Shiraz E-Med J. ; In Press(In Press): e148167 https://doi.org/10.5812/semj-148167

Published Online: 2024 December 28 **Research Article**

Gender Differences in Nurses' Knowledge, Practice, and Attitudes Towards Contact Isolation Precautions: A Measurement Invariance Study

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Received: 24 April, 2024; **Revised:** 26 November, 2024; **Accepted:** 3 December, 2024

Abstract

Background: Contact isolation precautions are essential for infection prevention and control in healthcare settings. Nurses play a critical role in implementing these precautions to prevent the spread of infectious diseases.

Objectives: This paper reviews nurses' current knowledge, practice, and attitude toward contact isolation precautions using differential item functioning (DIF).

Methods: This cross-sectional study used the contact isolation precautions questionnaire, completed by 676 nurses at Namazi Hospital, Shiraz, Iran, in May 2019. The Firth binary logistic regression (LR) was used to detect the DIF of the items.

Results: A total of 676 nurses were included in this study. Five hundred eighty-nine were female (81.1%), and the rest were male. Seventy-four percent of females and 65.5% of males had attended training courses on isolation precautions, which showed evidence of a weak difference (P = 0.08). The DIF analysis demonstrated that none of the items had considerable DIF. However, before (P = 0.048) and after (P = 0.472) removing item 8 in the knowledge section, the test's significance changed. The results showed that, except for item 8, nurses had good knowledge (> 81%), positive attitudes (> 77%), and relatively adequate practices (> 71%) related to contact isolation precautions. It was also observed that both males (6.6 ± 1.9) and females (6.9 ± 1.3) had high knowledge scores, but their practice scores were relatively low (males: 5.7 ± 2.4, females: 6.6 ± 1.6), especially for men, who had the lowest scores.

Conclusions: Overall, our results suggest that nurses had different perceptions of item 8 concerning contact precautions. Therefore, the contact precautions questionnaire should be cautiously used to compare nurses' knowledge, attitude, and practice (KAP) scores. We suggest that the analysis of DIF should be used in the validation of contact isolation precautions questionnaires across different groups of healthcare workers. This study highlights the importance of continuous education to ensure that nurses have the necessary knowledge and skills to implement effective infection prevention and control measures.

Keywords: Contact Isolation Precautions, Differential Item Functioning, Nurse

1. Background

Healthcare-associated infections (HAIs), previously known as nosocomial or hospital-acquired infections, are defined as the presence of infections occurring at least 48 hours after hospital admission or within 30 days following hospital discharge (1). The World Health Organization (WHO) declared that the global prevalence of HAIs was 15% in 2011 (2). Forrester et al. estimated that 7.2 to 14.9 billion US dollars were spent on HAIs in the United States (3). In 2016, Cassini et al. showed that more than 2.5 million new cases of HAIs were detected every

year in the European Union and European Economic Area (EU/EEA), and the cumulative burden of the six included HAIs is associated with increased in-hospital morbidity, hospital length of stay (HLOS), and costs. Therefore, the WHO and the centers for disease control and prevention (CDC) have proposed prophylactic approaches to decrease the burden of HAIs (3-8). These approaches include isolation precautions, which consist of hand hygiene, personal protective equipment, and the safe handling of sharp objects (9, 10). Contact precautions are one of the key guidelines to prevent the spread of multidrug-resistant organisms (MDROs) in this respect. Contact precautions are necessary to protect both patients and nurses from exposure to infectious agents through increasing knowledge and gaining experience (11). Nursing knowledge about the disease transmission pathway seems essential to stop the infection. Nurses are at a higher risk of developing HAIs than other healthcare workers since the risk and duration of close contact with patients are greater. Therefore, they should strictly adhere to isolation precautions to significantly decrease the rate of HAIs (9).

This adherence is primarily examined using a quantitative knowledge, attitude, and practice (KAP) questionnaire. To assess these values, Askarian et al. designed a questionnaire regarding standard isolation precautions with acceptable internal consistency (Cronbach's alphas > 0.7 for all three parameters) (12).

Studies have indicated significant heterogeneity in KAP parameters among nurses regarding standard isolation precautions, ranging from poor to adequate levels (13, 14). Apart from reliability and validity, it is crucial to address whether identifiable factors, such as demographic features, affect the uniformity and likelihood of responses to specific items. This process is known as differential item functioning (DIF). The DIF mainly occurs when groups (defined by gender, age, etc.) have different probabilities of selecting a specific item after controlling for overall scores. An item in a questionnaire is believed to have DIF if responders with the same ability (here defined as KAP), but from different groups (such as gender), have an unequal probability of endorsing a response (15). In contrast to simply comparing total scores (such as *t*-tests) between groups, which may lead to incorrect conclusions about test fairness, examining differences at the item level provides clarity regarding where exactly group differences are located and whether there is any pattern in those differences. Therefore, it is not clear whether the differences observed in the total scores of knowledge, practice, and attitude represent a real gap between different groups (such as males and females) in how they understand the concepts being tested, or if they are due to an item that exhibits bias towards or against certain groups of people.

Several studies have assessed KAPs among nurses using well-designed questionnaires worldwide. In all these studies, only the total score of each item was measured. If a question is unclear to the respondent, its score affects the total score and leads to incorrect conclusions (16-19). However, few studies have investigated DIF across genders for KAP. In 2020, Mousavi et al. used Mantel-Haenzel statistics to assess the presence of DIF among healthcare workers and indicated the presence of significant DIF among the participants (9). It is worth noting that several approaches are used to examine the presence of DIF. Studies have shown that logistic regression (LR) analysis is more powerful in detecting DIF (20, 21).

2. Objectives

Therefore, the current study aimed: (1) To assess the presence and extent of DIF across gender among nurses in terms of KAP items; and (2) to compare the mean scores between male and female nurses.

3. Methods

This cross-sectional study included 676 nurses who had completed their nursing education and were employed at the teaching hospital of Namazi in Shiraz, Iran, in May 2019. The questionnaires were conveniently distributed across all hospital wards by five trained interviewers. They worked during different shifts, explained the study's objectives to participants, and assured them that their responses would remain anonymous. It took about 15 minutes to complete each questionnaire. Individuals who did not wish to participate or had incomplete questionnaires were excluded.

The study was approved by the local Ethics Committee of Shiraz University of Medical Sciences with the code IR.SUMS.REC.1399.1036. Based on the approval of the Ethics Committee, oral informed consent to participate in this study was obtained from all participants before being included in the study.

3.1. Contact Precautions Questionnaire

The questionnaire, previously validated by four experts from the Iranian Association of Nosocomial Infection Control (22-24), gathered demographic information and included questions related to contact precautions. The collected data included demographic characteristics (including age, sex, and training) and questions related to adherence to contact precautions.

Questions on contact precautions consisted of eight items across the domains of knowledge, attitude, and performance. In the knowledge domain, scores of 1 and 0 were assigned for correct answers and incorrect answers, respectively. In the performance domain, the items used a 5-point Likert Scale (always = 5, often = 4, sometimes = 3, rarely = 2, and never = 1). The choice "always" was considered as good (or adequate) performance with a score of 1, while other choices were regarded as weak performance and were scored 0. In the attitude domain, the choices included very high, high, moderate, low, and unimportant. Responses of "very high" were considered positive attitudes and were coded 1, while other choices were regarded as negative attitudes and were coded 0. Therefore, the minimum score in each domain was 0, and the maximum score was 8.

In this study, the questionnaire demonstrated good reliability, with Cronbach's alpha of 0.77 for the knowledge domain, 0.73 for the attitude domain, and 0.71 for the practice domain.

3.2. Statistical Analysis

All eight items in the three domains were considered dependent variables in binary LR. Firth LR was used to examine the measurement equivalence of questionnaire items due to the small sample in the male group (18.9%) and the rare responses regarding some items of the contact isolation precautions questionnaire (with a minimum of 4.9%). Differential item functioning occurs when people in different groups perceive the meaning of items differently after controlling for the measured construct. In this model, the probability of answering a specific question to identify DIF is determined by comparing three logit models as follows: G in the models is the variable related to membership in the group, and θ is the level of ability. The level of ability is the score obtained by summing the answers to the questions in the survey, and π is the probability of providing the correct answer to a specified question. The LR, adjusted for age and training course, was used to detect DIF, both uniform and non-uniform, by comparing different models:

(a)

$$logit(\pi) = \ln\left(\frac{p(Y_i=1)}{1-p(Y_i=1)}\right) = \alpha + \beta_1 \times age + \beta_2 \times training + \beta_3 \times \theta$$

(b)

$$logit(\pi) = \ln\left(\frac{p(Y_i=1)}{1-p(Y_i=1)}\right) = \alpha + \beta_1 \times age + \beta_2 \times training + \beta_3 \times \theta + \beta_4 \times G$$

(c)

$$logit(\pi) = \ln\left(\frac{p(Y_i=1)}{1-p(Y_i=1)}\right) = \alpha + \beta_1 \times age + \beta_2 \times training + \beta_3 \times \theta + \beta_4 \times G + \beta_5 \times \theta \times G$$

In order to find DIF, the difference in [-2 log-likelihood] was used. The [-2 log-likelihood] of models (a) and (c), which have a chi-square distribution with two degrees of freedom, was utilized to find DIF. To investigate the presence of uniform DIF, the [-2 log-likelihood] of models (a) and (b) with a chi-square distribution with one degree of freedom was applied to test for uniform DIF. To test for non-uniform DIF, the [-2 log-likelihood] of models (b) and (c) with a chi-square distribution with one degree of freedom was applied (25). Since sometimes the probability of choosing one option is higher than others, this indicates that something rare has occurred. Moreover, when the sample size is small in one of the groups, the usual regression method might be biased in estimating regression coefficients. One technique for reducing the bias from a small sample size in the maximum likelihood estimate is using the Firth method (25).

Zumbo and Gelin (ZG) and Crane, van Belle, and Larson (CvBL) criteria were used to determine whether the detected DIF is practically or clinically important. According to the ZG criterion, values of < 0.035, 0.035 - 0.07, and > 0.07 are categorized as negligible, moderate, and large DIF, respectively. Based on the CvBL criterion, changes over 10% in the coefficients of the two models, 1

and 2, are regarded as having a significant impact on the diagnosis of DIF (26-28).

Statistical analysis was conducted using SPSS 18.0 and the "logistf" package in R (≥ 3.0.0) software (29, 30). A P-value < 0.05 was considered statistically significant.

4. Results

A total of 676 nurses from Shiraz Namazi Hospital were included in this study. Five hundred eighty-nine were female (81.1%), and the rest were male. The mean ± SD age of females was 29.7 ± 6.3 years, and for males, it was 29.8 ± 5.3 years. There was no statistical significance (P = 0.85). Seventy-four percent of females and 65.5% of males had attended training courses on isolation precautions. This difference was relatively statistically significant (P = 0.08).

The percentage of respondents' correct answers to KAP questions is reported in Table 1. The results show that the knowledge percentage of female nurses is higher than that of male nurses in all items except for item 7, "Cleaning and disinfecting all common equipment between isolated patients". Additionally, women had higher positive attitudes and better practices than men in all items. It was observed that the percentages for both men and women were very high (more than 70%), but in item 8, "Double plastic gloving for prevention of transmission of hospital-acquired infections," the percentages were very low.

Table 2 shows the results of the firth LR for detecting DIF across males and females, adjusting for the effect of age and training course. The majority of the items did not show DIF between the two sexes.

In the knowledge items, only 2 (25%) items, items 7 and 8, showed U-DIF. According to the CvBL and ZG criteria, no items revealed a considerable DIF across male and female nurses.

In the attitude items, 2 (25%) showed significant DIF. One item (13%), item 4, displayed U-DIF, and one (13%), item 8, displayed NU-DIF. According to the CvBL and ZG criteria, the detected DIF was not practically or clinically significant.

In the practice items, 2 (25%) items showed significant DIF. One item (13%), item 4, displayed U-DIF, and one (13%), item 8, displayed NU-DIF. According to the CvBL and ZG criteria, no items revealed a considerable DIF across male and female nurses. The DIF analysis demonstrated that none of the items had considerable DIF, either practically or clinically.

Table 3 compares the mean KAP item scores across male and female nurses after the detected DIF. As shown in the table, before removing item 8, there was a statistically significant difference between the two sexes based on knowledge (P = 0.048), attitude (P = 0.004), and practice (P < 0.001) components. However, after removing item 8, which was of little importance (P = 0.472), there was no statistically significant difference between the two sexes based on knowledge score. It was found that female nurses had significantly higher scores than male nurses in all three domains. It was also observed that both males and females had high knowledge scores, but their practice scores were low, especially for males, who had the lowest scores.

5. Discussion

Nurses play a critical role in implementing contact isolation precautions and ensuring that patients receive appropriate care while minimizing the risk of infection. However, nurses are also at higher risk of HAIs compared to other healthcare workers because of their close contact with patients. Therefore, they should strictly adhere to standard precautions to reduce the rate of HAIs (9). The effectiveness of these precautions relies heavily on nurses' knowledge, practice, and attitude toward them. Some studies have been conducted on the importance of nurses' knowledge, practice, and attitude toward contact isolation precautions in ensuring effective infection control (16-19). However, none have addressed the different understanding of the questionnaire questions between the two sexes, especially using the DIF method. To our knowledge, this study is the first on DIF related to contact isolation precautions conducted across male and female nurses. The gender differences in infection control practices may be rooted in a combination of sociocultural factors, work environment conditions, and disparities in training (31). Additionally, gender differences in access to training opportunities and the content of infection control education may also contribute to these disparities. Men and women may receive different levels of training or face implicit biases in the educational content, leading to varying levels of knowledge and practice.

Table 1. Percentage of Respondents' Correct Answers to Knowledge, Attitude, and Practice Questions Regarding Contact Precautions [a]

Items	Contact Precaution Items	Correct Knowledge		Positive Attitude		Practice Compliant	
		Male	Female	Male	Female	Male	Female
1	Isolation of patients needing contact precautions in a private room.	81.6	85.2	85.1	91.5	74.7	89.0
2	Gloving on entry and removing gloves before leaving patient's room	90.8	95.8	82.8	94.1	79.3	91.7
3	Washing hands with antibacterial agent on removal of gloves	88.5	89.3	88.5	91.2	85.1	88.5
4	Wearing gown on entry to patient's room	90.8	94.2	77.0	92.2	71.3	91.0
5	Notifying ward prior to receiving patient	88.5	89.1	82.8	90.0	74.7	87.4
6	Dedicating noncritical patient care equipment to isolated patient	88.5	89.8	85.1	90.3	77.0	86.9
7	Cleaning and disinfecting all common equipment between isolated patients	90.8	86.9	83.9	88.5	78.2	83.9
8	Double plastic gloving for prevention of transmission of hospital-acquired infections	40.2	61.8	28.7	25.8	29.9	43.1

[a] Values are expressed as percentage.

Table 2. The Results of Differential Item Functioning Analysis Among Female and Male Nurses Based on PML Method

Item	DIF	Uniform Dif				Non-uniform Dif		
	P-Value	β_4 [b] (Se)	P-Value	ΔR^2 [a]	CVBL	β_5 [b] (Se)	P-Value	ΔR^2
Knowledge								
1	0.965	0.096 (0.384)	1.000	< 0.001	0.228	-0.408 (0.383)	0.514	0.002
2	1.000	0.102 (0.763)	1.000	< 0.001	1.163	-0.338 (0.462)	0.630	0.006
3	1.000	-0.621 (0.579)	0.420	0.003	0.295	-0.025 (0.317)	1.000	< 0.001
4	1.000	-0.397 (0.812)	1.000	< 0.001	0.703	0.139 (0.343)	1.000	0.003
5	1.000	-0.722 (0.614)	0.360	0.003	0.370	-0.192 (0.413)	1.000	< 0.001
6	0.319	-0.527 (0.587)	0.642	0.002	0.381	0.442 (0.232)	0.150	0.007
7	0.011	-1.840 (0.710)	0.003	0.019	2.823	0.306 (0.242)	0.555	0.003
8	0.001	0.946 (0.257)	< 0.001	0.015	2.205	-0.643 (0.457)	0.783	< 0.001
Attitude								
1	0.828	0.162 (0.467)	1.000	0.001	0.758	0.208 (0.212)	0.415	0.005
2	0.058	1.272 (0.483)	0.015	0.020	0.550	0.001 (0.262)	1.000	0.003
3	0.647	-0.607 (0.542)	0.341	0.004	1.638	-0.176 (0.303)	1.000	0.003
4	0.016	1.505 (0.472)	0.003	0.024	0.247	-0.211 (0.380)	1.000	0.003
5	1.000	-0.091 (0.521)	1.000	0.001	0.207	0.232 (0.283)	1.000	0.003
6	0.453	-0.466 (0.559)	0.803	0.002	1.138	0.478 (0.271)	0.217	0.007
7	0.957	-0.405 (0.478)	0.600	0.002	1.062	-0.229 (0.322)	1.000	0.002
8	< 0.001	-0.321 (0.263)	0.242	0.001	1.869	0.755 (0.186)	< 0.001	0.020
Practice								
1	0.640	0.568 (0.402)	0.236	0.004	0.882	-0.140 (0.258)	1.000	0.002
2	0.975	0.475 (0.518)	0.805	0.003	0.576	-0.455 (0.448)	1.000	0.005
3	0.091	-0.152 (0.542)	0.028	0.012	4.694	-0.220 (0.278)	1.000	0.003
4	0.021	1.411 (0.440)	0.002	0.021	0.385	-0.104 (0.329)	1.000	0.002
5	1.000	0.180 (0.413)	1.000	0.001	0.780	-0.141 (0.275)	1.000	0.001
6	1.000	-0.559 (0.524)	0.498	0.003	1.691	0.125 (0.365)	1.000	< 0.001
7	0.053	-1.072 (0.501)	0.029	0.009	4.395	0.434 (0.233)	0.291	0.005
8	0.029	0.386 (0.255)	0.129	0.002	4.407	0.291 (0.122)	0.029	0.005

Abbreviation: SE, standard error.

[a] ΔR^2 is the ZG criterion

[b] Coefficients in formula b and c.

Our results showed that the detected DIF was negligible across genders, although, clinically, attention to this negligible DIF should be considered. After removing item 8 ("Wearing two plastic gloves

Table 3. Comparison of the Mean Score Between Male and Female Nurses [a]

Variables	Male (n = 87)	Female (n = 589)	P-Value	Effect Size [b]
Before delete item of 8				
Knowledge	6.6 ± 1.9	6.9 ± 1.3	0.048	0.18
Attitude	6.1 ± 1.9	6.6 ± 1.4	0.004	0.30
Practice	5.7 ± 2.4	6.6 ± 1.6	< 0.001	0.44
After delete item of 8				
Knowledge	6.2 ± 1.8	6.3 ± 1.2	0.472	0.07
Attitude	5.9 ± 1.9	6.4 ± 1.4	0.002	0.30
Practice	5.4 ± 2.4	6.2 ± 1.6	< 0.001	0.39

[a] Values are expressed as mean ± SD.
[b] Cohen's d.

simultaneously is equal to one surgical glove for taking care of patients?"), there was no statistically significant difference between the two sexes based on knowledge scores. This item should be interpreted with caution due to the inverse response to the knowledge score (in other words, an incorrect answer is considered correct). After detecting the DIF, a standard recommendation is to delete such items. However, this solution is not suitable for the present study. Since the items in the Contact Precautions Questionnaire are short, deleting an item from the eight subscales would severely reduce the number of measurement levels for these subscales. Revising item 8 is a better solution for future research (32).

Comparing the scores of different domains after the DIF analysis showed that both male and female nurses had high knowledge scores, but their practice scores were relatively low, especially for men, who had the lowest scores. On the other hand, there was a statistically significant difference between male and female nurses in three areas. Women seem to be more compliant with what they have learned in training courses. This finding also aligns with some studies conducted in Jordan (18), Western Cape (19), and Palestinian hospitals (33). Additionally, we found that most of our nurses had good knowledge and attitudes but relatively poor performance. These results are consistent with some studies (10, 16) and in contrast with research conducted in Malaysia and North-Eastern Nigeria, which reported that knowledge, attitude, and compliance among nurses were adequate (17, 34). A study in Palestinian hospitals also reported that, despite having fair knowledge levels regarding infection control, nurses had good practice levels (33).

This lack of knowledge can result in poor implementation of contact isolation precautions, leading to an increased risk of transmission of infectious agents. Additionally, nurses' attitudes toward contact isolation precautions can significantly impact their compliance.

Overall, the findings of this review highlight the need for comprehensive education and training programs for nurses to improve their knowledge, practice, and attitude toward contact isolation precautions. Considering the study's findings, it is crucial to implement targeted educational interventions to enhance infection control practices among healthcare workers. We recommend the development of specialized training modules tailored to various experience levels, incorporating interactive e-learning and scenario-based learning. Additionally, simulation-based training sessions should be introduced to provide hands-on experience, complemented by mandatory annual refresher courses and competency assessments. Establishing a peer mentorship program can further support continuous learning, while ongoing evaluation and feedback mechanisms will ensure the long-term effectiveness and refinement of these initiatives. These actionable steps are designed to directly address the gaps identified in our study, promoting better infection control practices and improving patient outcomes.

While this study provides valuable insights into infection control practices among male and female nurses, one of the main limitations of this study is that the research was conducted in a single hospital in Iran. The cultural, organizational, and systemic characteristics of this setting may have influenced the findings, and as such, the broader implications should

be interpreted with caution. Cultural factors unique to Iran, such as local norms, values, and religious beliefs, may shape healthcare behaviors differently compared to other regions or countries. These cultural differences could impact the perception and adherence to infection control measures, potentially limiting the generalizability of our results. Therefore, further research is necessary to consider the different cultural and systemic contexts in this case.

5.1. Conclusions

In conclusion, our results suggest that nurses had different perceptions of item 8 related to contact precautions. Therefore, the contact precautions questionnaire should be used cautiously when comparing nurses' KAP scores. We suggest that DIF analysis should be used in the validation of contact isolation precautions questionnaires across different groups of healthcare workers. Despite having adequate knowledge and a positive attitude, nurses, unfortunately, exhibit a relatively poor level of performance. Additionally, improving nurses' knowledge, practice, and attitude toward contact isolation precautions is crucial for effective infection prevention and control.

Acknowledgements

The present article was extracted from a thesis written by Nahid Khoddami for the degree of Master of Science at Shiraz University of Medical Sciences. The authors would like to thank all nurses who participate in this research.

Footnotes

Authors' Contribution: Z. Sh. contributed to the study conception, implementation of the study, design, analysis, interpretation and critical was involved in drafting of the manuscript. N. K. contributed to data analysis and implementation of the study. P. J. was involved in interpretation of data. M. A. contributed to collection and interpretation of data. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

Conflict of Interests Statement: The authors declare no conflict of interest.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

Ethical Approval: This study was conducted according to the principles expressed at Shiraz University of Medical Sciences, and it was approved by the local Ethics Committee of Shiraz University of Medical Sciences by the code IR.SUMS.REC.1399.1036 .

Funding/Support: This work was financially supported by Shiraz University of Medical Sciences (grant No. 21402). The funding source had no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

Informed Consent: Based on the approval of the Ethics Committee, informed consent to participate in this study has been obtained from all participants before being included.

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