



Knowledge, Attitude, and Practice of Nurses Regarding Nosocomial Infection Control: A KAP Study in Iran

Mojtaba Senmar ¹, Hamidreza Ghafelehbashi ¹, Zahra Hosseinkhani ², Najmeh Chegini ³, Farnoosh Zarabadi Poor ³, Fatemeh Nazari Shadokam ², Ahmad Reza Barzegar Shaghaghi ³, Mohammadreza Asadi ^{3,*}

¹ Metabolic Diseases Research Center, Research Institute for prevention of Non-communicable Disease, Qazvin University of Medical Sciences, Qazvin, Iran

² Non-communicable Diseases Research Center, Research Institute for Prevention of Non-communicable Diseases, Qazvin University of Medical Sciences, Qazvin, Iran

³ Student Research Committee, Qazvin University of Medical Sciences, Qazvin, Iran

*Corresponding Author: Student Research Committee, Qazvin University of Medical Sciences, Qazvin, Iran. Email: mr.asadi@qums.ac.ir

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Abstract

Background: Healthcare-associated infections (HAIs) pose major challenges to health systems worldwide and threaten patients and staff. Nurses play a key role in their prevention and control.

Objectives: This study investigated nurses' knowledge, attitudes, and practices (KAP) regarding nosocomial infection control in Iran.

Methods: This cross-sectional study included 430 nurses selected by systematic random sampling from three tertiary teaching hospitals in Qazvin, Iran, in 2024. The inclusion criteria were ≥ 3 months of nursing experience, a bachelor's degree, and willingness to participate. Data were collected using a demographic checklist and a self-administered KAP questionnaire and analyzed in SPSS using descriptive statistics and linear regression.

Results: Most nurses were female (70.5%) and married (60.7%). Moderate knowledge, positive attitudes, and good self-reported practice were reported among 67.4%, 49.5%, and 86.3% of nurses, respectively. Univariate regression showed significantly lower KAP scores in male nurses than in female nurses (knowledge: $\beta = -0.27$; attitude: $\beta = -0.25$; practice: $\beta = -0.41$). Married nurses had higher knowledge scores than single nurses ($\beta = 0.27$), and nurses working rotating shifts scored higher than those working fixed shifts ($\beta = 0.39$). Nurses with 16 - 20 years of experience had higher knowledge scores than those with < 1 year of experience. Multiple regression confirmed sex-related differences and the associations between shift type and work experience and knowledge.

Conclusions: Most nurses had moderate knowledge, nearly half had positive attitudes, and most reported good practices. Managers should prioritize improving knowledge and fostering positive attitudes among nurses with neutral attitudes, along with direct observational monitoring, to support effective infection control.

Keywords: Knowledge, Attitudes, Practices, Infection, Nurses

1. Background

Healthcare-associated infections (HAIs), historically termed nosocomial infections, are defined by the World Health Organization (WHO) as infections acquired during hospital care that were neither present nor incubating at admission. They typically manifest 48 - 72 hours after

admission or shortly after discharge (1-3). Globally, HAIs pose a serious threat to patient safety and are a major indicator of healthcare quality (4). At any given time, more than 1.4 million hospitalized individuals worldwide are affected by these infections, which contribute to substantial morbidity, prolonged hospital stays, antimicrobial overuse, and increased mortality (5-10).

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Although HAIs have substantial economic consequences in high-income countries (11-13), developing health systems bear an estimated 25% higher burden because of infrastructure and resource constraints (14).

Up to one-third of HAIs are preventable through consistent adherence to standard infection control protocols and strict hand hygiene (15). Transmission frequently occurs via the contaminated hands of healthcare personnel or through improper handling of clinical equipment and medical waste (1); therefore, healthcare workers serve as the first line of defense (16). Nurses constitute the largest group of clinical professionals and have the most continuous, direct bedside contact with patients (17-18). Their adherence to infection control measures is therefore a key determinant of whether pathogen transmission is interrupted or cross-contamination occurs in clinical settings (18).

Effective infection prevention depends on the interplay of knowledge, attitude, and practice (KAP) (19). Within behavioral frameworks such as Kelman's theoretical model, adequate knowledge provides a conceptual foundation for adherence to procedures, whereas a favorable professional attitude helps translate awareness into sustained clinical behavior (5, 20-22). Nevertheless, studies in diverse international settings have identified substantial differences in nurses' KAP profiles (21, 23-26). For example, an Iranian survey by Soleimani et al. found predominantly average levels of knowledge (79.8%) and practice (62.8%), along with notable gaps in adherence (27). Studies in other regional settings have also reported discrepancies between theoretical knowledge and self-reported adherence (26).

These differing findings indicate that infection control behaviors are strongly influenced by institutional infrastructure, organizational safety culture, and local clinical training programs (16, 28). Evolving clinical challenges and the need for updated baseline data from Iranian tertiary care centers underscore the importance of assessing current KAP levels to design targeted, evidence-based in-service training programs.

2. Objectives

This study aimed to assess knowledge, attitudes, and self-reported practices regarding infection control and to identify associated sociodemographic predictors among clinical nurses at teaching hospitals in Iran.

3. Methods

3.1. Study Design and Setting

This descriptive cross-sectional study was conducted in 2024 among clinical nurses employed at three major teaching hospitals affiliated with Qazvin University of Medical Sciences: Velayat, Bu-Ali, and Shahid Rajaei. The sample size was calculated using Cochran's single-proportion formula:

$$n = \frac{Z_{1-\frac{\alpha}{2}}^2 p(1-p)}{d^2}$$

In this formula, $Z_{1-\alpha/2} = 1.96$ corresponds to a 95% confidence level, $p = 0.37$ represents the expected proportion with satisfactory infection control practice based on previous evidence, $1-p = 0.63$, and $d = 0.05$ is the margin of precision. The calculation yielded a baseline sample size of 358 nurses. To account for potential clustering across hospital departments and shifts (design effect = 1.2) and anticipated incomplete questionnaires, the final target sample size was set at 431 nurses.

A proportional stratified systematic random sampling strategy was used. Complete staff registries were obtained from the nursing management offices of the three hospitals. The sample was allocated proportionally across the centers: 162 nurses from Velayat Hospital, 142 from Bu-Ali Hospital, and 127 from Shahid Rajaei Hospital. The sampling interval ($k = N/n$) was calculated for each institution. The first participant was selected using a random integer between 1 and k , and every k th nurse thereafter was approached systematically across departments and shifts. The inclusion criteria were at least three months of clinical nursing experience, at least a bachelor's degree in nursing, and the provision of written informed consent. Nurses who left more than 20% of questionnaire items unanswered or withdrew from participation were excluded.

3.2. Data Collection Instruments

3.2.1. Demographic Checklist

Demographic information was collected using a researcher-developed checklist that covered age, sex, marital status, employment status, work experience, hospital department, and shift type.

3.2.2. Knowledge, Attitude and Practice of Clinical Staff About Nosocomial Infections Instrument

We used the validated Persian instrument developed by Soleimani et al. (27), which comprises 45 items across three 15-item domains: knowledge (dichotomous responses; score range 0 - 15), attitude (3-point Likert scale; score range 0 - 30), and self-reported practice (5-point Likert scale; score range 0 - 60). The practice domain assesses self-reported behavior rather than directly observed behavior. Following the original validation, scores were classified into three mutually exclusive tiers based on the percentage of the total score: $\leq 33.3\%$, $33.4\% - 66.7\%$, and $> 66.7\%$. The corresponding categories were low, moderate, and high knowledge, with scores of 0 - 5, 6 - 10, and 11 - 15; negative, neutral, and positive attitudes, with scores of 0 - 10, 11 - 20, and 21 - 30; and poor, moderate, and good practice, with scores of 0 - 20, 21 - 40, and 41 - 60, respectively. Construct validity was originally confirmed by confirmatory factor analysis (root mean square error of approximation [RMSEA] = 0.075; comparative fit index [CFI] = 0.89; Content Validity Index [CVI]/content validity ratio [CVR]: 0.80 - 1.00). The original reliability coefficients were 0.75 for knowledge (Kuder-Richardson formula 20 [KR-20]), 0.71 for attitude, and 0.82 for practice; the corresponding test-retest coefficients were 0.81, 0.84, and 0.92 (27). In the present study, a 10-member expert panel reconfirmed qualitative content validity. In our sample ($n = 430$), internal consistency was 0.82 for knowledge (KR-20), 0.79 for attitude, and 0.86 for practice. Test-retest reliability over 14 days ($n = 30$) yielded correlation coefficients of 0.81, 0.78, and 0.88, respectively.

3.3. Statistical Analysis

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Categorical data were expressed as frequencies and percentages, and continuous scores as the mean $\pm$ standard deviation (SD). Normality was confirmed using the Kolmogorov-Smirnov and Shapiro-Wilk tests ($P > 0.05$), with skewness and kurtosis within ± 1.0 . Univariate and backward stepwise multivariable linear regression analyses were used to identify predictors of KAP; variables with univariate $P < 0.20$ were entered as candidates. Model assumptions were assessed using probability-probability plots for residual normality and scatterplots for homoscedasticity. The absence of multicollinearity was assessed using a variance inflation factor (VIF) < 2.0 and

tolerance > 0.50 . Analyses included 430 complete records, and statistical significance was set at a two-tailed $P < 0.05$.

4. Results

Across the three teaching hospitals, 455 eligible nurses were approached, of whom 24 declined because of clinical workload constraints. Of the 431 returned questionnaires, one was excluded during data auditing because of substantial missing data ($> 20\%$), leaving a final analyzed sample of 430 nurses (response rate = 94.5%). Among the participants, 303 (70.5%) were female and 127 (29.5%) were male; 169 (39.3%) were single and 261 (60.7%) were married. Table 1 summarizes the participants' demographic and occupational characteristics.

Table 1. Demographic and Occupational Characteristics of the Participating Nurses (N = 430)

Variables	No. (%)
Age (y)	
20 - 24	38 (8.8)
25 - 29	147 (34.2)
30 - 34	86 (20.0)
35 - 39	79 (18.4)
40 - 44	66 (15.3)
≥ 45	14 (3.2)
Sex	
Female	303 (70.5)
Male	127 (29.5)
Marital status	
Single	169 (39.3)
Married	261 (60.7)
Work experience (y)	
< 1	61 (14.2)
1 - 4	111 (25.8)
5 - 10	120 (27.9)
11 - 15	49 (11.4)
16 - 20	56 (13.0)
> 20	33 (7.7)
Hospital unit	
Operating room	37 (8.6)
Dialysis	35 (8.1)
Emergency	58 (13.5)
CCU/ICU	105 (24.4)
Internal	110 (25.6)
Surgery	85 (19.8)
Shift status	
Fixed	60 (14.0)
Rotating	370 (86)
Employment status	
Permanent	223 (51.9)
Contractual	207 (48.1)

Table 2. Overall Levels of Knowledge, Attitude, and Self-reported Practice Regarding Nosocomial Infection Control Among Nurses (N = 430)

Variables	No. (%)
Knowledge	
Low	37 (8.6)
Moderate	290 (67.4)
High	103 (24.0)
Attitude	
Negative	9 (2.1)
Neutral	208 (48.4)
Positive	213 (49.5)
Practice	
Poor	2 (0.5)
Moderate	57 (13.3)
Good	371 (86.3)

Most nurses had moderate knowledge (67.4%). Nearly half reported positive attitudes (49.5%), whereas 48.4%

Table 3. Distribution of Responses to Individual Knowledge Items Regarding Nosocomial Infection Control (N = 430) ^a

Question	False Answer	True Answer
K1	108 (25.1)	322 (74.9)
K2	146 (34.0)	284 (66.0)
K3	246 (57.2)	184 (42.8)
K4	161 (37.4)	269 (62.6)
K5	162 (37.7)	268 (62.3)
K6	318 (74.0)	112 (26.0)
K7	142 (33.0)	288 (67.0)
K8	105 (24.4)	325 (75.6)
K9	219 (50.9)	211 (49.1)
K10	259 (60.2)	171 (39.8)
K11	88 (20.5)	342 (79.5)
K12	132 (30.7)	298 (69.3)
K13	337 (78.4)	93 (21.6)
K14	144 (33.5)	286 (66.5)
K15	143 (33.3)	287 (66.7)

^a Values are expressed as No. (%).

Table 4. Distribution of Responses to Individual Attitude Items Regarding Nosocomial Infection Control (N = 430) ^a

Question	Disagree	Neutral	Agree
N1	37 (8.6)	34 (7.9)	359 (83.5)
N2	41 (9.5)	36 (8.4)	353 (82.1)
N3	61 (14.2)	41 (9.5)	328 (76.3)
N4	32 (7.4)	26 (6.0)	372 (86.5)
N5	157 (36.5)	47 (10.9)	226 (52.6)
N6	16 (3.7)	27 (6.3)	387 (90.0)
N7	47 (10.9)	16 (3.7)	367 (85.3)
N8	50 (11.6)	26 (6.0)	354 (82.3)
N9	120 (27.9)	41 (9.5)	269 (62.6)
N10	280 (65.1)	33 (7.7)	117 (27.2)
N11	336 (78.1)	24 (5.6)	70 (16.3)
N12	307 (71.4)	28 (6.5)	95 (22.1)
N13	190 (44.2)	34 (7.9)	206 (47.9)
N14	78 (18.1)	22 (5.1)	330 (76.7)
N15	39 (9.1)	45 (10.5)	346 (80.5)

^a Values are expressed as No. (%).

reported neutral attitudes and 2.1% reported negative attitudes. Most reported good practice (86.3%), whereas 13.3% reported moderate practice and 0.5% reported poor practice (Table 2). At the item level, the highest proportion of correct knowledge responses concerned Ambu-bag disinfection (K11: 79.5%), whereas indications for negative-pressure rooms had the highest error rate (K13: 78.4%) (Table 3). For attitude items, agreement was highest for

immediate reporting of sharps injuries (N6: 90.0%), whereas disagreement was highest with the statement that hand hygiene training is unnecessary for all personnel (N11: 78.1%) (Table 4). Table 5 presents item-level distributions of self-reported practice across clinical procedures.

In univariate linear regression, male nurses had significantly lower mean scores than female nurses across

Table 5. Distribution of Responses to Individual Self-Reported Practice Items Regarding Nosocomial Infection Control (N = 430)^a

Question	Never	Rarely	Sometimes	Often	Always
P1	1 (0.2)	10 (2.3)	10 (2.3)	36 (8.4)	373 (86.7)
P2	1 (0.2)	18 (4.2)	36 (8.4)	131 (30.5)	244 (56.7)
P3	23 (5.3)	64 (14.9)	34 (7.9)	133 (30.9)	176 (40.9)
P4	9 (2.1)	43 (10.0)	45 (10.5)	146 (34.0)	187 (43.5)
P5	1 (0.2)	16 (3.7)	44 (10.2)	137 (31.9)	232 (54.0)
P6	13 (3.0)	24 (5.6)	55 (12.8)	129 (30.0)	209 (48.6)
P7	84 (19.5)	28 (6.5)	38 (8.8)	81 (18.8)	199 (46.3)
P8	8 (1.9)	11 (2.6)	30 (7.0)	111 (25.8)	270 (62.8)
P9	14 (3.3)	12 (2.8)	74 (17.2)	124 (28.8)	206 (47.9)
P10	7 (1.6)	10 (2.3)	38 (8.8)	100 (23.3)	275 (64.0)
P11	7 (1.6)	20 (4.7)	27 (6.3)	72 (16.7)	304 (70.7)
P12	8 (1.9)	34 (7.9)	68 (15.8)	84 (19.5)	236 (54.9)
P13	34 (7.9)	51 (11.9)	79 (18.4)	99 (23.0)	167 (38.8)
P14	5 (1.2)	19 (4.4)	30 (7.0)	81 (18.8)	295 (68.6)
P15	28 (6.5)	27 (6.3)	51 (11.9)	101 (23.5)	223 (51.9)

^a Values are expressed as No. (%).

all three domains: knowledge ($B = -0.27$, $P = 0.011$), attitude ($B = -0.25$, $P = 0.017$), and self-reported practice ($B = -0.41$, $P < 0.001$). Married nurses had significantly higher knowledge scores than single nurses ($B = 0.27$, $P = 0.005$), and nurses working rotating shifts had higher knowledge scores than those working fixed shifts ($B = 0.39$, $P = 0.005$). Work experience of 11 - 15 years ($B = 0.57$, $P = 0.003$) and 16 - 20 years ($B = 0.45$, $P = 0.013$) were positively associated with knowledge compared with < 1 year of experience. Nurses working in surgery units had higher practice scores than those working in the operating room ($B = 0.39$, $P = 0.040$) (Table 6).

In multivariable linear regression adjusting for confounders, male sex remained an independent negative predictor across all domains: knowledge ($B = -0.25$, $P = 0.015$), attitude ($B = -0.28$, $P = 0.008$), and practice ($B = -0.44$, $P < 0.001$). In the knowledge model, rotating shifts ($B = 0.45$, $P = 0.002$) and clinical experience of 11 - 15 years ($B = 0.53$, $P = 0.009$) and 16 - 20 years ($B = 0.43$, $P = 0.032$) retained independent positive associations. Attitude was positively predicted by age ($B = 0.14$, $P = 0.002$) and rotating shifts ($B = 0.29$, $P = 0.040$). Assignment to surgery units independently predicted higher practice scores ($B = 0.39$, $P = 0.038$). Full parameter estimates, 95% confidence intervals, and model summaries are presented in Table 7.

4.1. Variable Selection and Modeling

Candidate variables with $P < 0.20$ in univariate screening (Table 6) were entered into outcome-specific multivariable linear regression models using backward elimination to obtain the final parsimonious models. In Model 1 (knowledge), marital status was initially entered but was excluded from the final model because its association was attenuated and non-significant ($P > 0.05$) after adjustment for work experience and shift type. In Model 3 (practice), age was adjusted for but was no longer significant in the presence of unit type and sex.

4.2. Collinearity Diagnostics

Multicollinearity was evaluated in all models. Variance inflation factors ranged from 1.08 to 1.84 across all included predictors, below the conservative threshold of 2.5, and tolerance values were > 0.54 . These findings indicated no multicollinearity.

5. Discussion

This study assessed nurses' KAP regarding nosocomial infection control and found that most nurses had moderate knowledge. This finding is consistent with studies from Palestine, China, and Saudi Arabia (29-31), suggesting that knowledge gaps occur across settings. Knowledge of infection control may be influenced by access to educational resources, educational structures, staffing shortages, and heavy workloads. The studies cited

Table 6. Univariate Linear Regression Analysis of Factors Associated with Nurses' Knowledge, Attitude, and Self-Reported Practice Scores (N = 430) ^a

Variables	Crude β coefficient		
	Knowledge	Attitude	Practice
Age	0.06 (-0.004, 0.13); P = 0.066	0.03 (-0.03, 0.10); P = 0.323	0.07 (0.00, 0.14); P = 0.047
Sex			
Female	1		
Male	-0.27 (-0.47, -0.06); P = 0.011	-0.25 (-0.45, -0.05); P = 0.017	-0.41 (-0.61, -0.21); P < 0.001
Marriage status			
Single	1		
Married	0.27 (0.08, 0.47); P = 0.005	-0.08 (-0.27, 0.11); P = 0.402	0.12 (-0.07, 0.31); P = 0.219
Work experience (y)			
< 1	1		
1 - 4	-0.06 (-0.36, 0.25); P = 0.706	-0.18 (-0.49, 0.14); P = 0.267	-0.26 (-0.57, 0.05); P = 0.106
5 - 10	0.20 (-0.09, 0.51); P = 0.187	-0.11 (-0.42, 0.19); P = 0.447	0.01 (-0.29, 0.32); P = 0.947
11 - 15	0.57 (0.20, 0.94); P = 0.003	0.07 (-0.30, 0.45); P = 0.701	0.21 (-0.16, 0.58); P = 0.227
16 - 20	0.45 (0.09, 0.81); P = 0.013	0.08 (-0.27, 0.45); P = 0.641	0.22 (-0.14, 0.58); P = 0.227
> 20	-0.17 (-0.58, 0.25); P = 0.427	-0.23 (-0.65, 0.19); P = 0.294	0.11 (-0.31, 0.53); P = 0.559
Unit of the hospital			
Operating room		1	1
Dialysis	-0.39 (-0.84, 0.07); P = 0.097	-0.17 (-0.64, 0.28); P = 0.448	-0.15 (-0.61, 0.29); P = 0.495
Emergency	0.18 (-0.23, 0.59); P = 0.390	-0.05 (-0.46, 0.36); P = 0.787	-0.14 (-0.55, 0.26); P = 0.483
CCU/ICU	0.15 (-0.21, 0.53); P = 0.404	-0.17 (0.54, 0.20); P = 0.371	0.20 (-0.16, 0.57); P = 0.274
Internal	0.16 (-0.20, 0.54); P = 0.368	-0.18 (0.55, 0.19); P = 0.333	-0.09 (0.46, 0.27); P = 0.617
Surgery	-0.11 (-0.50, 0.27); P = 0.554	0.13 (-0.25, 0.52); P = 0.498	0.39 (0.02, 0.78); P = 0.040
Shift status			
Fixed	1	1	1
Rotating	0.39 (0.12, 0.66); P = 0.005	0.18 (-0.09, 0.45); P = 0.193	-0.18 (-0.46, 0.08); P = 0.175

^a Values are expressed as (95% CI). Reference categories: Female (sex), Single (marital status), Permanent (employment status), < 1 year (work experience), Operating room (unit of the hospital), Fixed (shift status). Abbreviations: B, unstandardized regression coefficient; CI, confidence interval.

above and the present study may therefore reflect similar challenges. However, our finding differs from studies reporting good knowledge of nosocomial infections among most healthcare workers (1, 21, 23). These differences may reflect their broader study populations, which included physicians, dentists, nurses, pharmacologists, radiologists, and optometrists. Nurses have extensive patient contact and provide much of the direct care; therefore, their knowledge levels may differ from those of professionals with less patient contact. A Nigerian study reported that more than half of healthcare workers lacked adequate knowledge of nosocomial infection prevention (32). That study included physicians and nurses from internal medicine, obstetrics, and pediatrics units, whereas the present study included nurses from internal medicine, surgery, dialysis, emergency, ICU, and CCU units. Nurses working in intensive care units usually have stronger scientific and practical skills than other nurses (33), which

may help explain the differences between the studies. Nursing administrators and managers should identify knowledge gaps and promptly organize in-service training to address them.

Nearly half of the nurses (49.5%) had a positive attitude toward nosocomial infection control, consistent with findings from Africa (23, 34) and China (30). Abalkhail et al. and Gezie et al. also reported positive staff attitudes (21, 35), although the proportions were higher than those in the present study. Differences in professional settings, managerial support for infection control programs, and healthcare workers' participation in infection control decisions may explain this variation. In Sarani et al.'s study of Iranian nurses, only 33% had a good attitude toward infection control (36), a lower proportion than that in the present study. Although both studies were conducted in Iran, our substantially larger sample provided greater statistical power [430 vs. 145 nurses in Sarani et al.'s study

Table 7. Multivariable Linear Regression Models Identifying Independent Predictors of Nurses' Knowledge, Attitude, and Self-reported Practice Regarding Infection Control (N = 430)^a

Independent Variables	Adjusted β	95% Confidence Interval	P-Value
Model 1: Predictors of Knowledge			
Sex			
Female (Reference)	1.00	—	—
Male	-0.25	-0.45 to -0.05	0.015
Shift status			
Fixed (Reference)	1.00	—	—
Rotating	0.45	0.16 to 0.73	0.002
Work experience (y)			
< 1 (Reference)	1.00	—	—
1 - 4	-0.06	-0.35 to 0.25	0.716
5 - 10	0.17	-0.14 to 0.49	0.279
11 - 15	0.53	0.13 to 0.93	0.009
16 - 20	0.43	0.04 to 0.82	0.032
> 20	-0.03	-0.47 to 0.42	0.906
Model 2: Predictors of Attitude			
Age (y)			
continuous	0.14	0.05 to 0.22	0.002
Sex			
Female (Reference)	1.00	—	—
Male	-0.28	-0.48 to -0.07	0.008
Employment type			
Contractual (Reference)	1.00	—	—
Permanent	0.39	0.16 to 0.62	0.001
Shift status			
Fixed (Reference)	1.00	—	—
Rotating	0.29	0.01 to 0.58	0.040
Model 3: Predictors of Practice			
Sex			
Female (Reference)	1.00	—	—
Male	-0.44	-0.65 to -0.23	<0.001
Hospital unit			
Operating room (Reference)	1.00	—	—
Dialysis	-0.22	-0.67 to 0.22	0.326
Emergency	-0.11	-0.51 to 0.29	0.586
CCU/ICU	0.10	-0.26 to 0.47	0.584
Internal medicine	-0.18	-0.54 to 0.18	0.328
Surgery	0.39	0.02 to 0.77	0.038

^a A dash (—) in reference rows denotes the reference category. Abbreviations: β , standardized regression coefficient; CI, confidence interval.

(36)]. Differences in assessment instruments and regional access to education in Zabol and Qazvin may also explain the findings. The proportion with positive attitudes (49.5%) should be interpreted alongside the 48.4% with neutral attitudes, which warrants attention from managers and policymakers. From a clinical perspective, neutral attitudes may pose a risk to patient safety. These nurses may not fully understand the importance of infection control, or

existing processes and policies may not sufficiently support their commitment. Managers and policymakers should strengthen the patient safety culture and use qualitative studies to explore the reasons underlying neutral attitudes.

Most nurses reported good practice in controlling nosocomial infections, consistent with findings from

China and Saudi Arabia (5, 21, 30). Although those studies included diverse healthcare professionals, institutional infection surveillance systems and structured protocols may contribute to these similar findings. In contrast, healthcare workers in Ethiopia reported poorer practices (1, 23), possibly reflecting differences in institutional resources, staff-to-patient ratios, and access to infection control supplies. Because our assessment used a self-administered questionnaire rather than direct observation or objective infection surveillance, favorable ratings reflect perceived adherence and may be influenced by social desirability bias rather than verified bedside compliance.

Economic conditions and patient volume may also affect staff practice and help explain differences between studies. Staff training may be another contributing factor. The two Ethiopian studies also included participants with diplomas, whereas the present study included only nurses with at least a bachelor's degree. According to Kelman's theory, knowledge, attitude, and practice influence one another (20). Das et al. also reported that repeated training significantly improved infection control practices among healthcare personnel in India (37). Educational level is therefore one factor affecting practice. Periodic evaluation of nurses' practice may help prevent deterioration and identify areas requiring improvement. Addressing these areas may strengthen the patient safety culture and reduce the adverse effects of nosocomial infections.

Female nurses scored significantly higher than male nurses in knowledge, attitude, and practice, consistent with previous studies (38-39). Conversely, studies in Saudi Arabia (31) and Poland (40) found no significant differences or reported contrary patterns. These discrepancies may reflect differences in nursing workforce composition, sampling frameworks, or ward assignments. Although female nurses may demonstrate greater adherence to some hygiene protocols in certain clinical settings (39), explanations for sociodemographic or behavioral differences remain hypothetical because our cross-sectional study did not assess personal motivation, baseline clinical training exposure, or daily task allocation. Our multivariable findings that permanent employment, longer clinical experience, and rotating shifts positively predicted KAP scores are also consistent with recent Iranian evidence from Shajari Sales et al. In their study of midwifery personnel, 73.5% were classified as having good practice and 56.8% had moderate knowledge. Employment status and specialized training were significantly

associated with knowledge, and non-permanent staff were more vulnerable (41). Healthcare administrators should conduct formal in-service training-needs assessments, particularly for contractual and less-experienced personnel, to assess gaps in adherence objectively and ensure that infection control education reaches all nursing staff.

5.1. Study Limitations

The study was conducted in three tertiary teaching hospitals in a single city, Qazvin, Iran, using a cross-sectional design. Caution is therefore needed when generalizing the findings to non-academic or private hospitals or to nationwide healthcare settings; multicenter and longitudinal studies are recommended. The self-report format was another limitation because perceived practice may not reflect observed bedside adherence or infection outcomes and may be affected by social desirability bias. The researchers sought to address this limitation by ensuring anonymity and explaining the importance of accurate responses. Future studies should supplement questionnaires with direct observational audits. Nurses' mental and physical condition and workload may also affect the results; the researchers therefore attempted to administer the questionnaires when participants were in a relatively stable condition. Corrections for multiple testing were not applied to the exploratory univariate analyses, which may increase the risk of type I error; these findings consequently warrant cautious interpretation.

5.2. Conclusions

Reducing the adverse effects of nosocomial infections requires adequate knowledge, favorable attitudes, and appropriate infection control practices among nurses. Most nurses in this study had moderate knowledge, nearly half had positive attitudes, and most reported good practice. Managers and educational policymakers should address the moderate knowledge levels through in-service training. The attitude findings suggest that existing educational and safety policies are not sufficiently effective and that motivational interventions are needed. Improving knowledge and promoting positive attitudes among nurses with neutral attitudes may support more effective infection control.

Remaining weaknesses in clinical practice should be identified and addressed through intervention studies and direct observational audits. Qualitative studies are

recommended to identify barriers to positive attitudes. Longitudinal studies should assess the effects of management policies, interventions, and training programs.

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Footnotes

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References

1. Bayleyegn B, Mehari A, Damtie D, Negash M. Knowledge, Attitude and Practice on Hospital-Acquired Infection Prevention and Associated Factors Among Healthcare Workers at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. *Infect Drug Resist.* 2021;**14**:259-66. [PubMed ID: 33536767]. [PubMed Central ID: PMC7850400]. <https://doi.org/10.2147/IDR.S290992>.
2. World Health Organization. . Geneva: World Health Organization; 2016. [PubMed ID: 27977095].
3. Breathnach AS. Nosocomial infections and infection control. *Medicine.* 2013;**41**(11):649-53. <https://doi.org/10.1016/j.mpmed.2013.08.010>.
4. Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, et al. Strategies to prevent healthcare-associated infections: a narrative overview. *Risk management and healthcare policy.* 2020;**13**:1765-80. [PubMed ID: 33061710]. [PubMed Central ID: PMC7532064]. <https://doi.org/10.2147/RMHP.S269315>.
5. Wu W, Wang W, Yuan Y, Lin L, Tan Y, Yang J, et al. Knowledge, attitude and practice concerning healthcare-associated infections among healthcare workers in Wuhan, China: cross-sectional study. *BMJ Open.* 2021;**11**(1). e042333. [PubMed ID: 33402407]. [PubMed Central ID: PMC7786794]. <https://doi.org/10.1136/bmjopen-2020-042333>.
6. Blot S, Ruppé E, Harbarth S, Asehnoun K, Poulakou G, Luyt CE, et al. Healthcare-associated infections in adult intensive care unit patients: Changes in epidemiology, diagnosis, prevention and contributions of new technologies. *Intensive and Critical Care Nursing.* 2022;**70**. 103227. [PubMed ID: 35249794]. [PubMed Central ID: PMC8892223]. <https://doi.org/10.1016/j.iccn.2022.103227>.
7. Haque M, Sartelli M, McKimm J, Abu Bakar MB. Health care-associated infections-an overview. *Infection and drug resistance.* 2018;**11**:2321-33. [PubMed ID: 30532565]. [PubMed Central ID: PMC6245375]. <https://doi.org/10.2147/IDR.S177247>.
8. Mouajou V, Adams K, DeLisle G, Quach C. Hand hygiene compliance in the prevention of hospital-acquired infections: a systematic review. *Journal of Hospital Infection.* 2022;**119**:33-48. [PubMed ID: 34582962]. <https://doi.org/10.1016/j.jhin.2021.09.016>.
9. Giraldi G, Montesano M, Sandorfi F, Iachini M, Orsi GB. Excess length of hospital stay due to healthcare acquired infections: methodologies evaluation. *Ann Ig.* 2019;**31**(5):507-16. [PubMed ID: 31304530]. <https://doi.org/10.7416/ai.2019.2311>.
10. Blot K, Hammami N, Blot S, Vogelaers D, Lambert ML. Seasonal variation of hospital-acquired bloodstream infections: a national cohort study. *Infection Control & Hospital Epidemiology.* 2022;**43**(2):205-11. [PubMed ID: 33975668]. <https://doi.org/10.1017/ice.2021.85>.
11. Sun B. Nosocomial infection in China: management status and solutions. *American Journal of Infection Control.* 2016;**44**(7):851-852. [PubMed ID: 27067518]. [PubMed Central ID: PMC7135812]. <https://doi.org/10.1016/j.ajic.2016.01.039>.
12. Hosseinpour M, Eslami Akbar R, Faseleh Jahromi M, Badiyepymaiejahromi Z. The effect of interventional program underpinned by health belief model on awareness, attitude, and performance of nurses in preventing nosocomial infections: A randomized controlled trial study. *Investigación y educación en enfermería.* 2023;**41**(3). e10. [PubMed ID: 38589310]. [PubMed Central ID: PMC10990589]. <https://doi.org/10.17533/udea.iee.v41n3e10>.
13. Kollef MH, Torres A, Shorr AF, Martin-Loeches I, Micek ST. Nosocomial infection. *Critical care medicine.* 2021;**49**(2):169-87. [PubMed ID: 33438970]. <https://doi.org/10.1097/CCM.0000000000004783>.

14. Alrubaiee G, Baharom A, Faisal I, Hayati KS, Mohd. Daud S, Basaleem HO. Randomized community trial on nosocomial infection control educational module for nurses in public hospitals in Yemen: a study protocol. *BMC Nurs*. 2019;**18**(1). 10. [PubMed ID: 30936778]. [PubMed Central ID: PMC6425650]. <https://doi.org/10.1186/s12912-019-0333-3>.
15. Bolcato V, Robustelli della Cuna FS, Fassina G, Odone A, Gervasio L, Bosone D, et al. Preventing healthcare-associated infections: hand disinfection monitoring using an automated system in an Italian neurological hospital. *Healthcare*. 2023;**11**(23):3018. [PubMed ID: 38063584]. [PubMed Central ID: PMC10705975]. <https://doi.org/10.3390/healthcare11233018>.
16. Yosef T. Healthcare professionals' knowledge, attitude and practice of infection prevention in southwest Ethiopia. *Environmental Health Insights*. 2023;**17**. 11786302231218800. [PubMed ID: 38116490]. [PubMed Central ID: PMC10729614]. <https://doi.org/10.1177/11786302231218819>.
17. Hillier MD. Using effective hand hygiene practice to prevent and control infection. *Nurs Stand*. 2020;**35**(5):45-50. [PubMed ID: 32337862]. <https://doi.org/10.7748/ns.2020.e11552>.
18. Barrera-Cancedda AE, Riman KA, Shinnick JE, Buttenheim AM. Implementation strategies for infection prevention and control promotion for nurses in Sub-Saharan Africa: a systematic review. *Implement Sci*. 2019;**14**(1). 111. [PubMed ID: 31888673]. [PubMed Central ID: PMC6937686]. <https://doi.org/10.1186/s13012-019-0958-3>.
19. Shacho E, Ambelu A, Yilma D. Knowledge, attitude, and practice of healthcare workers towards healthcare-associated infections in Jimma University Medical Center, southwestern Ethiopia: using structural equation model. *BMC Health Services Research*. 2024;**24**(1). 1611. [PubMed ID: 39696490]. [PubMed Central ID: PMC11653541]. <https://doi.org/10.1186/s12913-024-12094-6>.
20. Kelman HC. The role of action in attitude change. *Nebr Symp Motiv*. 1980;**27**:117-94. [PubMed ID: 7242747].
21. Abalkhail A, Al Imam MH, Elmosaad YM, Jaber MF, Hosis KA, Alhumaydhi FA, et al. Knowledge, attitude and practice of standard infection control precautions among health-care workers in a university hospital in Qassim, Saudi Arabia: a cross-sectional survey. *International journal of environmental research and public health*. 2021;**18**(22):11831. [PubMed ID: 34831585]. [PubMed Central ID: PMC8624606]. <https://doi.org/10.3390/ijerph182211831>.
22. Karimian P, Akbari M, Shirzadi M, Safiri S, Alnaseri M, Karimi N, et al. Knowledge, attitudes, and practices of ICU head nurses regarding infection control and antimicrobial resistance in Iran: a cross-sectional study. *BMC nursing*. 2025;**24**(1). 278. [PubMed ID: 40075396]. [PubMed Central ID: PMC11905550]. <https://doi.org/10.1186/s12912-025-02937-w>.
23. Yazie TD, Sharew GB, Abebe W. Knowledge, attitude, and practice of healthcare professionals regarding infection prevention at Gondar University referral hospital, northwest Ethiopia: a cross-sectional study. *BMC research notes*. 2019;**12**(1). 563. [PubMed ID: 31500659]. [PubMed Central ID: PMC6734428]. <https://doi.org/10.1186/s13104-019-4605-5>.
24. Mbon EF, Chimezie OV, Ehioghare O, Adesegun OA, Fikayo BE. Knowledge, attitude and practice in the prevention of nosocomial infections among the hospital staff of a Nigerian tertiary hospital. *West Afr J Med*. 2023;**40**(4):389-96. [PubMed ID: 37119132].
25. Khatrawi EM, Prajwal P, Farhan M, Inban P, Gurha S, Al-ezzi SMS, et al. Evaluating the knowledge, attitudes, and practices of healthcare workers regarding high-risk nosocomial infections: A global cross-sectional study. *Health Science Reports*. 2023;**6**(9). e1559. [PubMed ID: 37701355]. [PubMed Central ID: PMC10494663]. <https://doi.org/10.1002/hsr2.1559>.
26. Bawaqneh KA, Ayed A, Salameh B. Nurses' Knowledge, Attitude, Practice, and Perceived Barriers of Infection Control Measures in the Intensive Care Units at Northwest Bank Hospitals. *Crit Care Nurs Q*. 2025;**48**(2):160-71. [PubMed ID: 40009862]. <https://doi.org/10.1097/CNQ.0000000000000538>.
27. Soleimani Z, Mosadeghrad AM, Abbasabadi-Arab M, Moradi M, Abediinjad P, Mesdaghinia A. Designing and psychometric testing of an instrument to assess the knowledge, attitude and practice of clinical staff about nosocomial infections. *Journal of Mazandaran University of Medical Sciences*. 2021;**31**(197):111-22.
28. Tenna A, Stenehjem EA, Margolis L, Kacha E, Blumberg HM, Kempker RR. Infection control knowledge, attitudes, and practices among healthcare workers in Addis Ababa, Ethiopia. *Infect Control Hosp Epidemiol*. 2013;**34**(12):1289-96. [PubMed ID: 24225614]. [PubMed Central ID: PMC3995333]. <https://doi.org/10.1086/673979>.
29. Eljedi A, Dalo S. Compliance with the national palestinian infection prevention and control protocol at governmental paediatric hospitals in gaza governorates. *Sultan Qaboos Univ Med J*. 2014;**14**(3):e375-81. <https://doi.org/10.18295/2075-0528.1602>.
30. Wang X, Liu C, Du Y, Wang D, Zhang X. Do knowledge, attitudes, and barrier perception affect the prevention and control of healthcare-associated infections? A structural equation modelling approach. *Infection and drug resistance*. 2023;**16**:3051-63. [PubMed ID: 37220611]. [PubMed Central ID: PMC10200105]. <https://doi.org/10.2147/IDR.S409398>.
31. Alsulami A, Sacgaca L, Pangket P, Pasay-an E, Al Amoudi FA, Alreshidi MS, et al. Exploring the relationship between knowledge, attitudes, self-efficacy, and infection control practices among Saudi Arabian Nurses: a multi-center study. *Healthcare*. 2025;**13**(3):238. [PubMed ID: 39942427]. [PubMed Central ID: PMC11817510]. <https://doi.org/10.3390/healthcare13030238>.
32. Alex-Hart BA, Opara PI. Handwashing practices amongst health workers in a teaching hospital. *Am J Infect Dis*. 2011;**7**(1):8-15. <https://doi.org/10.3844/ajidsp.2011.8.15>.
33. Danielis M, Destrebecq ALL, Terzoni S, Palese A. Are intensive care units good places for nursing students' learning compared to other settings? Findings from an Italian national study. *Intensive and Critical Care Nursing*. 2021;**66**. 103074. [PubMed ID: 34099331]. <https://doi.org/10.1016/j.iccn.2021.103074>.
34. Sahiledengle B, Gebresilassie A, Getahun T, Hiko D. Infection Prevention Practices and Associated Factors among Healthcare Workers in Governmental Healthcare Facilities in Addis Ababa. *Ethiop J Health Sci*. 2018;**28**(2):177-86. [PubMed ID: 29983515]. [PubMed Central ID: PMC6016341]. <https://doi.org/10.4314/ejhs.v28i2.9>.
35. Gezie H, Leta E, Admasu F, Gedamu S, Dires A, Goshiye D. Health care workers knowledge, attitude and practice towards hospital acquired infection prevention at Dessie referral hospital, Northeast Ethiopia. *Clinical Journal of Nursing Care and Practice*. 2019;**3**(1):59-63. <https://doi.org/10.29328/journal.cjncp.1001019>.
36. Sarani H, Balouchi A, Masinaeinezhad N, Ebrahimitabas E. Knowledge, Attitude and Practice of Nurses about Standard Precautions for Hospital-Acquired Infection in Teaching Hospitals Affiliated to Zabol University of Medical Sciences (2014). *Glob J Health Sci*. 2015;**8**(3):193-8. [PubMed ID: 26493432]. [PubMed Central ID: PMC4804055]. <https://doi.org/10.5539/gjhs.v8n3p193>.

37. Das A, Garg R, Kumar ES, Singh D, Ojha B, Kharchandy HL, et al. Implementation of infection prevention and control practices in an upcoming COVID-19 hospital in India: An opportunity not missed. *PLoS One*. 2022;**17**(5). e0268071. [PubMed ID: [35604919](#)]. [PubMed Central ID: [PMC9126379](#)]. <https://doi.org/10.1371/journal.pone.0268071>.
38. Rahiman F, Chikte U, Hughes GD. Nursing students' knowledge, attitude and practices of infection prevention and control guidelines at a tertiary institution in the Western Cape: A cross sectional study. *Nurse Educ Today*. 2018;**69**:20-5. [PubMed ID: [30007142](#)]. <https://doi.org/10.1016/j.nedt.2018.06.021>.
39. Zhou J, Chen S. Knowledge, attitudes, and practices of NICU doctors and nurses toward prevention and control of nosocomial infection with multidrug resistant organism. *Frontiers in Pediatrics*. 2022;**10**: 817030. [PubMed ID: [35515349](#)]. [PubMed Central ID: [PMC9062780](#)]. <https://doi.org/10.3389/fped.2022.817030>.
40. Fortunka K, Strzelecka A, Król G, Paprocka P, Mańkowska A, Lesiak A, et al. Knowledge and training needs in nosocomial infection among hospital staff in the City of Kielce, Poland: A Cross-Sectional Study. *Journal of Nursing Management*. 2024;**2024**(1):9243232-19. [PubMed ID: [40224882](#)]. [PubMed Central ID: [PMC11919185](#)]. <https://doi.org/10.1155/2024/9243232>.
41. Shajari Sales S, Montazeri S, Mousavi P, Ghanbari S. Knowledge, attitude, and practice of midwives toward intrapartum and postpartum management of COVID-19 patients: a cross-sectional analysis. *Care Pathway Hospital to Home*. 2026;**1**(3). e173505. <https://doi.org/10.69107/cphh-173505>.