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The effect of an educational program on hand hygiene compliance among nursing students

Hamed Gholizad Gougjehyaran[1,2*], Hossein Motaarefi[2], Shahriar Sakhaei[2], Mahsa Ashrafi[2] and Sorayya Zeinalpoor[2]

Abstract

Background Hand hygiene is one of the most important measures for preventing infections acquired in healthcare settings. Nursing students are at risk of these infections due to their frequent contact with patients and contaminated surfaces. Educational programs can be effective in improving hand hygiene compliance among nursing students.

Objective To determine the effect of an educational program on hand hygiene compliance among nursing students.

Methods This study utilized a quasi-experimental two-group pretest-posttest design in 2023 with senior nursing students. All students were included in the study using a census method, and the intervention and control groups were randomly assigned. Data collection tools included a demographic questionnaire, and hand hygiene compliance was monitored through non-participant and non-intrusive observation methods, using the World Health Organization paper-based hand hygiene observation tool. The overall hand hygiene compliance rate was calculated by dividing the number of observed hand hygiene actions by the total number of recorded opportunities, with 100 observations before and after the intervention in both groups for each hand hygiene moment. Three months after the intervention, hand hygiene compliance was reassessed. The educational program was based on Kirkpatrick's learning model and consisted of a three-hour workshop to educate participants on the importance of hand hygiene. Descriptive statistics were used for data analysis, and the chi-square test was applied to assess compliance across the five hand hygiene moments. Data analysis was conducted using SPSS version 22 software.

Result The results showed that hand hygiene compliance rates in the intervention group increased compared to the control group across all five hand hygiene moments, indicating a significant improvement in adherence to hand hygiene practices following the educational intervention.

Conclusion An educational program can be effective in improving hand hygiene compliance among nursing students.

Clinical trial number Not applicable.

Keywords Hand hygiene, Nursing students, Education, Healthcare-associated infections

*Correspondence:
Hamed Gholizad Gougjehyaran
h.gholizad1991@gmail.com
[1]Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Department of Nursing, Khoy University of Medical Sciences, Khoy, Iran

Background

Healthcare-associated infections (HAIs), also known as hospital-acquired infections, are a significant global public health concern, posing a major threat to patient safety and healthcare systems worldwide [1, 2].

In low- and middle-income countries, the rate of HAIs can be alarmingly high, affecting over 25% of hospitalized patients. This represents a two to twenty-fold increase compared to the rates observed in developed countries [3–5]. Evidence indicates that a substantial proportion, ranging from 35 to 55%, of HAIs could be prevented, regardless of a country's economic status [6].

Moreover, in resource-constrained settings, accurately determining the true burden of HAIs remains a significant challenge [7]. While documented rates already exceed 15.5 cases per 100 patients, this number is likely an underestimate due to limitations in surveillance and reporting [7]. This critical knowledge gap hinders effective interventions and masks the true impact of HAIs on patient safety and healthcare systems. The alarming rise of HAIs globally underscores the urgent need for robust infection prevention and control programs, particularly in these resource-limited settings [8, 9].

Effective hand hygiene is the most effective way to prevent HAIs, with studies estimating that it can reduce these infections by up to 50% [10]. Despite this well-established fact, adherence to hand hygiene principles among healthcare workers remains low [11, 12]. To tackle this issue, it is crucial to improve healthcare workers' understanding of hand hygiene practices, address their attitudes toward it, and ensure the availability of hand hygiene products [13].

Nurses, due to the nature of their profession, are frequently in direct contact with patients and are closely involved with hospital environments and the associated infection risks. As future healthcare providers, nursing students play a vital role in infection prevention and adhering to hand hygiene principles. Undoubtedly, one of the ways that can strengthen the attitude of nurses and students in applying the policy and adherence to infection control standards is education [14]. Training is one of the main elements in increasing awareness and improving the clinical performance of employees [15].

There are several models for determining the value of training courses, and Kirkpatrick's model is one of the most popular for evaluating training effectiveness. This model assesses effectiveness across four levels. Level 1 (Reaction) evaluates if the learners are satisfied with the program. Level 2 (Learning) measures if the program successfully increased the knowledge of learners to a satisfactory degree. Level 3 (Behavior) assesses if the program was able to bring about positive changes in the behavior of learners. Level 4 (Results) determines if the educational program was effective in solving existing problems and meeting organizational goals [16, 17].

These data illustrate the importance of controlling hospital-acquired infections. One of the most effective measures to achieve this is ensuring healthcare workers comply with hand hygiene principles. As medical and nursing students represent the future healthcare workforce, it is logical to focus our study on their adherence to hand hygiene practices and their educational background in this area. Therefore, a study was conducted to evaluate the impact of an educational program on hand hygiene compliance among nursing students.

Methods

Study design, setting, and participants

In this study, a quasi-experimental design was employed, conducted from January to October 2023 among final-year nursing students at Khoy University of Medical Sciences and Khoy Azad University, located in West Azerbaijan, Iran. The students at Khoy University of Medical Sciences were assigned to the intervention group, while those at Khoy Azad University formed the control group. The intervention and control groups were randomly assigned. To minimize the potential for contamination between the groups, the intervention and control groups were selected from two separate universities to reduce the likelihood of cross-group influence or information sharing. Prior to the study, it was ensured that both groups had similar educational backgrounds. To calculate the required sample size, software like G*Power was used. Based on previous studies [18], with an expected effect size ($d = 0.8$), a significance level ($\alpha = 0.05$), and a desired statistical power of 80%, a sample size of 30 participants per group was determined. Considering a 15% attrition rate, a total of 70 participants were selected.

The inclusion criteria for participation included willingness to participate and not having taken any related educational courses in the past six months. Exclusion criteria were refusal to continue and absence from the training program. In this study, informed consent was obtained from all participants. Participants were provided with comprehensive information regarding the study's objectives, procedures, data collection methods, and the voluntary nature of their involvement. They were assured that they could withdraw from the study at any time without facing any negative consequences. Confidentiality of all personal data was strictly maintained, with assurances that information would be used solely for research purposes and that individual identities would remain confidential.

Data collection

Data collection tools included a demographic questionnaire assessing variables such as age, gender, marital status, direct contact with patients, and duration of handwashing. Hand hygiene compliance was recorded using a non-participant, non-intrusive observation method, where the researcher observed participants without direct interaction to minimize potential biases and preserve natural behavior, utilizing the World Health Organization (WHO) paper-based hand hygiene observation tool and method [8]. Hand hygiene opportunities and actions were documented based on the following criteria: [1] before touching the patient [2], before performing clean or aseptic procedures [3], after the risk of contact with body fluids [4], after touching the patient, and [5] after touching the patient's surrounding environment. If two or more opportunities occurred simultaneously (e.g., after touching patient A and before touching patient B), only one hand hygiene action was recorded.

During observations, two types of hand hygiene measures were noted: hand washing with soap and water and the use of alcohol-based hand sanitizer (ABHR). The overall hand hygiene compliance ratio was calculated by dividing the number of observed hand hygiene practices by the total number of recorded opportunities. A total of 100 observations were conducted for each situation within each group (intervention and control).

In terms of observation and data collection, two evaluators were trained to observe participants in different positions. Regarding the training of observers, they were educated based on the Five Moments for Hand Hygiene principles. Their proficiency was validated through assessments conducted by a senior observer. The observation period took three months after the training. Observations were carried out during the morning and afternoon shifts based on the students' internship schedules. The observation took place in the departments of Imam Khomeini Hospital, and the environmental conditions remained consistent throughout the study. To prevent the Hawthorne effect, the identity of the observers was kept concealed from the participants. The educational program was designed based on Kirkpatrick's learning model, which evaluates the effectiveness of education across four levels. It assesses both formal and informal training methods by categorizing them based on four levels of criteria: reaction, learning, behavior, and results. Based on Level 2 of the model, which pertains to learning, a three-hour workshop was conducted to educate participants on the importance of hand hygiene. The training content comprised PowerPoint presentations, WHO video tools, and lectures. Level 3 of the model evaluates behavior change; in this study, it was employed to assess the effectiveness of the educational program and the resulting behavior change, as indicated by the rate of hand hygiene compliance among nursing students. The control group did not receive any training during the study. However, the educational materials and WHO training videos were provided to the control group after the completion of the study to ensure equal access to educational resources. This measure aimed to enhance ethical considerations and allow all participants to benefit from the training after the study concluded.

Data analysis

For data analysis, descriptive statistics were used, and the chi-square test was applied to examine the five hand hygiene situations. Additionally, an independent t-test was used for continuous variables. The analysis was conducted using SPSS version 22 software, with a significance level of 0.05 considered statistically significant.

Result

The total number of participants in this study was 70 student nurses with no cases of refusal to participate by eligible persons. The participants' ages ranged from 21 to 28 ($\bar{x}=22.48 \pm 1.44$). Most of them were females (53.5%) and single (84.3%).

The two groups did not show any significant differences in terms of demographic characteristics. An independent t-test indicated that there was no statistically significant difference in age between the two groups ($p > 0.05$). Additionally, the Chi-square test showed no statistically significant differences between the two groups regarding other demographic variables, including gender, marital status, direct contact with patients, and duration of hand-washing ($p > 0.05$) Table 1.

We recorded a total of 500 hand hygiene opportunities across 28 observation sessions, with 100 opportunities observed for each situation.

The results of the Chi-Square test showed that there is a statistically significant difference in each of the 5 hand hygiene positions after the training program. Table 2.

Discussion

Hand hygiene is one of the most effective measures for preventing HAIs. Nursing students play a crucial role in preventing HAIs by adhering to proper hand hygiene practices. However, studies have shown that hand hygiene compliance among nursing students is often suboptimal [19–22].

Our study demonstrated that a structured educational program significantly improved hand hygiene compliance among nursing students across five WHO hand hygiene moments. These findings align with several recent studies that have explored various educational interventions to enhance hand hygiene practices among healthcare workers and students. Fouad and Eltaher (2020) conducted a study that results showed that compliance with hand

Table 1 Demographic characteristics and hand hygiene practices among participants

Characteristic	Intervention group ($n=35$)	Control group ($n=35$)	*p*- value
Age (years, Mean ± SD)	22.6 ± 2.12	22.36 ± 1.94	$P=0.382^{*}$
Gender			$P=0.631^{**}$
Male	15 (42.9%)	17 (48.5%)	
Female	20 (57.1%)	18 (51.5%)	
Marital Status			$P=0.74^{**}$
Single	30 (85.7%)	29 (82.9%)	
Married	5 (14.3%)	6 (17.1%)	
Direct Contact with Patients (times/day)			
1 to 5	10 (28.6%)	8 (22.9%)	$P=0.614^{**}$
6 to 10	12 (34.3%)	15 (42.9%)	
11–15	6 (17.1%)	3 (8.6%)	
>15	7 (20%)	9 (25.6%)	
Duration of Hand-Washing (seconds)			
<20 s	6 (17.1%)	8 (22.9%)	$P=0.788^{**}$
21 to 40 s	18 (51.4%)	19 (54.3%)	
41 to 60 s	7 (20%)	6 (17.1%)	
>60 s	4 (11.5%)	2 (5.7%)	

* Independent Groups T Test

** Chi-square test

Table 2 Hand hygiene compliance rates before and after the intervention among nursing students based on observed opportunities and hand hygiene indications

Hand hygiene indication by healthcare provider	Compliance rates		*P*
	Observed Opportunities ($N=100$)		
Before touching a patient	**Before**	**After**	
Intervention	20%	31%	< 0.05
Control	19%	18%	
Before clean/aseptic procedure			
Intervention	26%	37%	< 0.05
Control	25%	24%	
After body fluid exposure risk			
Intervention	43%	57%	< 0.05
Control	44%	45%	
After touching a patient			
Intervention	38%	51%	< 0.05
Control	33%	34%	
After touching patient surroundings			
Intervention	24%	36%	< 0.05
Control	22%	23%	

hygiene significantly increased after the intervention. Both studies utilized the World Health Organization's Five Moments for Hand Hygiene framework and direct observation as a method for evaluating compliance. This standardized approach allows for comparison between studies [23].

Chen et al. (2024) conducted a cluster randomized clinical trial examining hand hygiene education components among first-year nursing students [1]. Their results, similar to ours, showed that targeted educational interventions can significantly improve hand hygiene knowledge and skills. This reinforces the importance of incorporating comprehensive hand hygiene training early in nursing education programs.

The improvement in hand hygiene compliance observed in our study can be attributed to several factors. First, the use of Kirkpatrick's learning model [17] in designing our educational intervention likely contributed to its effectiveness. This model's focus on reaction, learning, behavior, and results aligns well with the multifaceted nature of hand hygiene compliance.

The use of WHO educational videos and hands-on training sessions in our study led to an improvement in hand hygiene compliance. Our findings align with the systematic review by Gould et al. (2017), which demonstrated that educational interventions, particularly when combined with other training methods and WHO instructional videos, have a significant impact on enhancing hand hygiene adherence [24].

Interestingly, our study found significant improvements in four out of five hand hygiene moments, with the moment "after touching patient surroundings" showing the least improvement. This finding is consistent with a systematic review by Labrague et al. (2018), which identified that compliance with hand hygiene after contact with patient surroundings was generally lower compared to other moments [25]. This suggests a need for targeted interventions focusing on this specific moment in future educational programs.

Our study demonstrated that applying Kirkpatrick's model in hand hygiene education particularly through WHO instructional videos and hands-on training sessions significantly improved compliance with hand hygiene practices. Similarly, the study by Shohani et al. (2020) found that peer-to-peer instruction was more effective than traditional instructor-led training in enhancing hand hygiene skills among nursing students [26]. Both Kirkpatrick's model and peer teaching emphasize active learning, direct interaction, and continuous feedback. Additionally, both approaches focus on behavioral change and improving practical performance in clinical settings, which was also observed in our study. This alignment suggests that interactive and multi-level educational strategies can play a crucial role in enhancing adherence to hand hygiene principles.

Our findings also align with those of Ghorbanmovahhed et al. (2023), who examined the impact of an educational program on hand hygiene compliance among nurses [27].Their study, like ours, used direct observation to assess hand hygiene compliance and found significant

improvements following the educational intervention. This consistency across different healthcare provider groups underscores the universal applicability and effectiveness of targeted hand hygiene education.

While our study showed promising results, it's important to acknowledge its limitations. The Hawthorne effect, despite our efforts to minimize it, may have influenced participants' behavior during observation periods. Additionally, the relatively short follow-up period limits our ability to assess the long-term impact of the educational intervention on hand hygiene compliance.

Based on the results of the present study, educational interventions have contributed to improving hand hygiene compliance among students. Future research could focus on evaluating the long-term sustainability of these changes to assess the enduring impact of educational interventions. Additionally, considering the need for further improvement in hand hygiene compliance, exploring the use of technologies such as electronic monitoring systems or mobile applications in future studies could provide more accurate and continuous assessments.

Limitations

This study has several limitations. First, the study was conducted in a single institution, which may limit the generalizability of the findings to other healthcare settings. Second, the Hawthorne effect may have influenced participants' behavior despite efforts to conceal observer identities. Third, the study relied on direct observation for assessing hand hygiene compliance, which, while a validated method, is subject to potential observer bias. Additionally, we did not assess long-term retention of hand hygiene practices after the intervention, which limits conclusions about its sustained impact. Future studies with a larger sample size, multi-center design, and long-term follow-up assessments are recommended to further validate these findings.

Conclusion

Our study provides evidence that a structured educational program based on Kirkpatrick's learning model can significantly improve hand hygiene compliance among nursing students. These findings have important implications for nursing education and healthcare-associated infection prevention strategies. By implementing comprehensive hand hygiene education programs, we can enhance the knowledge, skills, and behavior of future healthcare professionals, ultimately contributing to improved patient safety and reduced healthcare-associated infections.

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Author contributions
H.G. and H.M. completed the research design and writing of this article. H.G. and S.S. sorted out and analyzed the data. H.G. and M.A. reviewed and corrected important points in this article. S.Z. played an important role in the data acquisition of this study. All authors contributed to this article and approved the submitted version.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The Research Ethics Committee of Khoy University of Medical Sciences reviewed and approved this study (approved number IR.KHOY.REC.1400.005). Adhering to the ethical guidelines, protocols, and regulations outlined in the Declaration of Helsinki and the Measures of the Ethical Review of Life Science and Medical Research Involving Humans, the study ensured that informed consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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