

# Prevalence and Associated Factors of *Staphylococcus aureus* and Methicillin-Resistant *Staphylococcus aureus* on the Hands of Health Science Students at Da Nang University of Medical Technology and Pharmacy

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## ABSTRACT

**Background:** *Staphylococcus aureus* (*S. aureus*), including methicillin-resistant *S. aureus* (MRSA), is a major cause of healthcare-associated infections, with hands serving as a key transmission vector. Health science students, frequently exposed to clinical settings, are at risk of hand contamination. **Methods:** A cross-sectional study with a controlled comparison was conducted from January to May 2024 at Da Nang University of Medical Technology and Pharmacy. Hand samples were collected from 120 students across Medicine, Medical Laboratory Technology, and Nursing programs using the glove juice method. *S. aureus* was identified via Gram staining, coagulase, and mannitol fermentation tests, with MRSA confirmed using oxacillin disk diffusion. Hand hygiene's impact was assessed by comparing *S. aureus* prevalence before and after handwashing. Data were analyzed using SPSS 20.0, with Chi-square tests for associations ( $p < 0.05$ ). **Results:** The prevalence of *S. aureus* on students' hands was 32.5% (39/120), with 12.8% (5/39) identified as MRSA, all from students with hospital training experience. Handwashing reduced *S. aureus* prevalence significantly (16.7% vs. 32.5%,  $p < 0.05$ ). No significant associations were found between *S. aureus* carriage and gender, academic program, or hospital training status ( $p > 0.05$ ). **Conclusion:** Hand carriage of *S. aureus* and MRSA is prevalent among health science students, particularly those with hospital exposure. Hand hygiene significantly reduces contamination, emphasizing its importance in infection control training.

**Keywords:** *Staphylococcus aureus*, Methicillin-Resistant *Staphylococcus aureus*, Hand Hygiene, Health Science Students, Infection Control.

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## INTRODUCTION

*Staphylococcus aureus* (*S. aureus*) is a ubiquitous bacterium commonly colonizing human skin, nasal mucosa, and hands, acting as a commensal in 30–50% of healthy individuals [1]. However, it is also a leading opportunistic pathogen responsible for a spectrum of infections, from mild skin and

soft tissue infections (e.g., impetigo, folliculitis) to life-threatening conditions such as bacteremia, pneumonia, osteomyelitis, and toxic shock syndrome [2]. Methicillin-resistant *S. aureus* (MRSA), characterized by resistance to  $\beta$ -lactam antibiotics due to the *mecA* gene, poses a significant global health challenge,

complicating treatment and increasing mortality [3]. In Vietnam, *S. aureus* is a major cause of healthcare-associated infections, with studies reporting high MRSA prevalence in clinical settings, including 61.43% at Thai Nguyen Central Hospital in 2021 [4] and 64.7% in pediatric peritonitis cases at the National Children's Hospital in 2022 [5].

Hands are a primary vector for *S. aureus* transmission, particularly in healthcare settings where contact with patients, contaminated surfaces, or medical equipment facilitates pathogen spread [6]. Health science students, such as those in medicine, medical laboratory technology, and nursing, are at elevated risk of hand contamination due to frequent exposure to clinical environments during training [7]. In Vietnam, prior studies have highlighted *S. aureus* hand carriage among healthcare workers and students. For instance, Phan et al. (2021) found 43.6% of healthcare workers' hands at Vinh Medical University Hospital carried *S. aureus* [8], while Nguyen et al. (2019) reported a 22% prevalence among medical laboratory students, with 9.1% being MRSA [9]. The rise in antibiotic resistance, particularly to penicillin (98.9%) and oxacillin (70–80%) [10], underscores the need for surveillance and infection control measures.

Hand hygiene is a critical intervention to reduce *S. aureus* transmission, with studies demonstrating significant reductions in bacterial load post-handwashing [11]. In Vietnam, the Ministry of Health has promoted hand hygiene campaigns, yet compliance among students remains variable [12]. This study aims to determine the prevalence of *S. aureus* and MRSA on the hands of health science students at Da Nang University of Medical Technology and

Pharmacy, assess associated factors, and evaluate the impact of hand hygiene, providing evidence to enhance infection control education.

## MATERIALS AND METHODS

### Study Design

A cross-sectional study with a controlled comparison was conducted from January 1 to May 31, 2024, at Da Nang University of Medical Technology and Pharmacy. The cross-sectional component assessed *S. aureus* prevalence, while the controlled comparison evaluated hand hygiene's effect by comparing *S. aureus* carriage before and after handwashing.

### Participants

The study included 120 students from programs of Medicine, Medical Laboratory Technology, and Nursing.

*Inclusion criteria:* Students enrolled in the above programs, consenting to participate, and providing hand samples.

*Exclusion criteria:* Students with hand skin infections or using antibiotics at the time of sampling.

*Control group:* The same 120 students, sampled after handwashing with soap, served as the control for the hand hygiene comparison.

### Sample Size

The sample size was calculated using the formula for cross-sectional studies:

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

With: ( $z = 1.96$ ) (95% confidence level), ( $p = 0.193$ ) (based on a 19.3% *S. aureus* prevalence from Pham et al. [13]), ( $d = 0.08$ ) (margin of error). This yielded ( $n = 93.49$ ). Accounting for a 10% data loss, the minimum sample size was 103. A total of 120 students were recruited using convenience sampling.

### Data Collection

Hand samples were collected using the glove juice method [14]. Sterile gloves were worn by participants, and 10 mL of 0.9% sterile saline was introduced into the glove. The hand was massaged for 1 minute to dislodge microorganisms, and 2 mL of the resulting solution was collected in sterile tubes. For the control group, hands were washed with soap following WHO guidelines before sampling. Samples were centrifuged at 3000 rpm for 5 minutes, and the sediment was used for culture.

### Microbiological Analysis

Samples were cultured on blood agar and Chapman agar to isolate *S. aureus*. Identification was based on:

- Gram-positive cocci in clusters under microscopy.
- $\beta$ -hemolysis on blood agar.
- Golden-yellow colonies on Chapman agar.
- Positive coagulase and mannitol fermentation tests.

MRSA was confirmed using oxacillin (5  $\mu$ g) disk diffusion on Mueller-Hinton agar, per CLSI 2011 guidelines [15]. Antibiotic susceptibility was assessed using the Kirby-Bauer method.

### Statistical Analysis

Data were processed using SPSS 20.0. Prevalence was expressed as percentages. Associations between *S. aureus* carriage and gender, academic program, hospital training, and hand hygiene were analyzed using Chi-square tests, with p-value < 0.05 considered significant.

### Ethical Issues

The study was conducted according to the Declaration of Helsinki and approved by the Biomedical Ethics Committee of Da Nang University of Medical Technology and Pharmacy (No. 2024-01/DHKTYDDN, December 2023). Participants provided written informed consent, and data were anonymized to ensure confidentiality.

## RESULTS

### Participant Characteristics

Of the 120 students, 71.7% (86) were female, and 28.3% (34) were male. Medicine students comprised 46.7% (56), Nursing 36.7% (44), and Medical Laboratory Technology 16.6% (20). Hospital training experience was reported by 53.3% (64), while 46.7% (56) had not yet trained in hospitals (Table 1).

**Table 1.** Demographic Characteristics of Study Participants

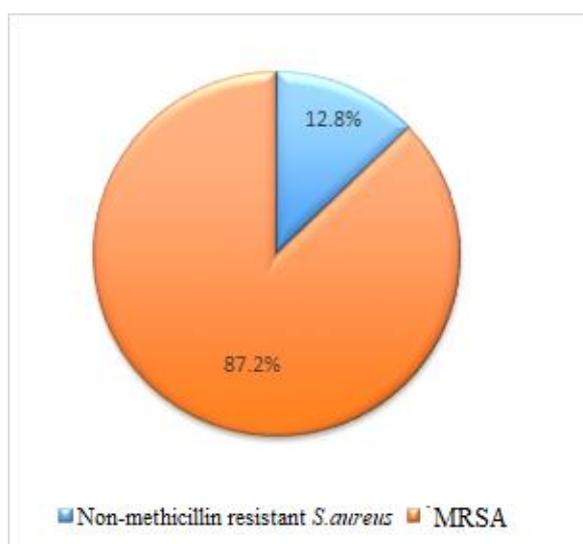
Characteristic	Number (percentage)
<b>Gender</b>	
Male	34 (28.3)
Female	86 (71.7)
<b>Academic Program</b>	
Medicine	56 (46.7)
Medical Laboratory Technology	20 (16.6)
Nursing	44 (36.7)
<b>Hospital Training</b>	
Yes	64 (53.3)
No	56 (46.7)

### Prevalence of *S. aureus* and MRSA

*S. aureus* was detected on the hands of 32.5% (39/120) of students. Among these, 12.8% (5/39) were MRSA, all isolated from students with hospital training experience (Table 2, Figure 1).

**Table 2.** Prevalence of *S. aureus* on Students' Hands

<i>S. aureus</i> analysis result	Number (percentage)
Positive	39 (32.5)
Negative	81 (67.5)



**Figure 1.** Proportion of MRSA Among *S. aureus* Isolates

Of 39 *S. aureus* isolates, 5 (12.8%) were MRSA, all from students with hospital training.

### Factors Associated with *S. aureus* Carriage

*S. aureus* prevalence was 35.3% (12/34) in males and 31.4% (27/86) in females, with no significant difference ( $p = 0.692$ , Table 3). *S. aureus* prevalence was 23.1% (6/20) in Medical Laboratory Technology, 38.5% (17/44) in Nursing, and 38.5% (16/56) in Medicine students, with no significant difference ( $p = 0.347$ , Table 3). Students with hospital training had a higher *S. aureus* prevalence (39.1%, 25/64) than those without (25.0%, 14/56), but the difference was not significant ( $p = 0.099$ , Table 3).

**Table 3.** *S. aureus* Carriage by factors

Category	<i>S. aureus</i> Positive number (percentage)	p-value
<b>Gender</b>		
Male	12 (35.3)	0.692
Female	27 (31.4)	(ns)
<b>Academic Program</b>		

Category	<i>S. aureus</i> Positive number (percentage)	p-value
Medical Laboratory Technology	6 (23.1)	0.347
Nursing	17 (38.5)	(ns)
Medicine	16 (38.5)	
<b><i>Hospital Training</i></b>		
Yes	25 (39.1)	0.099
No	14 (25.0)	
<b><i>Handwashing</i></b>		
Before	39 (32.5)	0.003
After	20 (16.7)	

## DISCUSSIONS

This study found a 32.5% prevalence of *S. aureus* on the hands of health science students at Da Nang University of Medical Technology and Pharmacy, with 12.8% of isolates being MRSA, all from students with hospital training. Handwashing significantly reduced *S. aureus* carriage, underscoring its role in infection control. These findings align with prior Vietnamese and international studies, highlighting the need for enhanced hand hygiene education.

### Prevalence of *S. aureus* and MRSA

The 32.5% *S. aureus* prevalence is higher than reported in previous Vietnamese studies, such as Nguyen et al. (2019) at the same institution (22%) [9] and Pham et al. (2022) at Hanoi Medical University (19.3%) [13]. This increase may reflect the broader inclusion of Medicine, Nursing, and Medical Laboratory Technology students, who have varying levels of clinical exposure. However, the prevalence is lower than Phan et al.'s (2021) finding of 43.6% among healthcare workers at Vinh Medical University Hospital [8], likely due to healthcare workers' prolonged and frequent

exposure to clinical environments. Internationally, our results exceed Marques et al.'s (2010) 3.3% prevalence on Portuguese medical students' hands [16], possibly due to differences in sampling methods (glove juice vs. fingertip sampling) or environmental factors, such as hygiene practices and hospital infection control standards.

The 12.8% MRSA prevalence among *S. aureus* isolates is higher than Nguyen et al.'s (2019) 9.1% [9] but lower than Akpinar et al.'s (2008) 6.1% among Turkish nursing students post-clinical practice [17]. All MRSA isolates were from students with hospital training, consistent with hospitals being reservoirs for resistant strains [18]. The rise in MRSA prevalence compared to earlier local studies may reflect increasing antibiotic resistance in Vietnamese healthcare settings, driven by overuse of  $\beta$ -lactam antibiotics [19]. *S. aureus*'s ability to produce  $\beta$ -lactamase and acquire the *mecA* gene, encoding PBP2a, renders it resistant to methicillin and other  $\beta$ -lactams, complicating treatment [20].

### Factors Associated with *S. aureus* Carriage

No significant gender differences in *S. aureus* carriage were observed (males: 35.3%, females: 31.4%,  $p = 0.692$ ), aligning with Nguyen et al. (2019) and Pham et al. (2022) [9,13]. This suggests that gender does not influence hand colonization in this population, possibly due to similar exposure patterns during training. Similarly, academic program showed no significant association ( $p = 0.347$ ), despite Medical Laboratory Technology students having a lower prevalence (23.1%) than Medicine and Nursing students (38.5%). This trend may reflect differences in clinical tasks, with Medicine and Nursing students having more direct patient contact, though larger studies are needed for confirmation [21].

Hospital training was associated with a higher *S. aureus* prevalence (39.1% vs. 25.0%), though not statistically significant ( $p = 0.099$ ). This aligns with the hospital environment's role as a source of pathogens, as students handle contaminated surfaces, patient wounds, or bodily fluids [22]. The lack of statistical significance may be due to the sample size, as larger studies, such as Wu et al. (2019), found significant associations between healthcare exposure and MRSA carriage [23]. All MRSA cases occurring in hospital-trained students further emphasize the need for infection control training before clinical placements.

### Impact of Hand Hygiene

Handwashing reduced *S. aureus* prevalence from 32.5% to 16.7% ( $p = 0.003$ ), consistent with WHO's assertion that hand hygiene is a cost-effective "self-vaccine" against infections [24]. Nguyen et al. (2019) reported similar reductions post-handwashing ( $p < 0.05$ ) [9], while Maliekal et al. (2005) found alcohol-based hand

sanitizers reduced bacterial load in 95% of cases compared to 50% for soap [25]. In Vietnam, hand hygiene compliance among students is suboptimal, partly due to limited awareness and training [26]. Our findings support integrating rigorous hand hygiene protocols into curricula, including soap and alcohol-based sanitizers, to mitigate *S. aureus* transmission.

Vietnam's healthcare system faces rising *S. aureus* and MRSA prevalence, driven by antibiotic misuse and inadequate infection control [27]. Health science students, as future healthcare workers, are critical targets for infection prevention education. The Ministry of Health's hand hygiene campaigns should be expanded to academic settings, with practical training on WHO's six-step handwashing technique [28]. Additionally, surveillance of MRSA among students could inform hospital infection control policies, reducing cross-transmission risks.

The study's limitations include its small sample size ( $n = 120$ ) and single-center design, limiting generalizability. Convenience sampling may introduce bias, and postprandial sampling was not assessed, potentially missing transient contamination. Future research should use larger, multi-center cohorts, random sampling, and longitudinal designs to track *S. aureus* carriage over time.

## CONCLUSIONS

In conclusion, the prevalence of *S. aureus* on health science students' hands was 32.5%, with 12.8% of isolates being MRSA, predominantly among hospital-trained students. Handwashing significantly reduced *S. aureus* carriage, highlighting its role in infection control. No significant associations were found with gender,

academic program, or hospital training. These findings underscore the need for enhanced hand hygiene education and MRSA surveillance in health science programs to prevent healthcare-associated infections.

### Supplementary Materials

None.

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### Author Contributions

Study concept and design: TTL; data acquisition: NTTU; data analysis and interpretation: NTTU, TTL; manuscript drafting: TTL; statistical analysis: TTL; supervision, writing–review & editing: T.T.L.

### Institutional Review Board Statement

The study was conducted according to the Declaration of Helsinki and approved by the Biomedical Ethics Committee of Da Nang University of Medical Technology and Pharmacy (No. 2024-01/DHKTYDDN, December 2023).

### Informed Consent Statement

Informed consent was obtained from all participants.

### Data Availability Statement

Data are available from the corresponding author upon reasonable request.

### Conflicts of Interest

The authors declare no conflicts of interest.

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