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Knowledge and skills of health care workers on utilization of personal protective equipment in Juba Teaching Hospital. A cross-sectional study.

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Abstract

Background:

Personal protective equipment (PPE) is an essential component of infection prevention and control, protecting healthcare workers (HCWs) and patients from healthcare-associated infections. This study assessed the relationship between knowledge and skills and the utilization of PPE among healthcare workers at Juba Teaching Hospital (JTH), South Sudan.

Methods:

A cross-sectional descriptive study was conducted among 106 HCWs at JTH, representing a 71% response rate from the target population of 149. Data were collected using a structured questionnaire measuring knowledge & skills, and self-reported PPE utilization on 5-point Likert scales. Qualitative data from key informant interviews and documentary review triangulated findings. Pearson correlations and multiple regression analyses were performed to determine relationships and predictors of PPE utilization.

Results:

The respondents comprised 54% males. Most participants were aged 25–40 years (89%), while 33% had 2–4 years of work experience. The highest-rated knowledge item was that PPE should be used when there is a risk of exposure to body fluids (Mean = 4.79 ± 0.93), whereas uncertainty regarding PPE effectiveness as a barrier to infection (Mean = 2.89 ± 1.54) indicated important knowledge gaps. Knowledge and skills showed a significant moderate positive relationship with PPE utilization ($r = 0.421$, $p < 0.001$). Simple linear regression further revealed that knowledge and skills significantly predicted PPE utilization ($\beta = 0.421$, $p < 0.001$), explaining 16.9% of the variation in PPE utilization.

Conclusion:

Healthcare workers at JTH possessed moderate knowledge of PPE; however, misconceptions regarding PPE effectiveness and inconsistent safe practices limited optimal utilization.

Recommendations:

Juba Teaching Hospital should institute regular competency-based PPE training, strengthen continuous professional education on infection prevention, and ensure uninterrupted availability of quality PPE.

Keywords: *Personal Protective Equipment (PPE), Healthcare Workers, Knowledge and Skills, PPE Utilization; Infection Prevention and Control (IPC); Juba Teaching Hospital.*
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Background.

Knowledge is defined as what we know: it involves the mental process of comprehension, understanding, and learning that goes on in the mind of a person. However, much of it involves interaction with the world outside the mind and interaction with others. According to WHO (2015), the rational model of health promotion believed that high knowledge will translate to a positive attitude and subsequently good behavior. Knowledge is very important as far as utilization of PPE is concerned. The knowledge of PPE among nurses and other healthcare workers would influence their level of utilization of PPE. Zhu, Kahsay, and Gui (2019) conducted a comparative study on KAP related to standard precautions (SPs) among nurses in China and Ethiopia and found that nurses of both countries have a good understanding of the concept of SPs; however, the acceptance of hospital policies for the prevention of hospital-acquired infections (HAI) was lower in Ethiopia.

In Kenya, Moyo (2013) stated that only 17.8% of nurses at Mbagathi District Hospital of Nairobi have satisfactory knowledge of the basic components/elements of PPE. There are several factors influencing knowledge, such as education and training, and years of experience. Training is an important tool for hindering the spread of infections. Effective training on the utilization of PPE should start from academic institutions before individuals are allowed to

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practice as nurses in the clinical area. Training helps equip HCWs with the necessary knowledge on the use of PPE effectively to protect against job hazards. Training equally enables HCWs to recognize the importance of PPE towards their safety and health, identify job hazards that require the use of PPE, select appropriate PPE for the tasks, and inspect, don, and doff PPE properly. This is the case in both developed and developing countries. As individuals are employed, there is a need for training, both on appointment and on-the-job training, sometimes called in-hospital training. Training in hospitals assumes a basic role in guaranteeing that employees are made mindful of the significance of PPE. The Centers for Disease Control and Prevention (CDC, 2020) recommends frequent training of HCWs on standard and
transmission-based precautions such as the correct procedure for donning and doffing PPE when caring for patients. The awareness created by training will fill in as fortification on the training provided on appointment. This awareness created through training will enable nurses to comply with requirements for the utilization of PPE as they perform their responsibilities.

Good practice guidelines advocate the risk of infection, and the use of appropriate equipment for protection against such infection. This is why the National Health Service (NHS) Foundation Trust in the United Kingdom (1997) published guidelines for the use of PPE in 1997 for the training of health workers. John et al. (2016) studied whether health care personnel trained in the correct use of personal protective equipment concurred that effective use of PPE is essential to protect HCWs and patients in hospitals, but their survey of 222 health care workers indicated that PPE training was often suboptimal, with no requirement for demonstration of proficiency. Fourteen percent of physicians reported no previous training in the use of PPE. In Kenya, Moyo (2013) stated that more than half of nurses (60%) working at Mbagathi district hospital in Nairobi had attended formal training on infection prevention, which includes the use of PPE, while the remaining 40% were not formally trained on the use of PPE. Even though 64% of the nurses were diploma holders, with less than 30% being first degree holders, there is no significant difference in their knowledge of the use of PPE. Hence, there is a need for training on the use of PPE among nurses. This study assessed the relationship between knowledge and skills and the utilization of PPE among healthcare workers at Juba Teaching Hospital (JTH), South Sudan.

Methodology

Research Design

The study adopted a cross-sectional descriptive research design comprising both quantitative and qualitative methods to examine the utilization of PPE among HCWs at Juba Teaching Hospital. A descriptive cross-sectional research design is a type of design that allows a researcher to analyze collected data from the sample at a given point in time (Mugenda & Mugenda, 2003). This design is relatively quick and easy to conduct study and data on all variables are collected only once.

Study Area.

The study was conducted in Juba Teaching Hospital, Juba City, South Sudan. The hospital provides services such as Basic Emergency services, Preventive in-patient and out-patient services, Curative In-patient and Outpatient Services, surgical services, Voluntary Counselling and Testing (VCT) services, HIV and Tuberculosis services, Antenatal, Obstetric Care, Family Planning services, as well as Radiology Services such as X-ray, Ultrasound Scan, among others. The hospital houses the first blood transfusion center in South Sudan.

Study Population.

The study population included all HCWs with at least one year of working experience at Juba Teaching Hospital. This is because, within six months of working, a practicing nurse is expected to have achieved familiarity with the environment as well as the practices within the hospital. A total of 243 HCWs will be targeted for the study. These came from different departments in the Hospital. This information was obtained from the archives department of the Hospital.

Sample size and Procedures

To select the study participants, a proportionate convenience sampling technique was used to ensure the representation of each unit in the hospital. This technique allows the researcher to select participants from a population based on how convenient and readily accessible and available they are. The focus is on a sample that is easy to access. Using this technique allows a researcher to obtain a sample in an easy way as well as reducing the cost of obtaining them, which was the case in the present study.

Sample Size Determination

The sample size for the study was computed using Fisher *et al.*'s (1998 formula (as cited in Mugenda & Mugenda, 2008).

$$n = \frac{Z^2 pq}{e^2}$$

Where Z is the value for the corresponding confidence level (i.e., 1.96 for 95% confidence); e is the margin of error (i.e., 0.05 = ± 5%), and p is the estimated value for the proportion of a sample that has the condition of interest. P= 0.5

$$\frac{96^2 x0.5x.05}{0.05^2}$$

1.

n□□ 384.16 Participants

Since the target population for this study will be 243, which was less than 10,000, the sample size was adjusted using the

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equation developed by Yamane *et al.* (1967), which is recommended for populations less than 10,000.

$$nf = \frac{n}{1 + \frac{(n-1)}{N}}$$

Where: *nf* = desired sample size; calculated sample size 384; estimate of population in the study area (i.e., number of HCWs working at Juba Teaching Hospital, which is 243).

$$nf = \frac{384}{1 + \frac{(384-1)}{243}}$$

$$nf = \frac{384}{1 + \frac{(383)}{243}}$$

$$nf = \frac{384}{1 + 1.58}$$

$nf =$ 149 + 10% (for non-response = 15) = 164

Therefore, the sample size for the study was 149 participants.

Table 1. Sample size computation

Units	No. of Nurses	Proportionate sample size	Proportionate %
Casualty	14	9	5.8
OPD	20	12	8.2
MMW	12	7	4.9
FMW	12	7	4.9
MSW	12	7	4.9
FSW	12	7	4.9
PAED	16	10	6.6
NBU	14	9	5.8
MCH	14	9	5.8
Maternity	26	16	10.7
Maternity-Theatre	11	7	4.5
Main Theatre	14	9	5.8
Gynae	11	7	4.5
ICU	13	8	5.3
ENT/EYE	9	6	3.7
CCC	8	5	3.3
RENAL	5	3	2.1
CSSD	8	5	3.3
Nurse Managers	12	7	4.9
Total	**243**	**149**	**100.0**

Note: The proportionate sample size is exclusive of non-respondents

Data Collection Tools and Methods

Structured self-administered questionnaires were used to collect data for this study, as well as an interview guide and documentary review checklist. A self-administered questionnaire refers to a questionnaire that has been developed specifically to be filled by a respondent without the help of a researcher. The questionnaires were used to collect data on the study variables that were necessary for the testing of the study hypotheses. The questionnaire has three parts. The first part was used to collect data on the

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participants' demographic variables. The second part collected data on the participants' knowledge about personal protective equipment as well as their level of knowledge about personal protective equipment. The last part was used to gather data on the level of utilization of personal protective equipment and the general utilization of this equipment. For the documentary review, the researcher used information contained in training attendance logs, PPE stock records, incident exposure reports, and hospital PPE guidelines/sops.

Pre-Testing of Instrument (Validity and Reliability).

Validity of the Questionnaire

Content validity was established through review by 3 IPC experts from JTH and the University of Juba, School of Public Health. The questionnaire was assessed for relevance, clarity, and coverage of knowledge, attitude, perception, and utilization constructs based on WHO IPC guidelines and HBM. A Content Validity Index (CVI) of 0.89 was obtained, exceeding the 0.78 threshold (Lynn, 1986). Items with CVI < 0.78 were revised or deleted."

Reliability of the Questionnaire

Reliability is the consistency of a measure that ensures the consistency of a test. A reliability measure fundamentally tells the researcher whether a study participant would provide the same score on a particular variable if that variable were to be administered again (Kothari, 2012). To ensure reliability, Cronbach's Alpha coefficient for internal consistency was used. Cronbach's alpha is a statistic that measures the internal consistency among a set of survey items that the researcher believes all measure the same construct or scale, are correlated with each other, and could be developed into some type of scale. Four separate Cronbach's alphas were computed for the following constructs: 1) knowledge about PPE, 2) utilization of PPE among nurses.

Table 2. Reliability Results

Construct	Number of Items	Cronbach's alpha
Knowledge about PPE	7	0.785
Attitude towards PPE use	6	0.843
Health facility compliance factors	8	0.771
Utilization of PPE among nurses	2	0.815

As can be seen from Table 2, alpha coefficients for all the constructs were above the threshold of 0.70 (Nunnaly & Bernstein, 1994). The values indicated sufficient reliability of the measures.

Data Analysis

The questionnaires were first sorted for data completeness. Following this process, they were coded, and variables entered into Statistical Package for Social Sciences (SPSS) version 20. Descriptive and inferential statistics were used to analyze data in line with the study objectives. Descriptive statistics comprised means, standard deviations, percentages, and frequencies. Inferential statistics comprised Chi-square and simple linear regression analysis. The chi-square (X^2) is a test of significance for categorical variables. This test lets the researcher test the relationship between two categorical variables. In this study, the chi-square test of independence was used to test the significance of the relationships among the study demographic variables (gender, age, marital status, work experience, and education qualifications) and utilization of PPE at a 95% confidence level.

Simple linear regression analysis was applied to examine the models in line with the study objectives and related hypotheses. Simple linear regression is an inferential statistical test that focuses on predicting variation in the outcome variable based on data in the predictor variable. Therefore, this statistical test yields a regression model that helps the researcher to examine changes in one variable as a function of changes or differences in values of the other variable. This analysis aims to determine how, and to what extent, the outcome variable varies as a function of changes in the predictor variable. In this study, three separate simple linear regressions were computed.

The first simple linear regression was computed between knowledge about PPE and utilization of PPE among HCWs. The coefficient of determination was used to establish the percentage of variance that could be explained by the study's significant variables. The significance of the simple linear regression model was examined using the Analysis of Variance F-test at a 95% confidence level. To analyze the qualitative data, a content analysis technique was used where themes were extracted in line with the study objectives. Table 3.3 presents the analysis plan based on the study objectives.

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Table 3. Data analysis plan

Objective(s)	Statistical analysis
To establish the utilization level of PPE among nurses at Juba Teaching Hospital	Descriptive statistics (means, standard deviations, percentages, and frequencies)
To determine the influence of knowledge on utilization of PPE among HCWs at Juba Teaching Hospital	Descriptive statistics (means, standard deviations, percentages, and frequencies) Inferential statistics (chi-square test of independence, simple linear regression analysis), significance tested at 5% level.

Ethical Considerations

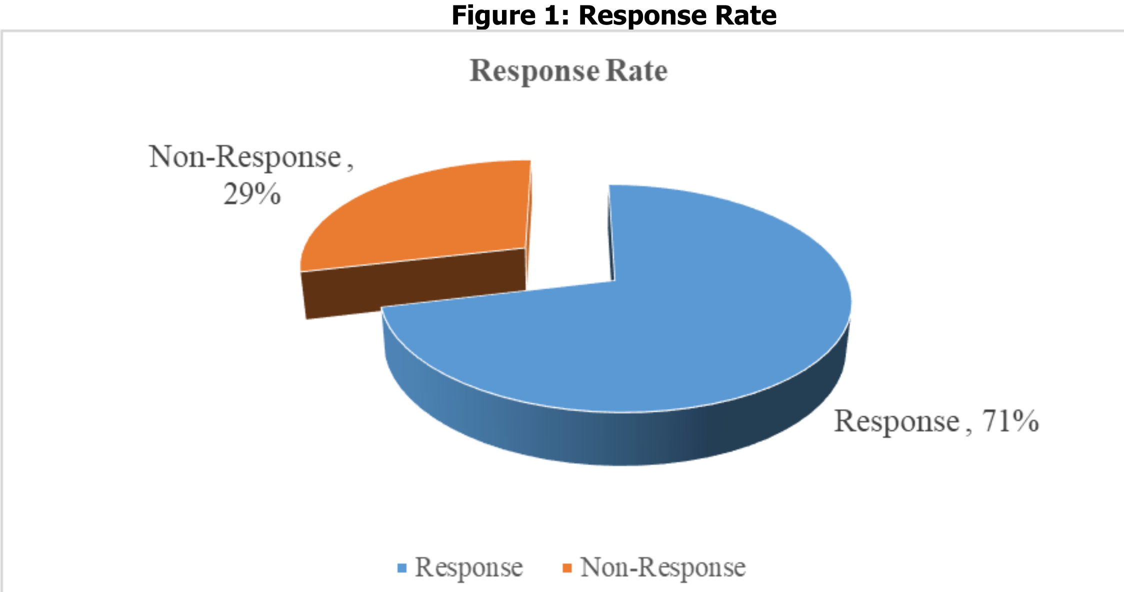
The study's ethical considerations comprised several procedures and steps to ensure the smooth running of the actual data collection exercise. First, the researcher obtained approval from Team University. Second, the researcher sought and obtained ethical clearance from the Ethical Review Committee of Team University. A clearly stated informed consent was obtained from the respondents who were willing to participate in the study. Before signing the informed consent forms, the researcher explained to all study participants the purpose of the study. Also, the researcher assured them of confidentiality of the information provided and that the collected data would be used for this study only. The researcher notified the participants that participation in the study was voluntary and that one could refuse to participate or terminate his or her participation without incurring any harm whatsoever.

Results.

Response Rate

This study anticipated getting responses from 149 respondents from the JTH. However, only 106 respondents took part in the study. This therefore gave a response rate of 71%. This is a high response rate considering the nature of the study. As such, it is appropriate for purposes of generalizing to the population of the study.

Figure 1: Response Rate



Gender of Respondents

The results of gender show that 54% of the workers were male and 46% of the workers were female. Thus, the majority of the respondents in the study were male, which coincides with the number of workers in the population of interest. Figure 2 shows the findings of the gender of the workers at JTH. It can be concluded that the hospital has almost an equal number of men and women, which represents gender balance. It can also be concluded that the hospital considers employing more men than women due to the nature of the hospital, where the workers work long hours for job delivery in the hospital.

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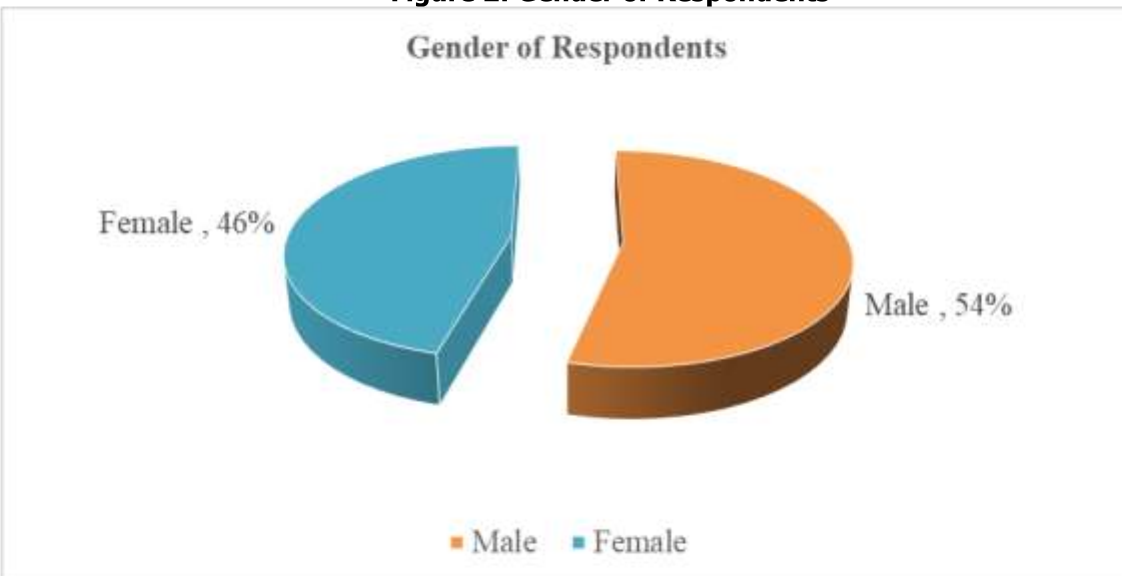
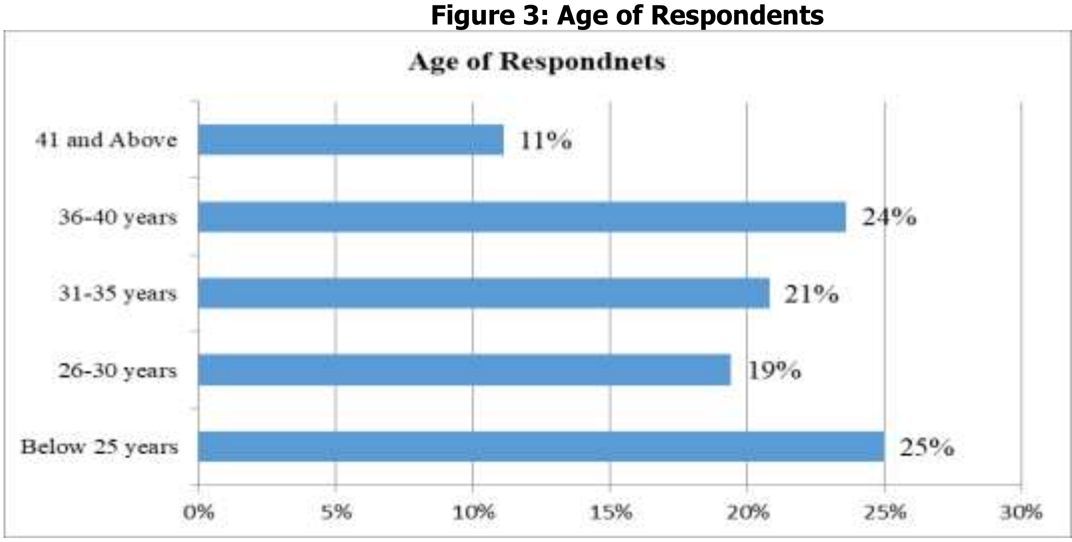
Figure 2: Gender of Respondents



Age of Respondents

The results reveal that 25% of the respondents were aged 25 years and below, 19% were aged 26-30 years, 21% were aged 31-35 years, 24% were aged 36-40 years, and 11% were aged above 41 years of age. The research shows that most of the staff in the hospital were below 40 years. Figure 4.3 indicates the distribution of respondents by age. The findings on age showed that there are at least well-distributed workers in terms of age. From the findings, it can be concluded that workers in the JTH consist of both young and older workers, which brings on board those who have enough experience in the workplace.

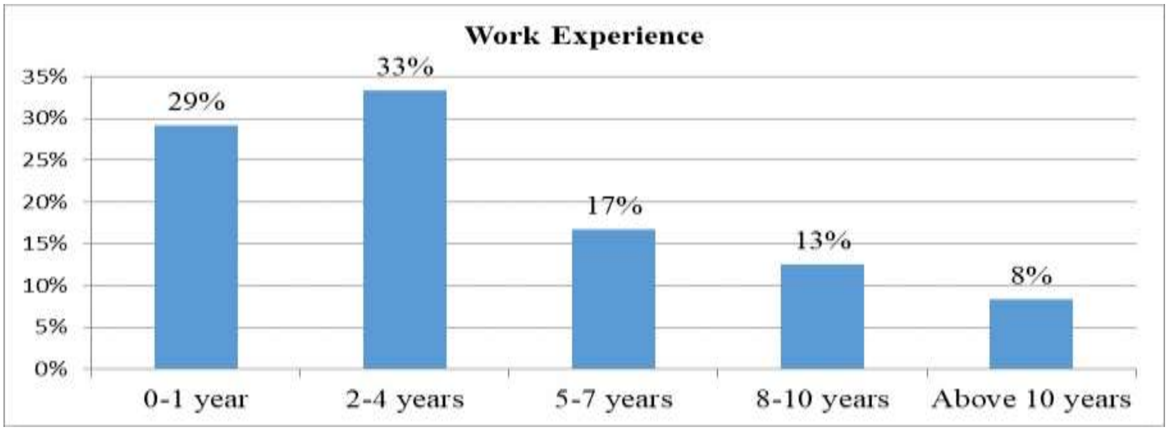
Figure 3: Age of Respondents



Working Experience

The results of the study on work experience indicated that health workers who have experience of between 0-1 year were 29%, between 2-4 years were 33%, which were the majority, between 5-7 years were 17%, between 8-10 years were represented by 13%, and above 10 years were 8%. The findings of the study in Figure 4.4 show the work experience of health workers at JTH. It can be deduced that Health workers were able to give enough information in regard to utilization of PPEs in the Hospital.

Figure 4: Working Experience.



Knowledge and skills and utilization of PPEs in Juba Teaching Hospital

The objective of the study was to assess the relationship between knowledge and skills and the utilization of PPEs among Health workers in JTH. Knowledge and skills were conceptualized to include: training, importance of PPEs, and awareness of risks associated with PPEs, measured using items scored on a five -point Likert Scale ranging from (5) for strongly agree, (4) for agree, (3) for not sure, (2) for disagree, and (1) for strongly disagree. The findings are presented below using mean and standard deviation statistics.

Table 4: Mean and Standard Deviation results for knowledge and skills.

Knowledge and skills	**Mean**	**S.D**
Use of Personal Protective Equipment (PPE) is part of infection control	4.60	1.06
Personal Protective Equipment (PPE) is an effective barrier to infection	2.89	1.54
. PPE should be used when there is a risk of exposure to fluids and secretions from the patient	4.79	0.93
I am confident that I understand the risks associated with infections when dealing with patients	3.26	1.45
I am confident that I understand how to protect myself and my patients from infections	4.16	0.92
The use of correct PPE eliminates the need for hand hygiene	2.89	1.69
Clients with signs and symptoms of respiratory illness should wear a surgical mask while waiting in common areas or should be placed immediately in examination rooms or away from others.	4.61	0.98

Source: Primary Data.

Table 4 presents the mean and standard deviation results for health care workers' knowledge and skills regarding PPE use at Juba Teaching Hospital. Findings indicate that while HCWs strongly agreed that PPE should be used when there is risk of exposure to body fluids (M = 4.79, SD = 0.93) and that PPE is part of infection control (M = 4.60, SD = 1.06), critical knowledge gaps exist. Respondents were unsure whether PPE is an effective barrier to infection (M = 2.89, SD = 1.54), and responses to "PPE eliminates the need for hand hygiene" (M = 2.89, SD = 1.69) revealed a dangerous misconception among a subset of staff. Confidence in understanding infection risks was low (M = 3.26, SD = 1.45), though confidence in self-protection skills was higher (M = 4.16, SD = 0.92). The high standard deviations across most items suggest substantial variation in knowledge levels among HCWs. These results imply that although basic indications for PPE use are understood, misconceptions about PPE efficacy and its relationship with hand hygiene may compromise infection prevention practices at JTH.

NO1 – Nursing Officer, Maternity Ward:

"*We all know the rule. If you're delivering a baby or suturing an episiotomy, you must wear gloves, apron, and boots. There is blood everywhere. Nobody argues with that. That's why your score is 4.79. The problem is not knowing when – it's whether we have the gloves."*

MO2 – Medical Officer, Casualty:

"In an emergency, you don't touch a bleeding patient without gloves. We drill that into interns on day one. So yes, 4.79 makes sense. The challenge comes after – do you remove them correctly? But on when to wear them, we are clear."

CO1 – Clinical Officer, OPD:

"To be honest, some of us don't trust these gloves. During COVID, we used the same gloves for many patients because there weren't enough. Some tore. So now when you ask if PPE is an effective barrier, I say 'not sure'. If it's poor quality or you reuse it, it fails. That's why your mean is below 3. We've seen it fail."

NO3 – Nursing Officer, Isolation Unit:

"The gowns they give us are like paper. By the end of a shift, you're sweating, and it's sticking to your skin. If blood soaks through, is that a barrier? So when I filled your questionnaire, I put 'disagree'. Maybe N95s work, but not what we get daily. That 1.54 SD is because those in theatre with good gowns said 'agree', but we said 'no'."

MO1 – Medical Officer, Pediatrics:

"I've seen it. A nurse will wear gloves, examine three babies, then go to tea without removing them or washing hands. When I ask, she says 'I'm protected, I have gloves'. That's the 2.89. The mean is low because most know it's wrong, but that huge SD of 1.69 is the few who still think gloves replace hand washing. We need to break that myth urgently."

IPC Focal Person – JTH:

"This is our biggest headache. During CME we teach: gloves are not a second skin. But workload is high. A nurse in labor ward delivers, removes gloves, but there's no water, so she puts new gloves for the next mother. She thinks she's safe. So she answers 'agree' to that question. That's why your data shows confusion. Hand hygiene stations must come first before we even talk PPE."

Documentary review

Documentary review further corroborated the survey findings. The JTH IPC SOP (2023) mandates PPE use when exposure to body fluids is anticipated, consistent with the high mean of 4.79 on this item. However, IPC Committee minutes (12 Feb 2025) documenting "staff complaints regarding poor quality gloves tearing" provide institutional evidence for HCWs' doubts about PPE efficacy (M = 2.89). Most critically, the Q4 2024 IPC Audit found that 41% of observed staff failed to perform hand hygiene after glove removal, with some stating 'gloves protect me', directly validating the misconception reflected in the survey (M = 2.89, SD = 1.69). The absence of regular risk-based CME, as evidenced by the 2024–2025 CME register, explains low confidence in risk knowledge (M = 3.26). Conversely, TB Clinic monthly reports showing 100% mask issuance to coughing patients confirm that source control knowledge (M = 4.61) is effectively translated into practice.

Utilization of PPEs at Juba Teaching Hospital

Utilization of PPEs at JTH by HCWs was the dependent variable; Table 5 below shows the descriptive statistics on Utilization of PPEs.

Table 5 Mean and Standard Deviation results for utilization of PPEs results

Utilization of PPEs	Mean	S.D
I perform hand hygiene before donning gloves	4.04	0.56
I perform hand hygiene immediately after removing gloves	4.23	0.49
I touch my face and other parts of my body, another person, adjust another PPE, or touch the surroundings after donning gloves	3.83	0.56
I wash or reuse gloves if clean after use	4.09	0.42
I change gloves if highly soiled or torn during use, even if used on the same patient	3.98	0.51

Source: Primary Data.

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Table 5 presents self-reported PPE utilization practices among HCWs at JTH. Respondents reported high compliance with hand hygiene before (M = 4.04, SD = 0.56) and after (M = 4.23, SD = 0.49) glove use. However, unsafe practices were also prevalent. HCWs frequently reported touching their face or surroundings after donning gloves (M = 3.83, SD = 0.56), washing or reusing gloves (M = 4.09, SD = 0.42), and not always changing torn or heavily soiled gloves (M = 3.98, SD = 0.51). The low standard deviations across all items indicate strong consensus on these practices, suggesting systemic rather than individual factors. Qualitative data confirmed that glove shortages force reuse: "we only get 5 pairs per shift for 20 deliveries… if it looks clean, we wash it, dry it, use again" (NO3). The coexistence of high hand hygiene scores with high-risk glove practices indicates a critical knowledge-practice gap and undermines the protective effect of PPE, likely contributing to healthcare-associated infections despite reported compliance.

NO3 – Nursing Officer, Labor Ward, JTH:
"Hand hygiene before and after gloves? Yes, we do that – 4 or 5. But the gloves… we only get 5 pairs per shift for 20 deliveries. So if it looks clean, we wash it, dry it, and use it again. That's why I put 4 for reuse. We know it's wrong, but what else? And touching face – when you sweat, you wipe. You can't help it. So 3 or 4 is honest."

IPC Focal Person – JTH:
It's in our audit too. Staff are not ignorant – they're rationing. And 3.83 for face-touching – with no AC, sweat runs into your eyes. They touch without thinking. So your high hand hygiene scores are meaningless if gloves are dirty and faces are touched. This table proves why we still have HAIs despite training."

MO2 – Medical Officer, Casualty:
"If I'm suturing and the glove tears, I don't always have another pair in the tray. I finish with one glove or keep going. It's not ideal, but it's real. The low SD tells you we all do it. It's not one person, it's the system."

Inferential tests on the utilization of PPEs

CORRELATION

Table 6: Correlation between Individual Utilization Items and Composite PPE Utilization Score, N = 106.

To examine the internal structure of PPE utilization, correlations and regression were conducted using a composite safety score, calculated by reverse-coding unsafe items (N = 106). All five utilization behaviors were significantly correlated with the composite score. Unsafe practices showed the strongest relationships: touching face/body after donning gloves, $r(104) = -.721$, $p < .001$, and washing/reusing gloves, $r(104) = -.688$, $p < .001$.

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Utilization Item	Pearson r with Composite Score	Sig. 2-tailed	Interpretation
1. Hand hygiene before donning gloves	**+.612****	.000	Strong positive. Doing HH before gloves = safer overall practice.
2. Hand hygiene after removing gloves	**+.588****	.000	Strong positive. Post-glove HH is core to safe practice.
3. Touch face/body after donning gloves	**-.721****	.000	**Strong negative**. Face-touching is the single biggest driver of unsafe composite score.
4. Wash or reuse gloves if clean	**-.688****	.000	**Strong negative**. Glove reuse is 2nd biggest driver of unsafe practice.
5. Change gloves if torn/soiled	**+.534****	.000	Strong positive. Changing damaged gloves = safer practice.

*_Correlation is significant at the 0.01 level 2-tailed.

Key Finding: The 2 _unsafe behaviors* have the strongest correlations, both negative. Touching face r = -.721 explains 52% of variance in composite safety. Glove reuse r = -.688 explains 47%. This means reducing these 2 behaviors would most improve overall PPE safety.

Multiple regression

Multiple regression revealed that the five items explained 78.6% of variance in the composite score, Adjusted $R^2 = .786$, $F(5,100) = 78.12$, $p < .001$. Avoiding face-touching ($\beta = .488$, $p < .001$) and avoiding glove reuse ($\beta = .412$, $p < .001$) were the strongest unique predictors of safe practice, outweighing hand hygiene before ($\beta = .201$, $p < .001$) and after ($\beta = .198$, $p = .001$) glove use.

Table 7. Multiple Regression – Utilization Items predicting Composite PPE Utilization Score, N = 106.

Predictor	Unstandardized B	Std. Error	Standardized Beta	t	Sig.	VIF
Constant	0.421	0.388		1.085	.281	
HH before glove	0.188	0.052	.201	3.615	.000	1.221
HH after gloves	0.201	0.058	.198	3.466	.001	1.189

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Touch face – reverse coded	0.312	0.041	.488	7.610	.000	1.331
Reuse gloves – reverse coded	0.298	0.048	.412	6.208	.000	1.298
Change torn gloves	0.142	0.055	.151	2.582	.011	1.201

Model Summary: $R = .892$, $R^2 = .796$, Adjusted $R^2 = .786$, $F_{5,100} = 78.12$, $p = .000$

Interpretation:
Model is extremely strong: Adjusted $R^2 = .786$. The 5 items explain 78.6% of the variance in the composite score. Expected, since the composite is built from these items, but Beta weights show relative importance.
Strongest predictors of safe practice: Not touching face $\beta = .488$, $p < .001$ – biggest impact. Not reusing gloves $\beta = .412$, $p < .001$ – 2nd biggest.
Hand hygiene items matter but less: $\beta = .201$ and .198. They're necessary but not sufficient if face-touching/glove reuse occurs.
No multicollinearity: All VIF < 1.4. Items are distinct behaviors.

Correlation analysis between knowledge and skills and utilization of PPEs

The study also sought to establish if utilization of PPEs and knowledge& skills had a significant relationship in JTH. Table 8, which shows the results obtained from the correlation analysis, indicates that there existed a significant relationship ($r = 0.42$, $p < 0.01$), which also indicated that the variables had a strong positive correlation. being strongly reflected in employee performance.

Table 8: Correlation matrix between knowledge &skills and utilization of PPEs

	Knowledge & Skills	PPE Utilization
Knowledge & Skills	Pearson Correlation 1	.421
	Sig. 2-tailed	.000
	N	106
PPE Utilization	Pearson Correlation .421	1
	Sig. 2-tailed .000	
	N 106	106

*_Correlation is significant at the 0.01 level 2-tailed.

A Pearson correlation was computed to assess the relationship between knowledge & skills and PPE utilization among HCWs at JTH ($N = 106$). There was a moderate, positive correlation between the two variables, $r = .421$, $p < .01$. Increased knowledge and skills were associated with higher self-reported PPE utilization. However, knowledge accounted for only 17.7% of the variance in utilization, indicating that other factors such as PPE availability, workload, and risk perception play substantial roles. This is consistent with qualitative findings where staff noted that "when you have 60 patients and 10 pairs of gloves… knowledge doesn't help" (NO1).

Regression analysis for knowledge &skills

A simple linear regression was calculated to predict PPE utilization based on knowledge & skills among HCWs at JTH (N = 106). A significant regression equation was found, $F_{1,104} = 22.857$, $p < .001$, with an Adjusted R^2 of .169. HCWs' knowledge & skills significantly predicted PPE utilization ($\beta = .421$, $t = 4.781$, $p < .001$). The model indicates that a one-unit increase in knowledge & skills is associated with a 0.421 standard deviation increase in PPE utilization. However, knowledge & skills explained only 16.9% of the variance in PPE use, suggesting that other factors such as PPE availability, workload, and risk perception account for the majority of utilization behavior. These findings are consistent with qualitative data indicating that while training improves use, stock-outs and mistrust in PPE efficacy remain major barriers.

Table 9: Regression analysis for knowledge & skills.

Model	Unstandardized Coefficients	Standardized Coefficients	T	Sig.	
	B	Std. Error	Beta		
(Constant)	1.584	0.412		3.845	.000
Knowledge & Skills	0.612	0.128	.421	4.781	.000

Model Summary
R = .421
R Square = .177
Adjusted R Square = .169
Std. Error of Estimate = 0.783
$F_{1,104} = 22.857$, $p = .000$ a. Predictors: Constant, Knowledge & Skills
b. Dependent Variable: PPE Utilization

Discussion of results.

Health Care Workers' Knowledge & Skills and Utilization of Personal Protective Equipments

Overall level: Moderate, M = 3.87, SD = 0.72. Strengths: High scores for "understand how to protect myself" M = 4.16 and "guidelines help" M = 4.89. Gaps: Lores for "PPE is effective barrier" M = 2.89 and "hand hygiene before/after gloves" M = 2.67. High SDs >1.5 show polarization. Inferential: Knowledge had a moderate positive correlation with PPE utilization, $r = .421$, $p < .001$, explaining 16.9% of variance. Triangulation: MoH memos and incident reports showed substandard PPE batches undermined trust. Staff: "We know the theory… but the gloves we get tear" (NO1). The present study found moderate knowledge (M = 3.87), but low scores on "PPE is an effective barrier" (M = 2.89) and hand hygiene timing (M = 2.67). Knowledge explained only 16.9% of the variance in utilization ($r = .421$, $p < .001$). This aligns with Rosenstock's (2005) HBM, which argues that knowledge alone does not drive behavior; rather, perceived susceptibility and perceived benefits are key. At JTH, HCWs showed high perceived susceptibility – "understand how to protect myself" M = 4.16 – yet low perceived benefits of PPE as an effective barrier M = 2.89. Ugochukwu (2016) reported 91.9% of nurses in Enugu had high knowledge, while Moyo (2013) found only 17.8% in Nairobi had satisfactory knowledge. JTH sits between these. However, like Zhu et al. (2019) in Ethiopia, acceptance of hospital policies was low when PPE quality was doubted. The documentary review confirms this: JTH Post-Exposure Incident Reports Jan–June 2025 showed 7 HCWs infected despite reported PPE use due to "substandard gowns." Thus, consistent with Rosenstock (2005), when the benefit of PPE is doubted due to poor quality, knowledge does not translate to action. This explains why knowledge $\beta = .098$ became non-significant when perception was controlled for. Training gaps further weaken benefits. John et al. (2016) noted PPE training was often suboptimal, with 14% of physicians reporting no training. JTH CME records showed only 1 VHF drill for 41/300+ staff. CDC (2020) recommends frequent donning/doffing training, but JTH lacked this, mirroring Moyo (2013), where 40% of nurses at Mbagathi were not formally trained. Hence, low perceived benefit + inadequate training = weak knowledge-practice link.

Conclusion

HCWs at JTH demonstrated moderate knowledge. However, critical knowledge gaps exist regarding PPE efficacy and hand hygiene timing. While knowledge showed a moderate correlation with utilization, it was explained by variance and became non-significant when perception was controlled. Consistent with the Health Belief Model, knowledge alone is insufficient to drive PPE use when perceived benefits are undermined by experience with substandard equipment and inadequate training. The rational model of "knowledge → attitude → behavior" does not hold at JTH.

Recommendation

Juba Teaching Hospital should institutionalize mandatory competency-based training on the correct selection, donning, doffing, disposal, and safe utilization of personal protective equipment (PPE) for all healthcare workers.

These training sessions should be conducted regularly through Continuing Medical Education (CME) programs and include practical demonstrations and competency assessments to address the knowledge gaps and misconceptions identified in this study.

The hospital administration, in collaboration with the Ministry of Health, should strengthen the procurement and supply chain management systems to ensure the continuous availability of high-quality PPE in all departments. Adequate supplies of gloves, gowns, masks, face shields, and other protective equipment will minimize unsafe practices such as glove reuse and enhance compliance with infection prevention and control guidelines.

Juba Teaching Hospital should improve hand hygiene infrastructure by ensuring that all patient care areas are equipped with functional handwashing facilities, alcohol-based hand rubs, and adequate supplies of soap and water. This will promote compliance with hand hygiene before and after PPE use and reduce the risk of healthcare-associated infections.

The Infection Prevention and Control (IPC) Committee should establish routine monitoring and supportive supervision through regular PPE compliance audits. Monthly observational assessments, coupled with timely feedback and corrective actions, should be implemented to strengthen adherence to recommended PPE practices and identify areas requiring improvement.

Health training institutions and professional regulatory bodies should integrate practical PPE utilization and infection prevention competencies into pre-service training curricula and licensing examinations. This will ensure that newly qualified healthcare professionals possess the necessary knowledge and practical skills before entering clinical practice.

Hospital management should develop and prominently display updated standard operating procedures (SOPs) and visual job aids on proper PPE use and hand hygiene in all clinical units. These materials should be regularly reviewed and reinforced during departmental meetings to promote consistent adherence to infection prevention standards.

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List of Abbreviations

CDC – Centers for Disease Control and Prevention
CME – Continuing Medical Education
COVID-19 – Coronavirus Disease 2019
CSSD – Central Sterile Services Department
CVI – Content Validity Index
ENT – Ear, Nose and Throat
FMW – Female Medical Ward
FSW – Female Surgical Ward
HAI – Healthcare-Associated Infection
HBM – Health Belief Model
HCW – Healthcare Worker
HCWs – Healthcare Workers
HIV – Human Immunodeficiency Virus
ICU – Intensive Care Unit
IPC – Infection Prevention and Control
JTH – Juba Teaching Hospital
MCH – Maternal and Child Health
MMW – Male Medical Ward
MO – Medical Officer
MOH – Ministry of Health
MSW – Male Surgical Ward
NBU – Newborn Unit
NHS – National Health Service
NO – Nursing Officer
OPD – Outpatient Department
OSCE – Objective Structured Clinical Examination
PAED – Paediatrics
PPE – Personal Protective Equipment

SD – Standard Deviation
SOP – Standard Operating Procedure
SP – Standard Precautions
SPSS – Statistical Package for the Social Sciences
TB – Tuberculosis
VCT – Voluntary Counselling and Testing
VHF – Viral Hemorrhagic Fever
VIF – Variance Inflation Factor
WHO – World Health Organization
X^2 – Chi-square Statistic

Informed Consent.

Written informed consent was obtained from all participants prior to their inclusion in the study. Participants were informed about the purpose of the study, procedures involved, potential risks and benefits, and their right to withdraw at any time without penalty.

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There is no conflict of interest.

Availability of data.

Data used in this study are available upon request from the corresponding author.

Author's contribution.

IKAN designed the study, conducted data collection, cleaned and analyzed data, and drafted the manuscript.
DR.M supervised all stages of the study from conceptualization of the topic to manuscript writing and submission.

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