliance, 85 (85%) in contrast, the lowest compliance was noted in Obstetrics and Gynecology, 57 (63.3%). Other departments, such as Internal Medicine 66 (78.6%), Surgery 61 (70.9%), and Pediatrics 62 (68.9%), exhibited intermediate levels of adherence. The difference across departments was statistically significant ($p=0.002$). Availability of PPE was also strongly associated with compliance ($p<0.001$). Participants who reported PPE as "always available" had the highest compliance rate, 170 (85%), compared to those with "occasional availability", 60 (60%), and "rare availability", 30 (30%). (Table-II)

Table-II: Association between Personal Protective Equipment compliance and selected variables

Variable	Compliant (%)	Non-Compliant (%)	P-value
Profession			
Doctors	80 (80%)	20(20%)	<0.001
Nurses	92 (76.7%)	28(23.3%)	
Allied Health Workers	82 (68.3%)	38(31.7%)	
Janitorial Staff	40 (57.1%)	30(42.9%)	
Department			
Internal Medicine	66 (78.6%)	18 (21.4%)	0.002
Surgery	61 (70.9%)	25 (29.1%)	
Pediatrics	62 (68.9%)	28 (31.1%)	
Emergency	85 (85%)	15 (15%)	
Obstetrics & Gynecology	57 (63.3%)	33 (36.7%)	
Availability of PPE			
Always Available	170 (85%)	30 (15%)	<0.001
Occasionally Available	60 (60%)	40 (40%)	
Rarely Available	30 (30%)	30 (30%)	

Self-reported barriers to personal protective equipment (PPE) compliance among healthcare workers (HCWs) were discomfort or poor fit of PPE, reported by 140 (45.2%) of participants, shortage of supplies was the second most common barrier identified by 118 (38.1%) and lack of training on proper PPE use was reported by 87 (28.1%). Additionally, 65 (21.9%) HCWs reported perceiving a low risk of infection, followed by time constraints reported by 56 (18.1%). (Table-III)

Table-III: Barriers to Personal Protective Equipment compliance reported by HCWs (n = 310)

Barrier	Frequency	Percentage (%)
Discomfort/Poor Fit	140	45.2%
Shortage of Supplies	118	38.1%
Lack of Training	87	28.1%
Perceived Low Risk of Infection	65	21.9%
Time Constraints	56	18.1%

The availability of PPE was significantly associated with higher compliance with an odds ratio (OR) of 4.2 (95% CI: 2.8-6.3; $p<0.001$), indicating that healthcare workers were over four times more likely to comply with PPE protocols when PPE was readily available. Similarly, those who received training on PPE use had significantly greater odds of compliance (OR = 3.1; 95% CI: 1.9-5.1; $p<0.001$). Working in high-risk departments such as the emergency

department was also associated with increased compliance (OR = 2.5; 95% CI: 1.6-3.9; $p=0.001$). In contrast, high workload was negatively associated with PPE compliance with an OR of 0.6 (95% CI: 0.4-0.9; $p=0.021$), suggesting that increased workload may hinder adherence to PPE protocols. (Table-IV)

Table-IV: Predictors of Personal Protective Equipment compliance (logistic regression analysis)

Variable	Odds Ratio (OR)	95% CI	P-value
Availability of PPE	4.2	2.8-6.3	<0.001
Training on PPE Use	3.1	1.9-5.1	<0.001
Department (ICU/ER vs. Others)	2.5	1.6-3.9	0.001
Workload (High vs. Low)	0.6	0.4-0.9	0.021

Discussion

This study investigated Personal Protective Equipment (PPE) compliance and its predictors among healthcare workers (HCWs) in a tertiary care setting. The overall findings underscore the crucial influence of workplace resources and training on PPE adherence, echoing global concerns raised during the COVID-19 pandemic and beyond. Availability of PPE emerged as the strongest predictor of compliance, with HCWs being over four times more likely to adhere to PPE protocols when supplies were consistently accessible. This finding aligns with recent literature indicating that PPE availability is a cornerstone for infection prevention behaviors among HCWs, especially during health emergencies.^{10,12} A multicenter study conducted in low- and middle-income countries also emphasized that inconsistent PPE availability significantly compromises frontline workers' safety and contributes to psychological distress.¹³ Training on the proper use of PPE was another significant predictor of compliance. HCWs who had received formal training were over three times more likely to adhere to PPE protocols. This is consistent with prior studies demonstrating that knowledge and competency in PPE use are directly associated with improved compliance.^{14,15} A 2021 systematic review noted that simulation-based and frequent refresher training significantly enhances PPE adherence, especially among non-

physician HCWs.¹⁶

Departmental affiliation also influenced compliance. Workers in high-risk settings such as the emergency department (ED) and intensive care units (ICUs) demonstrated significantly higher compliance. This likely reflects a heightened perception of infection risk in such departments and greater institutional emphasis on PPE protocols. Similar patterns have been documented elsewhere, where ED and ICU staff reported more frequent PPE use due to constant exposure to aerosol-generating procedures and critical care patients.^{17,18}

Interestingly, high workload was associated with decreased PPE compliance. HCWs experiencing high work pressure were 40% less likely to consistently use PPE. This finding is supported by recent studies that identify time constraints and task overload as major barriers to PPE adherence, especially in understaffed and resource-limited settings.^{19,20} High workload not only compromises compliance but may also elevate the risk of burnout and error-prone behaviors among healthcare staff.²¹

In terms of overall PPE usage, the highest compliance was reported for mask and glove use, whereas gowns had the lowest compliance rate. This trend is similar to other reports, which suggest that ease of use, perceived protection, and availability contribute to variations in adherence among different PPE types. Barriers such as discomfort or poor fit, cited by nearly half of the participants, further underscore the need for ergonomically designed PPE to enhance usability and reduce non-compliance.^{22,23}

The study also highlights significant differences in PPE compliance across professional categories, with doctors demonstrating the highest adherence and janitorial staff the lowest. This disparity may reflect differences in risk perception, training exposure, and access to PPE, as shown in previous studies.^{24,25} Targeted interventions that address these gaps, especially for non-clinical staff, are essential for comprehensive infection control.

Overall, these findings suggest that institutional policies ensuring uninterrupted PPE supply, mandatory training programs, and workload management could significantly improve PPE compliance among HCWs. Tailored strategies addressing both structural and behavioral barriers are imperative for sustainable infection prevention, especially in resource-constrained healthcare systems.

Conclusion

This study highlights that Personal Protective Equipment compliance among healthcare workers is significantly influenced by factors such as the availability of PPE, training, departmental assignment, and workload. Higher compliance was observed among those with consistent PPE access, formal training, and those working in high-risk departments. Conversely, high workload and inadequate resources were key barriers to adherence. Targeted interventions addressing these factors are essential to enhance PPE use and protect healthcare workers.

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