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Original Article

Hand Hygiene in a higher education institution in Salvador, BA, Brazil: student knowledge

Higienização das mãos em instituição de ensino superior em Salvador, BA, Brasil: conhecimento discente
Higiene de manos en una institución de enseñanza superior en Salvador, BA, Brasil: conocimiento de los estudiantes

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ABSTRACT

Background and Objectives: Hand hygiene (HH) is a pillar of quality, safety and infection prevention in health services and the object of interest to Higher Education Institutions offering undergraduate health programs. The purpose of this study was to investigate the knowledge of undergraduate nursing students on the subject of HH with a view to contributing to health safety. **Methods:** This is a cross-sectional study with undergraduate nursing students from a public institution located in the city of Salvador, BA. Variables studied: academic characterization and student performance. Data collection: direct observation of the HH technique and application of a form. **Results:** The sample consisted of 82.9% of the students enrolled. Predominance of female students (84%), aged 18 to 24 years (66.2%). Of the six steps recommended for the HH technique, only 3.6% of the students performed all the steps. A statistical correlation was identified between the semester of study and increased adherence to correct HH technique steps. Rubbing the palms of hands together interlacing fingers was the most performed step, most students (40.8%) sanitized their hands in less than 20 seconds, and although 58% identified the five moments for HH during health care, 87% did not know the recommended time for HH. **Conclusion:** While HH technique proficiency improved as students progressed through the semesters, overall knowledge and performance of HH techniques remained inadequate. These findings suggest that the institution must implement multidimensional teaching strategies to enhance the acquisition and retention of these essential skills in the studied program.

Keywords: *Hand hygiene. Nursing. Infection control.*

RESUMO

Justificativa e Objetivos: A higienização das mãos (HM) é pilar da qualidade, segurança e prevenção de infecções em serviços de saúde e objeto de interesse também das Instituições de Ensino Superior dos cursos de graduação em saúde. Este estudou objetivou investigar o conhecimento dos discentes de Curso de Graduação em Enfermagem acerca da temática da HM, com vista a contribuir para a segurança em saúde. **Métodos:** Estudo transversal, com discentes de Curso de Graduação em Enfermagem de uma Instituição pública localizada na cidade de Salvador, BA. Variáveis estudadas: caracterização acadêmica e desempenho discente. Coleta de dados: observação direta da técnica de HM e aplicação de formulário. **Resultados:** A amostra constou de 82,9% dos alunos matriculados. Predominância de alunos do sexo feminino (84%), idade 18 a 24 anos (66,2%). Dos seis passos recomendados para a técnica de HM, apenas 3,6% dos alunos realizaram todos os passos. Identificou-se correlação estatística entre semestres cursados pelos discentes e aumento na realização dos passos da técnica de HM. A fricção entre as palmas das mãos foi a etapa mais executada; a maioria dos alunos (40,8%) higienizou as mãos em menos de 20 segundos; 58% identificaram os cinco momentos para a HM durante os cuidados em saúde, entretanto, 87% desconhecem o tempo preconizado para HM. **Conclusão:** A despeito da técnica de HM melhorar com o avanço de semestres cursados, os discentes estudados apresentaram conhecimento e técnicas inadequadas de HM, o que sinaliza a necessidade de implementar estratégias multidimensionais de ensino e aprendizagem nessa temática no curso investigado.

Descritores: *Higiene das mãos. Enfermagem. Controle de infecções.*

RESUMEN

Justificación y Objetivos: La higiene de manos (HM) es un pilar de la calidad, la seguridad y la prevención de infecciones en los servicios de salud, y objeto de interés para las instituciones de educación superior que ofrecen programas de salud de pregrado. El propósito de este estudio fue investigar el conocimiento de los estudiantes de enfermería de pregrado sobre el tema de la HM con el fin de contribuir a la seguridad sanitaria. **Método:** Estudio transversal con estudiantes de enfermería de pregrado de una institución pública ubicada en la ciudad de Salvador, Bahia. Variables estudiadas: caracterización académica y desempeño de los estudiantes. Recopilación de datos: observación directa de la técnica de HM y aplicación de un formulario. **Resultados:** La muestra estuvo compuesta por el 82,9% de los estudiantes matriculados. Predominaron las mujeres (84%), con edades comprendidas entre los 18 y los 24 años (66,2%). De los seis pasos recomendados para la técnica de HM, solo el 3,6% de los estudiantes los realizó en su totalidad. Se identificó una correlación estadística entre el semestre de estudio y una mayor adherencia a los pasos correctos de la técnica de HM. Frotarse las palmas de las manos fue el paso más realizado. La mayoría de los estudiantes (40.8%) se desinfectaron las manos en menos de 20 segundos. Si bien el 58% identificó los cinco momentos para la HM durante la atención médica, el 87% desconocía el tiempo recomendado para la HM. **Conclusión:** A pesar de la mejora en la técnica de HH con el avance de los semestres cursados, los estudiantes demostraron conocimientos y técnicas inadecuados de HM. Los hallazgos sugieren que la institución debe implementar estrategias de enseñanza multidimensionales para mejorar la adquisición y retención de estas habilidades esenciales en el programa estudiado.

Palabras Clave: *Higiene de manos. Enfermería. Control de infecciones.*

INTRODUCTION

Hand hygiene (HH) is the primary infection prevention and control measure in healthcare settings, recognized as the cornerstone of quality and patient safety.[1] Although preventable, healthcare-associated infections (HAIs) constitute a public health problem. Data from the World Health Organization (WHO) estimate rates of around 3.5 to 12% in patients from high-income countries and 5.7 to 19.1% in low- and middle-income countries. These indicators are likely to increase due to underreporting of these infections in many countries.[2]

Healthcare-associated infections are mainly transmitted through the contaminated hands of healthcare professionals; consequently, strategies for maintaining clean hands have been one of healthcare's greatest challenges since the era of Ignaz Semmelweis and Florence Nightingale.[1]

The economic burden of HAIs on healthcare systems, especially those with universal access, is enormous, and data on financial costs vary between countries, but equally impact nation-states in their mission to protect their citizens.[3]

In this context, the prevention and control of HAIs should be a priority goal for managers and healthcare professionals. As contaminated hands constitute the main mode of transmission of pathogens within healthcare services, this practice is the key procedure for interrupting the transmission of microorganisms during healthcare.[1-3]

Contaminated hands transmit microorganisms, some of great epidemiological relevance, such as *Clostridium difficile*, vancomycin-resistant *Enterococcus*, or Methicillin-resistant *Staphylococcus aureus*. The contamination of healthcare professionals' hands results directly from contact with patients or indirectly through touching contaminated environmental surfaces.[2,4-7]

Despite its importance, lack of adherence to HH is a reality in healthcare services worldwide and data report adherence rates of approximately 20 to 40%.[1-3,8] In this context, education is central to behavioral change, and since 2009 the WHO has encouraged the updating of curricula in undergraduate health programs with the inclusion of disciplinary components that address the theme of patient safety, prevention of errors and adverse events in healthcare.[7,9-10]

Thus, health curricula at Brazilian Higher Education Institutions must urgently integrate the topic of HH to train professionals committed to patient safety and the prevention of HAIs.

To address this need, the present study aimed to investigate undergraduate nursing students' knowledge of HH to contribute to improved health safety.

METHODS

This is a cross-sectional descriptive quantitative study. It was conducted with undergraduate students of a Nursing Program at a state public university located in Salvador, Bahia, Brazil.

This Nursing Program is part of the Department of Life Sciences at this university, along with other undergraduate health programs: Medicine, Nutrition, Pharmacy, Physiotherapy, and Speech Therapy. Student admission occurs semiannually through a public selection process (university entrance exam), special categories (affirmative action policies), and the Unified Selection System (SISU). This is a full-time program and offers 60 seats annually, 30 in each semester. Its Pedagogical Project foresees the completion of the curriculum in 10 to 14 semesters with a total workload of 4,335 hours. Among the curricular components, this Nursing Program has an elective course entitled "Infection Control and Safety in Health Services", offered as "Special Topics" with a workload of 30 hours, where the topic of HH is addressed.

The convenience sample included all students enrolled in this program, according to the inclusion criteria: age over 18 years, being duly enrolled and attending the program during the data collection period. Exclusion criteria included students on leave due to leave of absence, maternity leave, or medical leave during the data collection period, or students with physical limitations that prevented them from performing the HH technique.

Theoretical and practical knowledge of students about HH was defined as the dependent variable.

Theoretical knowledge was assessed by the number of correct answers obtained in a self-administered questionnaire with six questions. The questions referred to: (i) the concept of HH; (ii) the relationship between the technique and the recommended time for HH; (iii) microbial activity of antiseptic solutions; (iv) indication for the use of alcohol-based antiseptic solution; (v) effectiveness of HH with alcohol solution; and (vi) on the five moments of HH recommended by the WHO (Annex or supplementary material 1).

Practical knowledge was measured by the number of steps recommended by the WHO performed during HH with alcohol solution. Participating students were asked to sanitize their hands with alcohol solution.[7,9] This procedure was observed by trained scholarship holders, who verified and recorded the completion of each of the six steps. Only the number of steps and areas of the sanitized hands were recorded. The sequence of the technique, as recommended by the WHO, was not considered for counting the correct answers.[7,9] The HH time was measured with a stopwatch. The observation data were recorded on an observation form (Appendix A or supplementary material 1).

Data relating to the academic characterization of participants were collected as independent variables.

Academic characterization was performed based on the information provided by students during data collection. The information gathered referred to sex at birth, age, current semester, and practical experience in health services through curricular or extracurricular internships. There were also open-ended questions inquiring about attendance in the "specific curricular component on Healthcare-Associated Infection (HAI)" course and another about the existence of any "curricular component in which the topic of HH in health services was addressed". Data were collected by four students previously trained by the researchers for 60 days. The collection took place in person between August and November 2023 in a specific room on the premises of this higher education institution. Two stages were carried out sequentially: 1st: direct observation of the HH technique using an alcoholic preparation (liquid solution), and 2nd: application of a self-administered questionnaire with semi-structured questions about the students' characterization and theoretical knowledge about HH. The HH technique using an alcohol-based solution was selected for its ease of observation, eliminating the need for a sink with soap and water.

Data collection appointments were scheduled in advance, on specific days, times, and locations according to a schedule created by the data collectors. After processing and recoding, data were processed using the IBM SPSS (Statistical Package for the Social Sciences) software. Initially, data on sex, age, current semester, experience in healthcare services, steps performed for HH, number of steps performed, correct answers to knowledge questions, and total number of correct answers were presented as absolute and relative frequencies. The range, mean, median, and standard deviation were used to assess the time students spent performing HH.

The normality of data distribution for correlation was assessed using the Shapiro-Wilk test. Given the lack of normality in the distribution of variables, the Spearman's correlation coefficient was used to analyze the relationship between the semester, the number of correct answers, and the correct steps. The significance level adopted was 5% ($p < 0.05$).

Each participating student signed the Informed Consent Form (ICF) before data collection. This study was submitted to Plataforma Brasil under CAAE No. 63764522.9.1001.0057 and was approved by the Research Ethics Committee of the Universidade do Estado da Bahia on February 24, 2022, according to Opinion No. 5.261.425.

RESULTS

This study included 169 of the 204 enrolled and eligible students of the Undergraduate Nursing Program, representing a sample of 82.8% of the sample universe.

The sociodemographic characteristics and semesters attended by the students participating in this study are presented below (Table 1).

Table 1. Sociodemographic characteristics and current semester of students in the Undergraduate Nursing program at the Higher Education Institution. Salvador, BA. Brazil. 2023.

Variables	N (%)
Sex	
Female	142 (84)
Male	27 (16)
Age range	
18 to 24 years	112 (66.2)
≥ 25 years	57 (33.7)
Current semester	**Participants/enrolled**
1º Semester	19/23 (82.6)
2º Semester	13/16 (81.2)
3º Semester	10/14 (71.4)
4º Semester	11/18 (61.1)
5º Semester	18/19 (94.7)
6º Semester	35/43 (81.3)
7º Semester	15/18 (83.3)
8º Semester	16/19 (84.2)
9º Semester	13/14 (92.8)
10º Semester	19/21 (90.4)
Practical experience in healthcare*	
Yes	120 (71)
No	49 (29)

Abbreviation: *Curricular component with practical experience in health services.

The HH technique is demonstrated below, based on non-participant observation.

Table 2. Steps of the hand hygiene technique performed by students, according to direct observation. Higher Education Institution. Salvador (BA). Brazil. 2023.

Hand hygiene steps	N (%)
Rub the palms of hands together with fingers interlaced	
Yes	164 (97)
No	05 (2.9)
Rub the back of each hand with the opposite palm, interlacing fingers	
Yes	136 (80,5)
No	33 (19.5)
Rub palms together with fingers interlaced	
Yes	58 (34,3)
No	111 (65.7)
Interlock fingers and rub the backs of the fingers against the opposing palms	
Yes	60 (35.5)
No	109 (64.5)
Rub each thumb rotationally, clasped in the opposite palm	
Yes	117 (69.2)
No	52 (30.8)
Rub fingertips and nails in the opposite palm in a rotational movement	
Yes	86 (50.9)
No	83 (49.1)

The following shows the number of steps in the HH technique performed by students during direct observation.

Table 3. Number of steps in the hand hygiene technique performed by students according to the current semester of the program. Higher Education Institution. Salvador, BA. Brazil, 2023.

Current semester	Number of HH steps performed						
	Step 1 N (%)	Step 2 N (%)	Step 3 N (%)	Step 4 N (%)	Step 5 N (%)	Step 6 N (%)	Total number of students per semester N (%)
1st semester	2 (1.2)	7 (4.14)	6 (3.6)	3 (1.8)	1 (0.6)	0 (0.0)	19 (11.2)
2nd semester	2 (1.2)	5 (3.0)	3 (1.8)	1 (0.6)	2 (1.2)	0 (0.0)	13 (7.7)
3rd semester	0 (0.0)	1 (0.6)	8 (4.7)	1 (0.6)	0 (0.0)	0 (0.0)	10 (5.9)
4th semester	0 (0.0)	2 (1.2)	5 (3.0)	3 (1.8)	1 (0.6)	0 (0.0)	11 (6.5)
5th semester	0 (0.0)	2 (1.2)	8 (4.7)	6 (3.6)	2 (1.2)	0 (0.0)	18 (10.7)
6th semester	1 (0.6)	1 (0.6)	11 (6.5)	11(6.5)	9 (5.3)	2 (1.2)	35 (20.7)
7th semester	0 (0.0)	1 (0.6)	3 (1.8)	8 (4.7)	2 (1.2)	1 (0.6)	15 (8.9)
8th semester	0 (0.0)	0 (0.0)	0 (0.0)	7 (4.14)	6 (3.6)	3 (1.8)	16 (9.5)
9th semester	0 (0.0)	1 (0.6)	1 (0.6)	4 (2.4)	7 (4.14)	0 (0.0)	13 (7.7)
10th semester	0 (0.0)	1 (0.6)	1 (0.6)	11 (6.5)	6 (3.6)	0 (0.0)	19 (11.2)
Total number of steps performed	5 (3.0)	21 (12.4)	46 (27.2)	55 (32.5)	36 (21.3)	6 (3.6)	169 (100)

When we correlated the number of steps performed by these students and their current semester, a rho of 0.531 (p<0.0001) was found, indicating a moderate correlation between the number of steps performed and the current semester in which the student is enrolled (Figure 1).

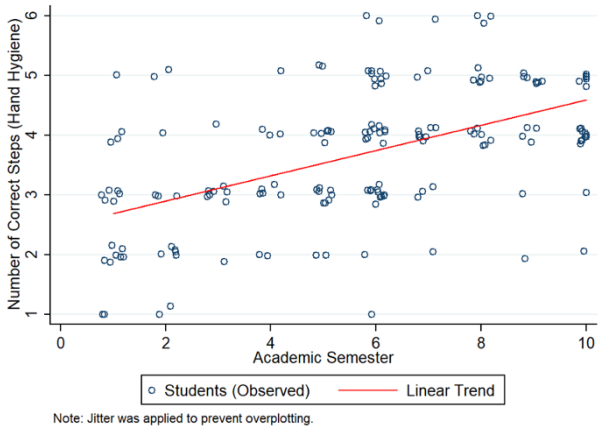

Figure 1. Correlation between the students' current semester X number of hand hygiene steps performed. Undergraduate Nursing Program. Higher Education Institution. Salvador, BA.

During direct observation, the time students spent performing HH with an alcohol solution ranged from seven to 63 seconds, mean of 23.2 seconds, median of 22 seconds, and a standard deviation of 9.8 seconds.

When categorizing the time, 40.8% (69) of the students performed HH in less than 20 seconds, 39.6% (67) within the recommended time, between 20 and 30 seconds; and 19.5% (33) exceeded 30 seconds.

The students' theoretical knowledge about HM is presented below (Table 4).

Table 4. Students' knowledge about the hand hygiene practice. Higher Education Institution. Salvador, BA. Brazil. 2023.

Knowledge Questionnaire Questions	N (%)
Concept of hand hygiene	
Correct	97 (57.3)
Incorrect	72 (42.6)
Relationship between hand hygiene technique and recommended time for its performance	
Correct	22 (13.0)
Incorrect	147 (86.9)
Microbial activity of alcohol-based antiseptic solution	
Correct	24 (14.2)
Incorrect	145 (85.7)
Indication of rubbing with alcohol-based antiseptic solution in hand hygiene	
Correct	116 (68.6)
Incorrect	53 (31.3)
On the effectiveness of hand hygiene with alcohol-based rubbing	
Correct	46 (27.2)
Incorrect	123 (72.7)
5 moments for hand hygiene recommended by the WHO	
Correct	98 (57.9)
Incorrect	71 (42.0)

Regarding the open-ended questions in the questionnaire, 101 (59.7%) students responded they had taken a specific component on HAIs and 99 (58.5%) stated there was a component that addressed the topic of HH. When describing this component, they cited Biosafety (18); Microbiology (1), Pathology (1), Care Process (1), Infectious Diseases and Immunization (29), Infection Control and Safety in Health Services (49).

Of the six questions related to students' knowledge of the topic of HH, out of a total of 169 evaluated, none managed to answer all six questions correctly. The average number of correct answers was 2.38, ranging from 0 to five questions. The median was two and the standard deviation was 1.16.

It was found that 57.3% of students are familiar with the concept of HH, 68.6% with the indication for alcohol-based hand rubbing preparation, and 58% are familiar with the five moments for HH recommended by the WHO during healthcare.

When comparing the number of correct answers to the questions in relation to the current semester, a rho of 0.291 (p=0.0001) was identified, indicating a weak correlation between the number of correct answers and the current semester of the student (Figure 2).

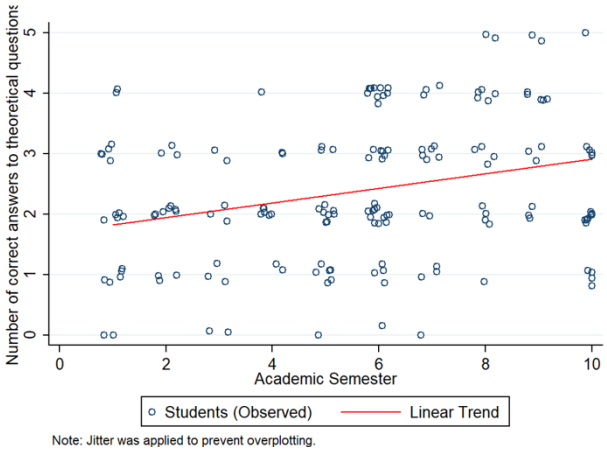

Figure 2. Correlation between students' current semester and number of correct answers to theoretical questions on hand hygiene. Undergraduate Nursing Program. Higher Education Institution. Salvador, BA.

DISCUSSION

The sociodemographic distribution of students in this Undergraduate Nursing Program shows a predominance of those aged 18 to 24 years (66.2%), mostly female (84%), reflecting the profile of Brazilian nursing, a relatively young workforce, in which 38% of professionals are under 35 years of age and 87% are female.[11]

The variable "academic characterization" sought to correlate the profile of the students and the inclusion of the HH topic in the theoretical-practical components of this Program. It was found that 59.7% of the students took a specific component on HAIs and 58.5% of these were exposed to the theoretical constructs of HH during participation in various other curricular components, showing that this Undergraduate Program has a curriculum that responds to the demands of the WHO. This organization calls upon its member countries to "improve education in patient safety, its principles and approaches", considering the need for training healthcare professionals in line with the accelerated pace of the various challenges in the healthcare sector and its demands for workforce change.[12]

The sample included students from all semesters of the Program, with the highest frequency of students from the fifth, ninth, and 10th semesters, (94.7%, 92.8%, and 90.4%), of whom 71% had practical experience in healthcare services and 29% had no curricular practice. In other words, a student body where the majority had been exposed to various theoretical curricular components and with practical clinical experience, conditions that, a priori, may favor knowledge about HH.

The WHO considers the HH technique adequate when the six complete steps are performed in a time between 20 and 30 seconds.[7,9] This recommendation is based on the rationale that the six recommended steps, regardless of the sequence performed, result in contact of the

alcoholic antiseptic solution with all areas/spaces of the hand and consequent reduction of the microbial load, compared to incomplete steps.[7,9,13-17]

Observation of the students' HH technique revealed that only 3.6% of the total students evaluated performed all six recommended steps, 32.5% four steps, and 27.2% three steps, highlighting the non-compliance with the correct HH technique by the vast majority in this study. However, Pearson's correlation test revealed that the more students advance through the semesters of the Program, the more steps of the HH technique are performed, pointing to the importance of reinforcing this knowledge throughout the evolution of the curriculum of this Program.

Of the recommended steps, rubbing the palms of hands together (step 1) was the most frequently performed by students (97%), followed by step 2, rubbing the back of each hand with the opposite palm, interlacing fingers (80.5%). The least frequently performed HH steps were rubbing palms together with fingers interlaced (65.7%), interlocking fingers and rubbing the back of fingers against the opposing palms (64.5%), and rubbing the fingertips and nails in the opposite palm in a rotational movement (49.1%), demonstrating negligence or lack of knowledge regarding the hygiene of heavily colonized areas of the hand implicated in pathogen transmission, such as the subungual and interdigital spaces.[2,7,9]

In healthcare settings, HH compliance among healthcare professionals, particularly the nursing staff, is crucial to prevent pathogen transmission, considering this professional category is responsible for 24-hour patient care, and their interventions require direct contact with patients and their surroundings.

Nursing students are considered healthcare professionals in training, and during their practice, they can also transmit microorganisms between patients if they are unfamiliar with HH or practice it incorrectly. In this sense, higher education institutions in the health field need to implement curricula, such as the one identified in this Program, that address issues of clinical practice and the culture of safety and error prevention in healthcare, reinforcing the encouragement of the WHO and regulatory bodies, such as the National Health Surveillance Agency.[11,16]

The duration of HH using an alcohol-based preparation is also a determining factor in the adequacy of this practice, considering the WHO recommendation of an exposure time of 20 to 30 seconds for the solution to achieve germicidal action. In relation to the HH technique, most students (40.8%) sanitized their hands for less than 20 seconds, falling short of the recommended duration; 39.6% of the students performed HH within the standard 20 to 30-second range; and 19.5% exceeded 30 seconds. These numbers also revealed time-related inadequacies for HH with alcohol-based solution.

Of the six questions that sought to identify the students' theoretical background regarding HH, out of a total of 169 students evaluated, none answered all six questions correctly. However, 57.3% of the students know the concept of HH, 68.6% know how to distinguish the indications for the use of hand rubbing with alcohol-based antiseptic preparation, and 58% recognize the five moments recommended by the WHO for HH during healthcare. A comparison between the number of correct answers to questions and the students' current semester revealed a weak statistical correlation; this suggests that progression through the Program does not significantly enhance knowledge regarding HH and the prevention of related HAIs.

Additionally, the recommended time for HH with an alcohol-based preparation and the microbial activity of this solution are unknown topics for 87% and 86.9% of students, respectively, as is the effectiveness of the alcohol-based preparation for HH for 72.8% of them.

Although most of these students understand the concept of HH and the indication for this practice, crucial information such as the biocidal action of alcohol and the necessary contact time with the hands is ignored, as revealed by the percentage of 40.8% of students who sanitized their hands in less than 20 seconds.

The change from handwashing with soap and water to rubbing with an alcohol-based preparation significantly reduces the microbial load on the hands. In addition, it decreases the time required from at least one minute to reach the sink, wash hands, dry them, and return to the patient, to just 20-30 seconds with the use of alcohol.[2] Therefore, despite the advantage of the minimum contact time of 20 to 30 seconds required for HH with the use of the alcohol solution, this is not followed by the vast majority of students.

This study reveals that this Undergraduate Nursing Program has a specific component on Infection Control and Health Safety, and students are exposed to various components that address the topic of HH. However, the students studied fail to comply with the technique by not performing all the recommended steps, neglecting the hygiene of hand areas involved with a higher microbial load, and not following the time required for the biocidal action of the alcohol solution. This situation constitutes poor HH practice on their part and signals the need to change teaching and learning models or to incorporate multimodal strategies into HH teaching practice, as well as those implemented in health services.

Our study diverges from previous international research regarding the evaluation of students and their knowledge in three primary aspects: i) the nursing curricula analyzed differ in duration and core

components; ii) while we evaluated HH practices through direct observation, other studies relied on self-reported data; iii) whereas those studies applied a form developed by the WHO, our study employed an instrument specifically designed by the authors.[2,18-20]

Despite the methodological differences, both international studies and our study identified gaps and/or moderate knowledge among students regarding the topic of HH. In a study with nursing students from Saudi Arabia, 58.6% of knowledge about HH was identified.[19] Another study using the WHO form in Switzerland revealed low scores on knowledge about HH (25% and 63% for students and 48.8% for nurses).[18] These data confirm the need to revise undergraduate nursing curricula and the continuing education for health professionals offered by health institutions.

Since the theoretical and practical content of HH passed on to students during the curricular components was not accessed in this study, the learning process and teaching methodological strategies are also unknown, which constituted a limitation and perhaps explains the results found.

Despite the aspects mentioned above, the objective of investigating students' knowledge about HH and contributing to national data on this topic was achieved.

Hand hygiene is also emblematic in the academic field, because even in an Undergraduate Nursing Program with a curriculum that includes disciplinary components addressing this topic, students do not have adequate HH practice, both in technique and in the recommended time. This finding signals the need to incorporate multidimensional teaching and learning strategies on this topic in this Program.

For the consolidation of the HH culture and the immersion of academia in the global fight for the control of HAIs, this study points not only to the importance of including HH constructs in the training of future nurses, but also of rethinking teaching in light of Paulo Freire's affirmation that "*teaching is not transferring knowledge, but creating the possibilities for its own production or construction*".

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AUTHORS' CONTRIBUTIONS

Eliana Auxiliadora Magalhães Costa contributed to the conception, data collection, data analysis, article writing, and revision for publication. **Tássia Teles Santana de Macedo** contributed to the data collection, data analysis, article writing, and revision for publication. **Mariana de Almeida Moraes** contributed to the data collection, data analysis, article writing, and revision for publication. **Adriana Cristina Oliveira** contributed to the data collection, data analysis, article writing, and revision for publication. **Rafael Lima Rodrigues de Carvalho** contributed to the data collection, data analysis, article writing, and revision for publication. **Rebeca Assis** contributed to the data collection and revision for publication. **Renata Gomes** contributed to the data collection and revision for publication. **Jaqueline Brazil Leite** contributed to the data collection and revision for publication. **Angela Gabriela da Silva Santana** contributed to the data collection and revision for publication.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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APPENDIX A

Observation Guide

Hand hygiene with alcohol-based antiseptic solution

Observer code:	**Student code:**	**Hand hygiene time (seconds):**

	Hand hygiene with alcohol-based antiseptic solution	**Yes**	**No**
	Rub the palms of hands together with fingers interlaced		
	Rub the back of each hand with the opposite palm, interlacing fingers		
	Rub palms together with fingers interlaced		
	Interlock fingers and rub the backs of the fingers against the opposing palms		
	Rub each thumb rotationally, clasped in the opposite palm		
	Rub fingertips and nails in the opposite palm in a rotational movement		

APPENDIX B

To be completed by the students of the Data Collection	
Institution code:	**Participant code:**

Student characterization

Age: _____years old

Sex: ( ) Female ( ) Male

Current semester: _____

( ) No practical experience in health services

( ) With practical experience in health services

Knowledge about healthcare-associated infections (HAIs) and hand hygiene (HH).

1. **Have you had a specific curricular component on the control of healthcare-associated infections (HAIs) during the program?**
   ( ) No
   ( ) Yes. Specify: _____

2. **Have you had a curricular component that addressed the topic of HH in healthcare services during the program?**
   ( ) No

   ( ) Yes. Specify: _____

3. **Hand hygiene refers to the following procedures (choose ONLY one of the options):**
   a) Hand washing with soap and water
   b) Rubbing with an alcohol-based antiseptic solution
   c) Hand washing with an antiseptic degerming solution (PVPI or chlorhexidine)
   d) a+b are correct
   e) a+b+c are correct
   f) I don't know

4. **Regarding the hand hygiene technique and the recommended time for its performance (choose one of the options):**
   a) Rubbing hands with an alcohol-based antiseptic solution should last between 20 and 30 seconds
   b) Washing with soap and water should last between 20 and 40 seconds
   c) Hand hygiene is guaranteed as long as the palms and backs of the hands are well rubbed
   d) Vigorous hand rubbing with soap and water should not be inferior to 10 seconds
   e) All of the above statements are correct
   f) I don't know

5. **Hand rubbing with an alcohol-based antiseptic solution has good or excellent antimicrobial activity against all microorganisms, except for (choose one option):**
   a) Viruses
   b) Fungi
   c) Mycobacteria
   d) *Clostridium difficile*
   e) Gram-positive and Gram-negative bacteria
   f) I don't know

6. **Hand rubbing with an alcohol-based antiseptic solution is indicated for all the situations described below, except for (choose one option):**
   a) When hands are visibly dirty
   b) Pre-surgical hand preparation
   c) Before performing aseptic procedures
   d) Before preparing medication
   e) I don't know

7. **Mark the incorrect statement (choose one of the options):**
   - **a)** Rubbing with an alcohol-based antiseptic solution is more effective in reducing the microbial load than washing hands with soap and water
   - **b)** Rubbing hands with an alcohol-based antiseptic solution requires less time than washing hands with soap and water
   - **c)** The use of wrist or finger accessories significantly reduces the effectiveness of rubbing with an alcohol-based antiseptic solution
   - **d)** Rubbing hands with an alcohol-based antiseptic solution is effective only if performed for 60 seconds
   - **e)** I don't know

8. **Which of the following options confirms the 5 moments for hand hygiene as recommended by the World Health Organization (choose one option):**
   - **a)** Before touching a patient; before a clean/aseptic procedure; after risk of exposure to body fluids, secretions, excretions, mucous membranes, non-intact skin or dressing; after touching a patient; after touching objects and equipment in the patient's surrounding environment.
   - **b)** Before entering the service area; before a clean/aseptic procedure; after risk of exposure to body fluids, secretions, excretions, mucous membranes, non-intact skin, or dressings; after touching a patient; after touching objects and equipment in the patient's surrounding environment.
   - **c)** Before touching a patient; before a clean/aseptic procedure; after risk of exposure to secretions in an isolated patient; after touching a patient; after touching objects and equipment in the patient's surrounding environment.
   - **d)** Before touching a patient; before a clean/aseptic procedure; after risk of exposure to body fluids, secretions, excretions, mucous membranes, non-intact skin, or dressings; after touching a patient; after using sanitary facilities.
   - **e)** I don't know