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ORIGINAL RESEARCH

Factors Associated with Patient Contact Management and Self-Reported Infection Risk Exposure Status Among Healthcare Workers: A Retrospective Cross-Sectional Study in Palu City, Indonesia

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ABSTRACT

Introduction: Effective disaster management at national and global levels remains a major challenge in preparing for future pandemic risks. Experiences from major outbreaks such as Ebola, SARS, and COVID-19 highlight the need to strengthen emergency response systems in healthcare facilities. Patient contact management is an important component of infection-risk mitigation in healthcare settings because it aims to interrupt the transmission of infectious microorganisms. This study aimed to analyze factors associated with patient contact management and self-reported infection-exposure risk status among healthcare workers during the COVID-19 pandemic in Palu City, Indonesia.

Methods: This quantitative retrospective cross-sectional study was conducted from April 2024 to July 2025 at 14 community health centers and one regional hospital in Palu City, Indonesia. Using proportional stratified random sampling, 131 participants were selected from a population of 198 healthcare workers. Data were analyzed using the chi-square test and Cramer's V.

Results: Health-worker protection measures ($p < 0.001$; Cramer's V = 0.543) and infection zoning ($p < 0.001$; Cramer's V = 0.612) showed the strongest associations with patient contact management, followed by institutional/facility policy ($p < 0.001$; Cramer's V = 0.506) and triage management ($p < 0.001$; Cramer's V = 0.500). Workplace, gender, and contact duration were not significantly associated with patient contact management ($p > 0.05$). Self-reported interactions lasting 3–5 minutes were the most frequent during patient care; however, contact duration was not significantly associated with either patient contact management or infection-exposure risk. Clinical skills were significantly associated with self-reported infection-exposure risk ($p < 0.001$; Cramer's V = 0.361).

Conclusion: Patient contact management among healthcare workers was associated with individual and institutional factors, including knowledge, institutional/facility policy, health-worker protection, triage management, and infection zoning. Self-reported infection-exposure risk was significantly associated with healthcare workers' clinical skills.

Keywords: Infection Exposure Risk; Patient Contact Management; Healthcare Workers; Healthcare Services

INTRODUCTION

Building effective disaster management at national and global levels remains a challenge as disaster risks become increasingly diverse (1). Experience from major outbreaks such as Ebola, SARS, and COVID-19 demonstrates the need to strengthen emergency response systems in healthcare facilities (2,3). The Middle East respiratory syndrome coronavirus (MERS-CoV), first identified in 2012, caused a major outbreak in South Korea in 2015, with 186 cases and 38 deaths. The outbreak highlighted vulnerabilities in healthcare facilities, where nearly half of all cases (44%) were associated with transmission in healthcare settings (4).

Healthcare-associated infections are a major challenge because they contribute substantially to morbidity, mortality, and reduced quality of life (5). Globally, they also impose a considerable economic burden on healthcare systems. Whether endemic or epidemic, healthcare-associated infections remain a serious threat to public health and a major barrier to safe healthcare delivery (6,7).

Hospital-acquired, or nosocomial, infections are infections acquired during the course of healthcare delivery. System-level problems, including inadequate decontamination procedures and poor hand hygiene, can facilitate the transmission of infectious agents and have been associated with outbreaks involving hepatitis B and C viruses and group A Streptococcus (8).

Contact precautions in healthcare settings comprise measures designed to reduce the transmission of pathogens spread through direct or indirect contact (3,9). Patient contact management is an important component of infection-risk mitigation in healthcare facilities because it aims to interrupt the chain of transmission. It combines standard precautions, isolation measures, and education to protect patients, healthcare workers, and visitors (10,11).

Healthcare workers may face greater infection risks than workers in other sectors, particularly in resource-constrained settings. One review reported frequent occupational exposure among healthcare personnel, whereas implementation of work-restriction policies for infected staff remained limited (8). High infection rates among healthcare workers during critical phases of outbreaks can create additional barriers within emergency response systems (12,13). During the SARS-CoV and MERS-CoV outbreaks, patient-to-patient and patient-to-healthcare-worker transmission occurred in healthcare settings (4,8). Many healthcare-associated infections can be prevented through systematic infection prevention and control (IPC) strategies (6).

A key concern is the limited implementation of protective policies in practice, particularly work restrictions for infected staff (14,15). Although IPC strategies can mitigate risk, evidence remains limited regarding how systematic patient contact management can be implemented effectively in resource-constrained settings (16). In addition, the literature has not clearly established whether the duration of physical interaction is associated with reduced transmission risk among healthcare workers during critical phases of emergency response (17).

Data from Anutapura Regional General Hospital in Palu indicated that 45% of healthcare workers in Palu City were infected with COVID-19 during the pandemic. High infection and mortality rates among healthcare workers can weaken health systems and expose gaps in preparedness for emerging infectious diseases (12,18). This study aimed to analyze factors associated with patient contact management and self-reported infection-exposure risk status among healthcare workers during the COVID-19 pandemic in Palu City, Indonesia. The study did not measure clinically or laboratory-confirmed infections.

METHODS

Research Type

This study used a retrospective cross-sectional design to analyze factors associated with patient contact management and self-reported infection-exposure risk among healthcare workers who provided care during the peak of the COVID-19 pandemic (2020–2022) in Palu City, Central Sulawesi, Indonesia. Data were collected retrospectively from April 2024 to July 2025 across 15 government-owned healthcare facilities, comprising 14 community health centers and one regional public hospital (RSUD Anutapura, Palu). The study sites were selected purposively and were limited to facilities that had implemented a standardized emergency medical triage system in their emergency departments. Reporting was checked against the STROBE recommendations for cross-sectional observational studies where applicable.

Population and Sample/Informants

The sample-size calculation used a 5% margin of error, a 95% confidence level, and a 50% response distribution for a population of 198 healthcare workers. Using the Raosoft sample-size calculator, the required sample was 131 participants. Proportional stratified random sampling was used because the population was heterogeneous and the number of individuals in each stratum varied. Eligible participants included physicians, nurses, midwives, and surveillance staff affiliated with Anutapura General Hospital or community health centers. The sampling frame was compiled from official staff rosters across the 15 facilities. Proportional allocation was planned across the sampling strata shown in Table 1, and participants were selected using a random-number generator. A 10% oversampling allowance was planned to mitigate potential nonresponse or withdrawal; the final analytical sample comprised 131 participants. Participants were required to have at least two years of work experience in their respective units and a history of providing direct care in isolation wards, emergency departments (EDs), or other COVID-19 treatment units during the pandemic, including the management of suspected or confirmed COVID-19 patients. Healthcare workers who provided only nonclinical administrative services during the pandemic or who had no involvement in COVID-19 patient care were excluded. The planned sample allocation is shown in Table 1.

Table 1. Planned Proportional Sample Allocation by Occupational Stratum

No	Health Workers	Population in Stratum	Sample Size
1.	General Practitioner/Specialist	18	12
2.	Midwife	15	10
3.	Surveillance	15	10
4.	Nurse	150	99
	Total		**131**

Research Location

Data collection was conducted at 15 government-owned healthcare facilities in Palu City, Indonesia: 14 community health centers (*Puskesmas*) and one regional general hospital (RSUD Anutapura Palu). These sites represented both community-based and hospital-based healthcare settings in which patient contact management and care for patients with suspected or confirmed COVID-19 were implemented.

Instrumentation or Tools

Data were collected retrospectively using a structured questionnaire developed for the study objectives. Respondents were asked to recall their experiences, working conditions, and practices during the peak of the COVID-19 pandemic (2020–2022) in Palu City, Indonesia. This retrospective approach was intended to capture healthcare workers' experiences of patient contact management and infection-exposure risk during the pandemic, which could not be observed directly during the post-pandemic data-collection period.

The questionnaire comprised two main sections. Section 1 collected respondent demographic and background characteristics, including work unit, gender, education level, length of service, and history of interactions and caregiving activities involving patients with infectious diseases. These characteristics were used to describe the study population and to examine their relationships with patient contact management and self-reported infection-exposure risk.

Section 2 assessed patient contact management and infection-exposure risk during 2020–2022. The components evaluated included: (1) patient classification and triage, including the accuracy and timeliness of initial triage according to patient condition; (2) clinical capacity and competence, including healthcare workers' knowledge and skills related to minimizing contact and managing infection risks; and (3) facilities, policies, and safety, including the availability of personal protective equipment (PPE), institutional policies, workplace safety procedures, contact-duration control, and implementation of risk zones (e.g., green, yellow, and red areas). The operational definitions are presented in Table 2.

Table 2. Operational Definition of Variables

Variable	Dimension/Indicators	Answer Option	Scale
Patient Contact Management: Measures taken by healthcare personnel in healthcare facilities to prevent the transmission of pathogens.	Assessment of Criteria and Patient Status: Identify patient status (suspected/confirmed infectious disease). Implementation of standard precautions and transmission based precautions.	Good / Not Good	Ordinal
Internal Factors	Knowledge regarding patient contact management and clinical skills in handling infectious patients Work Experience: Length of service/working duration in healthcare services.	Good / Not Good	Ordinal
External Factors	Institutional Policy: Availability and implementation of infection control guidelines/SOPs. Facility & Infrastructure: Availability of spatial facilities for infection control Protection & Safety: Availability and proper use of Personal Protective Equipment (PPE). Triage Implementation: Carrying out initial patient risk-sorting procedures upon entry. Zoning Implementation: Separation and enforcement of risk areas (e.g., green, yellow, red zones). Duration Control: Enforcement of time limits on direct interaction with infectious patients (based on respondents' perceptions or self-reports)	Good / Not Good	Ordinal
Risk of exposure to infection The susceptibility of healthcare workers to contracting infectious agents from patients, whether directly or indirectly.	Contact Probability; Intensity of direct or indirect contact.	Yes / No	Nominal

The research instrument comprised 14 questions mapped to the study domains. Patient contact management was measured using the first set of items, whereas self-reported infection-exposure risk was measured using items addressing contact intensity and probability. Respondent characteristics, including gender, workplace, and education level, were used to describe the study population. Knowledge was assessed using cognitive items, whereas clinical skills were assessed using indicators of operational actions. Institutional policy, healthcare-worker protection, triage management, contact duration, and infection zoning were assessed using corresponding facility- and service-related items.

To align the measurement approach with the variables presented in Tables 5 and 6, the instrument used two- and three-level categorizations according to the characteristics of each variable. Dichotomous categories (e.g., Poor/Good or Yes/No) were

used for patient contact management, knowledge, protection, policy, and triage management. Three-level categories were used for clinical skills and infection zoning (Poor, Fair, and Good) and for contact duration (<2 minutes, 3–5 minutes, and >5 minutes). The stated category thresholds were based on proportional cutoffs derived from accumulated indicator scores within each domain. Item mapping and scoring are shown in Table 3.

Table 3. Mapping of Items and Scores

No	Variable / Domain	Indicators / Dimensions	Questions / Statements	Answer Choices & Item Scoring	Domain Score Range & Categorization	Item r	Critical r
1	Patient Contact Management	Assessment of Criteria & Patient Status	Carefully identify the patient's status (suspect / confirmed infection) before taking action?	• Yes = 1 • No = 0	PCM Sub-scores (Items 1–3): • Total Score: 0 – 3 Categorization (2-Level): • Poor: 0–1 • Good: 2–3 Categorization (3-Level): • Poor: 0 – 1 (< 60%) • Adequate: 2 (60% – 79%) • Good: 3 (80% – 100%)	0.194	0.172
2	Patient Contact Management	Standard Precautions	Do you always apply standard precautions in every patient care?	• Yes = 1 • No = 0	(Included in PCM Sub-scores Item 1–3)	0.636	0.172
3	Patient Contact Management	Transmission-based Precautions	Do you apply transmission-based precautions according to the patient's pathogen type?	• Yes = 1 • No = 0	(Included in PCM Sub-scores Item 1–3)	0.044	0.172
4	Internal Factors	Knowledge	What is your level of understanding and knowledge regarding patient contact management procedures and clinical management of infectious patients?	• Good / Correct = 1 • Less / Wrong = 0	Knowledge Sub-score (Item 4): • Total Score: 0 – 1 Categorization (2-Level): • Poor: 0 (< 75%) • Good: 1 (≥ 75%)	0.192	0.172
5	Internal Factors	Clinical Skills	What is your level of clinical skills in managing and caring for patients with infectious diseases?	• Very Good = 4 • Good = 3 • Sufficient = 2 • Poor = 1	Skill Sub-score (Item 5): Categorization (3-Level): • Poor: (< 60%) • Adequate: (60% – 79%) • Good: (≥ 80%)	0.051	0.172
6a	Internal Factors	Work Experience (Perception Evaluation)	How do you evaluate/perceive the duration and support of work experience in handling infectious patients?	• Positive / Good = 1 • Negative / Less = 0	Work Experience Sub-score (Combined 6a & 6b): Categorization (3-Level): • Poor: (< 60%) • Adequate: (60% – 79%) • Good: (≥ 80%)	0.589	0.172
6b	Internal Factors	Work Experience (Work Period / Duration)	How long have you worked in a healthcare facility supporting patient care experience?	• >10 Years = 3 • 6–10 Years = 2 • 2–5 Years = 1	(Combined with Item 6a)	0.589	0.172
7	External Factors	Institutional Policy (Policy / SOP)	How is the availability and implementation of infection control guidelines/SOPs in your workplace?	• Existing & Implemented = 1 • Absent / Not Implemented = 0	External Factor Sub-scores (Items 7–12): • Total Score: 3 – 14 - Item 7, 10: Binary (0–1) - Item 8, 11: Scale (1–3) - Item 9: Scale (0–3) - Item 12: Reverse (1–3) Categorization (2-Level): • Poor: 3 – 10 (< 75%) • Good: 11 – 14 (≥ 75%) Categorization (3-Level): • Poor: 3 – 8 (< 60%) • Fair: 9 – 11 (60% – 79%) • Good: 12 – 14 (≥ 80%)	0.488	0.172

No	Variable / Domain	Indicators / Dimensions	Questions / Statements	Answer Choices & Item Scoring	Domain Score Range & Categorization	Item r	Critical r
8	External Factors	Facilities & Infrastructure	How are the availability and arrangement of room facilities to support infection control in your healthcare facility?	• Very Good = 3 • Good = 2 • Poor = 1	(Included in External Factors Sub-Scores Item 7–12)	0.589	0.172
9	External Factors	Protection & Safety (PPE)	How is the availability and appropriate use of Personal Protective Equipment (PPE) for health workers?	• Very Good = 3 • Good = 2 • Sufficient = 1 • Poor = 0	(Included in External Factors Sub-scores Item 7–12)	0.655	0.172
10	External Factors	Triage Implementation	How is the initial risk triage procedure carried out for patients when they first enter a health facility?	• Applied = 1 • Not Applied = 0	(Included in External Factors Sub-scores Item 7–12)	0.655	0.172
11	External Factors	Zoning Infection	How is the separation and enforcement of risk areas (e.g., green, yellow, red zones) implemented in your work environment?	• Very Good = 3 • Good = 2 • Poor = 1	(Included in External Factors Sub-scores Item 7–12)	0.574	0.172
12	External Factors	Duration Control (Time Limit)	What is the average duration of your direct interaction with an infectious patient in one procedure?	• <2 Minutes = 3 (Low Risk) • 3–5 Minutes = 2 (Medium Risk) • >5 Minutes = 1 (High Risk) (Reverse Scoring)	(Included in External Factors Sub-scores Item 7–12)	0.288	0.172
13	Risk of Exposure to Infection	Contact Intensity	Have you ever had direct or indirect contact with high intensity with suspected/confirmed patients?	• Yes (High Risk) = 1 • No (Low Risk) = 0	Exposure Risk Sub-score (Items 13–14): • Total Score: 0 – 2 Categorization (2-Level): • Low Exposure Level: 0 – 1 • High Exposure Level: 2	0.455	0.172
14	Risk of Exposure to Infection	Contact Probability	Have you ever been in a situation that increased the probability/likelihood of exposure to infectious agents while providing services?	• Yes (High Risk) = 1 • No (Low Risk) = 0	(Included in Exposure Risk Sub-score Item 13–14)	0.455	0.172

Instrument validity and reliability were evaluated at the item and domain levels. Item validity was assessed using Pearson product-moment correlations by comparing the calculated r value with the critical r value of 0.172 at a 5% significance level (df = 129; N = 131). Based on the values reported in Table 3, Items 1, 2, 4, and 6a–14 exceeded the stated critical value, whereas Item 3 (r = 0.044) and Item 5 (r = 0.051) did not. The overall Cronbach's alpha was 0.768.

Data Collection Procedures

Primary and secondary data were collected in the field. Researchers provided technical assistance during questionnaire completion to minimize information bias, support data accuracy, and protect respondent privacy. Patient contact management was defined as measures undertaken by healthcare workers to prevent pathogen transmission in healthcare facilities. Self-reported infection-exposure risk was operationalized using Items 13–14, which assessed high-intensity direct or indirect contact and situations that increased the probability of exposure to infectious agents while providing care. Contact duration was analyzed separately as an external factor rather than as the defining indicator of the exposure-risk outcome. The study also assessed triage management, risk-based zoning (green, yellow, and red), internal factors (competence and work experience), and external factors (institutional policies/SOPs, facility conditions, and PPE).

Data Analysis

Bivariate analyses were conducted to examine factors associated with patient contact management (Table 5) and self-reported infection-exposure risk (Table 6). Associations were tested using the chi-square test and Cramer's V. The strength of association was classified as very weak (0.00 to <0.10), weak (0.10–0.30), moderate (>0.30–0.50), and strong (>0.50). Statistical significance was defined as $p < 0.05$. All analyses presented in Tables 4–6 used the full analytical sample of 131 participants. Analyses were performed using IBM SPSS Statistics (IBM Corp., Armonk, NY, USA).

Ethical Approval

The study protocol was approved by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Tadulako University (No. 4608/UN28.1.30/KL/2024). All participants provided written informed consent, and the confidentiality of participant information and responses was maintained.

RESULTS

Participant characteristics are presented in Table 4.

Table 4. Respondent Characteristics

Characteristics	Description	Frequency	%
Gender	Female	26	19.8
	Male	105	80.2
Work experience	2–5 years	29	22.1
	6–10 years	37	28.2
	>10 years	65	49.6
Education level	D3 Nursing/Midwifery	12	9.2
	Bachelor of Nursing/Midwifery	76	58.0
	General Practitioner/Specialist	16	12.2
	Surveillance	27	20.6
Workplace	Community health centers	46	35.1
	Hospital	85	64.9
Close contact	Yes	107	81.7
	No	24	18.3

Among the 131 respondents, 105 (80.2%) were male. Nearly half had more than 10 years of work experience (49.6%), and 58.0% had a bachelor's degree in nursing or midwifery. Most respondents worked in hospitals (64.9%), and 107 (81.7%) reported a history of close contact.

Bivariate analyses using the chi-square test and Cramer's V examined factors associated with two outcomes: patient contact management (Table 5) and self-reported infection-exposure risk (Table 6). These outcomes were based on retrospective self-reports and did not represent clinically or laboratory-confirmed infection diagnoses.

Table 5. Patient Contact Management

Variables		Patient Contact Management (%)		X^2 Value	df	p value	Cramer's V
		Not Good	Good				
Workplace	Community health centers	11.5%	23.7%	0.144	1	0.705 [a]	0.033
	Hospital	19.1%	45.8%				
Gender	Female	4.6%	15.3%	0.851	1	0.356 [a]	0.081
	Male	26.0%	54.2%				
Education/professional category	D3 Nursing/Midwifery	0.8%	8.4%	12.101	3	0.007 [b]	0.295
	Bachelor of Nursing/Midwifery	19.8%	38.2%				
	General Practitioner/Specialist	6.9%	5.3%				
	Surveillance and others	3.1%	17.6%				
Work experience	2–5 years	2.3%	19.8%	8.487	2	0.014 [a]	0.255
	6–10 years	12.2%	16.0%				
	>10 years	16.0%	33.6%				
Knowledge	Not good	27.5%	28.2%	27.418	1	<0.001 [a]	0.457
	Good	3.1%	41.2%				
Skills	Not good	1.5%	6.9%	11.543	2	0.003 [a]	0.297
	Enough	22.9%	29.8%				
	Good	6.1%	32.8%				
Institutional / Facility Policy	Not good	16.8%	6.1%	33.603	1	<0.001 [a]	0.506
	Good	13.7%	63.4%				
Protection for Health Workers	Not good	15.3%	3.1%	38.618	1	<0.001 [a]	0.543
	Good	15.3%	66.4%				
Triage Management	Not good	14.5%	3.8%	32.763	1	<0.001 [a]	0.500
	Good	16.0%	65.6%				
Contact Duration	<2 minutes	7.6%	15.3%	4.536	2	0.104 [a]	0.186
	3–5 minutes	20.6%	38.2%				
	>5 minutes	2.3%	16.0%				
Infection zone	Not good	6.1%	0.0%	49.010	2	<0.001 [a]	0.612
	Enough	9.9%	1.5%				
	Good	14.5%	67.9%				

χ^2 values were calculated using Pearson's chi-square test. Superscript a indicates that Pearson's chi-square test was used; superscript b indicates that Fisher's exact test or the likelihood-ratio test was used when the expected-frequency assumption was not met (expected count <5 in >20% of cells). Statistical significance was defined as $p < 0.05$.

The bivariate analysis indicated that patient contact management was associated with several individual and institutional factors. Under the Cramer's V thresholds specified in the Methods, infection zoning ($p < 0.001$; $V = 0.612$), healthcare-worker protection ($p < 0.001$; $V = 0.543$), and institutional/facility policy ($p < 0.001$; $V = 0.506$) showed strong associations; triage management ($p < 0.001$; $V = 0.500$) and knowledge ($p < 0.001$; $V = 0.457$) showed moderate associations; and profession ($V = 0.295$), clinical skills ($V = 0.297$), and work experience ($V = 0.255$) showed weak associations. Workplace, gender, and contact duration were not significantly associated with patient contact management ($p > 0.05$). Contact duration was not statistically significant ($p = 0.104$; $V = 0.186$), although interactions lasting 3–5 minutes were the most frequently reported category. Infection zoning showed the largest Cramer's V value ($V = 0.612$).

These findings suggest that institutional policy, healthcare-worker protection, triage management, and infection zoning are important components of patient contact management in healthcare settings. Good infection zoning was reported for 67.9% of respondents. The data for factors associated with self-reported infection-exposure risk are presented in Table 6.

Table 6. Infection Exposure Risk Status Based on Self-Reporting

Variables		Risk of Exposure to Infection		X^2 Value	df	p value	Cramer's V
		Yes	No				
Workplace	Community Health Centers	31.3%	3.8%	2.630	1	0.105 [a]	0.142
	Hospital	50.4%	14.5%				
Gender	Female	17.6%	2.3%	0.997	1	0.406 [a]	0.087
	Male	64.1%	16.0%				
Education/professional category	D3 Nursing/Midwifery	6.9%	2.3%	3.609	3	0.307 [b]	0.170
	Bachelor of Nursing/Midwifery	50.4%	7.6%				
	General Practitioner/Specialist	8.4%	3.8%				
	Surveillance and others	16.0%	4.6%				
Work experience	2–5 years	17.6%	4.6%	0.803	2	0.669 [a]	0.078
	6–10 years	24.4%	3.8%				
	>10 years	39.7%	9.9%				
Knowledge	Not good	44.3%	11.5%	0.547	1	0.460 [a]	0.065
	Good	37.4%	6.9%				
Skills	Not good	3.8%	4.6%	15.835	2	<0.001 [b]	0.361
	Enough	48.9%	3.8%				
	Good	29.0%	9.9%				
Policy	Not good	20.6%	2.3%	1.800	1	0.180 [a]	0.117
	Good	61.1%	16.0%				
Protection for Health Workers	Not good	16.0%	2.3%	0.665	1	0.564 [b]	0.071
	Good	65.6%	16.0%				
Triage Management	Not good	15.3%	3.1%	0.054	1	1.000 [b]	0.020
	Good	66.4%	15.3%				
Contact Duration	<2 minutes	20.6%	2.3%	2.333	2	0.311 [b]	0.129
	3–5 minutes	47.3%	11.5%				
	>5 minutes	13.7%	4.6%				
Infection zone	Not good	5.3%	0.8%	0.559	2	0.756 [b]	0.063
	Enough	9.9%	1.5%				
	Good	66.4%	16.0%				

χ^2 values were calculated using Pearson's chi-square test. Superscript a indicates that Pearson's chi-square test was used; superscript b indicates that Fisher's exact test or the likelihood-ratio test was used when the expected-frequency assumption was not met (expected count <5 in >20% of cells). Statistical significance was defined as $p < 0.05$.

Table 6 presents self-reported infection-exposure risk among 131 respondents. Among the 46 respondents working in community health centers, 41 (31.3% of the total sample) were classified as exposed to infection risk and 5 (3.8%) were not. Among the 85 respondents working in hospitals, 66 (50.4%) were classified as exposed to infection risk and 19 (14.5%) were not.

Within each facility type, 89.13% of respondents working in community health centers (41/46) were classified as exposed to infection risk, compared with 77.65% of hospital respondents (66/85). Despite this difference in proportions, workplace was not significantly associated with self-reported infection-exposure risk.

Among 26 female respondents, 23 (17.6% of the total sample) were classified as exposed to infection risk and 3 (2.3%) were not. Among 105 male respondents, 84 (64.1%) were classified as exposed to infection risk and 21 (16.0%) were not. Workplace and gender were not significantly associated with infection-exposure risk. Contact duration of 3–5 minutes was the most frequently reported category (58.8% of respondents), but contact duration was not significantly associated with infection-exposure risk ($p = 0.311$; Cramer's $V = 0.129$). Knowledge, institutional policy, healthcare-worker protection, triage management, and infection zoning were also not significantly associated with infection-exposure risk ($p > 0.05$). Clinical skills were significantly associated with infection-exposure risk ($p < 0.001$; Cramer's $V = 0.361$).

Self-reported infection-exposure risk was most frequent among respondents with a bachelor's degree in nursing or midwifery and among those with more than 10 years of work experience; however, these descriptive patterns should not be interpreted as evidence of association where the corresponding statistical tests were nonsignificant. Contact duration

of 3–5 minutes was also the most common duration among respondents classified as exposed to infection risk (47.3% of the total sample). Of the variables examined, clinical skills showed a statistically significant association with infection-exposure risk ($p < 0.001$; Cramer's V = 0.361).

DISCUSSION

Respondent characteristics, including length of service, education level, and professional background, may shape healthcare workers' knowledge and practical experience. Previous studies have reported relationships between work experience, knowledge, and clinical skills, particularly among healthcare workers with several years of service in hospitals and community health centers (2,18). In the present study, work experience was significantly associated with patient contact management but not with self-reported infection-exposure risk.

Healthcare-worker competence reflects the interaction of internal and external factors. Nurses and physicians require knowledge and technical skills to implement infection-control measures (19,20), but these individual capabilities operate within institutional systems such as policies, healthcare-worker protection, triage management, and infection zoning. Knowledge of disease transmission, patient assessment, and contact monitoring can support safe care; however, institutional workflows and resources also influence how these competencies are applied in practice. The following sections discuss factors associated with patient contact management and self-reported infection-exposure risk across the participating healthcare facilities.

Patient Contact Management

In this study, patient contact management was defined as measures implemented by healthcare workers to prevent pathogen transmission. Table 5 shows statistically significant associations between patient contact management and several individual and institutional factors, including knowledge, clinical skills, institutional/facility policy, healthcare-worker protection, triage management, and infection zoning. Patient contact management therefore appears to reflect both individual capacity and institutional support systems (17,21). Professional knowledge and technical skills may provide the foundation for safe patient care, while standardized workflows and organizational resources support implementation in practice (13,22–26).

Patient contact management should not be viewed as an isolated process; rather, it is shaped by interactions between individual capacity and the work environment (19,27). Infection-control zoning can create physical separation between risk areas, while effective triage can support early screening and appropriate patient placement. By separating infectious from noninfectious areas, these measures may reduce unnecessary contact among healthcare personnel and limit cross-transmission through droplets, direct contact, or contaminated surfaces (8).

Consistent with the significant association between triage management and patient contact management observed in Table 5, previous literature has emphasized the role of triage in healthcare facilities (23). Effective triage can serve as an initial screening step for identifying transmission risk and guiding patient placement according to established zoning criteria. Separating infectious and noninfectious areas may reduce unnecessary interactions among personnel and limit cross-transmission through droplets, direct contact, or contaminated objects (21).

Overall, the findings indicate that patient contact management is associated with a combination of individual and institutional factors. Knowledge can support early risk recognition, while policies, triage procedures, healthcare-worker protection, and infection zoning can translate that knowledge into operational practice. Effective patient contact management therefore depends on both staff competence and supportive institutional systems.

Risk of Exposure to Infection

Table 6 showed that the proportion of respondents classified as exposed to infection risk was higher in community health centers (89.13%) than in hospitals (77.65%), but the association between facility type and infection-exposure risk was not statistically significant. Demographic variables were likewise not significantly associated with infection-exposure risk. These measures reflected self-reported exposure-related conditions rather than clinically confirmed infections. Interactions lasting 3–5 minutes were the most common contact-duration category. Although exposure-risk classifications were frequent among respondents with a bachelor's degree in nursing or midwifery and among those with more than 10 years of service, profession and work experience were not significantly associated with the exposure-risk outcome (24,25,28).

Previous research has identified clinical competence as an important component of infection prevention and safe patient care (10,29). Appropriate clinical skills may help healthcare workers reduce unsafe close contact and follow infection-control procedures (9,30). Inadequate decontamination, poor hand hygiene, and errors in the use or removal of PPE can increase opportunities for pathogen transmission (8,9,11,26). In the present study, clinical skills were significantly associated with self-reported infection-exposure risk, whereas the other examined individual and institutional factors were not.

Limitations and Cautions

This retrospective study has several limitations. First, data were collected using self-administered questionnaires and depended on respondents' recall of events that occurred during 2020–2022, creating a risk of recall and information bias. Second, the cross-sectional design captured data at a single post-pandemic assessment and did not include longitudinal monitoring or laboratory confirmation of infection. Accordingly, infection-exposure risk was based on self-report. Third, only bivariate analyses were performed, so the observed associations may have been influenced by unmeasured or unadjusted factors such as profession, facility type, and specific job responsibilities.

Recommendations for Future Research

Future research should address these limitations by prospectively evaluating whether and how healthcare workers' technical skills are associated with infection exposure. Observational studies or direct competency assessments may help clarify the relationship between clinical skills, adherence to standard operating procedures, and objectively measured infection-exposure outcomes in healthcare settings.

CONCLUSION

The outcomes in this study were patient contact management and self-reported infection-exposure risk, not clinically or laboratory-confirmed infection. The findings are summarized as follows:

Patient contact management was significantly associated with knowledge, clinical skills, profession, work experience, institutional/facility policy, healthcare-worker protection, triage management, and infection zoning. The strongest effect-size category was observed for infection zoning, healthcare-worker protection, and institutional/facility policy; knowledge and triage management were moderate, while profession, clinical skills, and work experience were weak under the thresholds specified in the Methods.

Interactions lasting 3–5 minutes were the most frequently reported contact-duration category, but contact duration was not significantly associated with either patient contact management or self-reported infection-exposure risk.

Clinical skills were significantly associated with self-reported infection-exposure risk among healthcare workers across community health centers and the hospital.

DECLARATIONS

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