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Nasal carriage of MRSA among clinically affiliated undergraduate students at the College of Health and Medical Sciences, Haramaya University, Ethiopia

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Medical and health science students are among the demographics most at risk from Methicillin-resistant Staphylococcus aureus (MRSA), which is a serious hazard to public health. The main reservoir for MRSA is the nasal cavity, and colonization of this area can raise the risk of infection and transmission in healthcare settings. This study aimed to assess the nasal carriage rate of MRSA among clinically affiliated students at Haramaya University, College of Health and Medicine Sciences, Ethiopia, from July to August 2022. An institution-based cross-sectional study of 250 study participants was conducted using a stratified random sampling methods. The data were collected via structured questionnaires. Nasal swabs were cultured on mannitol salt agar and blood agar at 37 °C for 24 h. *Staphylococcus aureus* was identified using catalase and coagulase tests. The MRSA was screened using the cefoxitin disk diffusion method on Muller Hinton agar. The data were entered and analyzed by SPSS version 25. Pearson's chi-square test was performed to predict associations between variables. A p value less than 0.05 was regarded as statistically significant. The nasal carriage rate of *S. aureus* was 8% (95% CI: 4.6-11.3%). The Nasal carriage rate of MRSA was 4.8% (95% CI: 2.1-7.4%). Overall, 4.8% of all the students were identified as MRSA carriers. MRSA carriage was high among medical students (33.3%). Nose-picking habit ($X^2 = 16.7$, $P = 0.001$) and dormitory occupancy ($X^2 = 3.6$, $P = 0.045$) were significantly associated with the MRSA rate. All the MRSA strains were resistant to penicillin and ampicillin. However, all the MRSA strains were susceptible to chloramphenicol and clindamycin. This study revealed that MRSA is a threat due to significant resistance. Nasal carriage is associated with nose picking and dorm occupancy. Encourage practices such as avoiding nose picking and maintaining personal cleanliness. Regular cleaning and disinfection of shared spaces can reduce the presence of MRSA.

Keywords Clinically affiliated students, Methicillin-resistant *Staphylococcus aureus*, Nasal carriage, Associated factors, Antibiotic susceptibility patterns

Staphylococci can spread from person to person, and their carriers are frequently asymptomatic. Therefore, identifying carriage is a necessary first step in effectively stopping the spread of the more harmful MRSA, as well as any diseases that may arise from them[1]. The anterior nares are the most common site of MRSA colonization in humans and serve as a reservoir for pathogens[2]. These bacteria can establish solid interactions with nasal epithelial cells via various proteins and many cell surface components[3]. It is a common cause of clinically significant infections, which range in severity from minor infections to severe invasive illnesses[4].

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*Staphylococcus aureus*is one of the most prevalent and clinically significant pathogens worldwide, causing a variety of illnesses ranging from benign superficial skin eruptions to life-threatening systemic infections such as bacteremia, endocarditis, pneumonia and toxic shock syndrome. MRSA has become the most common cause of nosocomial and community infections worldwide[5,6]. In recent decades, MRSA has become a common cause of infections in hospitals and communities around the world[7]. There are several factors that influence the incidence of MRSA among medical students, including sharing personal items, performing ward rotations, nose-picking habits, length of hospital stay, and glove usage during hospital attachment[8,9].

Medical and health science students are more likely to come into contact with MRSA since they are often required to interact with patients and attend a hospital field trip throughout their undergraduate studies[5]. In addition, medical students are an important part of the healthcare workforce because they have frequent contact with the community in general and with the healthcare environment in particular. In addition, they live in dormitories sharing spaces with other students in crowded living settings, which increases the probability of acting as a vehicle for multidrug-resistant bugs such as MRSA[10]. Therefore, this study examined the nasal carriage rate, associated factors, and antibiotic susceptibility patterns of methicillin-resistant *S. aureus* among clinically affiliated undergraduate students at Haramaya University's College of Health and Medical Sciences in Ethiopia.

Methods and materials

Study area and period

The study was carried out at Haramaya University, College of Health and Medical Sciences (HUCHMS) from July 01 to August 30, 2022. Haramaya University was established in 1954 next to Addis Ababa University in Ethiopia. It is located approximately 510 km away from Addis Ababa in the Oromia National Regional State, East Hararghe administrative zone. The study programs of the university range from undergraduate to postgraduate levels on its 3 campuses and 13 colleges. Among these colleges, the College of Health and Medical Science (CHMS) is one of the colleges that was established in September 1996 with the objective of training health professionals who contribute to filling the health needs of the country. The CHMS is organized for the School of Medicine, School of Pharmacy, School of Nursing and Midwifery, School of Medical Laboratory Science, School of Public Health and Environmental Health Department. Currently, 1754 students are enrolled in undergraduate and postbasic programmes at the college (source: CHMS registrar office).

Study design, period and population

An institutional-based cross-sectional study was conducted. The source population was all students in the faculty of health and medical sciences affiliated with clinical attachment, and all students selected from each department at HUCHMS with clinical attachment composed the sample population. All undergraduate clinically affiliated students from the selected department at the CHMS were recruited. Patients who had nasal infections, nose bleeding during the study period, or who received intranasal antibiotic ointment or other antibiotics within the previous two weeks of the commencement of the study were excluded. The source population for this study comprised all undergraduate students enrolled during the study period at Haramaya University's CHMS. On the other hand, all of the selected students from each department were considered the study population during the study period.

Sample size determination and sampling technique

The sample size was determined by a single population proportion formula using the prevalence of nasal carriage of *S. aureus*from a study conducted at Arbaminch University and was 27.1%[9], with a *Z* score for a 95% confidence interval of 1.96 and a margin of error of 5%. Since there is a small population of students with clinical attachment at the campus ($N=909$), a reduction formula was used, and a 10% nonresponse rate was added. The final sample size was 250. Then, this sample size was allocated proportionally to each department and then batches within the departments. Health and medical sciences students were stratified based on academic year; the final sample size was allocated proportionally to each academic year during the study period. A simple random sampling technique was used to select participants who fulfilled the inclusion criteria from each departmental batch by using a student roster as a sampling frame that was collected from each department. Finally, a simple random sampling technique was used to select the participants. The randomness of the sample was ensured by using a lottery method (Fig. 1).

Data collection and laboratory investigations

A structured questionnaire developed from different types of literature was used to collect the data[1,6,9]. The questionnaire aimed to assess sociodemographic variables, behavioral features and clinical information. Nasal swab specimens were collected by using sterile cotton tip swabs prewetted with sterile saline for participants' anterior nares to a depth of approximately 1 cm and rotation against the interior surface of the nostril. Then, the swabs were inserted into Amies transport medium (Oxoid, UK) and transported to the Microbiology Laboratory for investigation.

The samples were inoculated onto Mannitol Salt Agar (MSA) (Oxoid Ltd. England) to confirm the fermentation of Mannitol, the growth of golden yellow colonies on MSA (Oxoid, Cambridge, UK) surrounded by yellow zones after 24 h of incubation at 37 °C indicated a positive result for *S. aureus*. Furthermore, isolates were sub-cultured onto Blood Agar Plate, and incubated at 37 °C for 24 h. Colony morphology, Gram stain reaction, and biochemical tests such as catalase, coagulase, and DNase tests test were performed to confirm *S. aureus*[11,12].

Antibiotic susceptibility profiling of all isolates was achieved by the Kirby–Bauer disk diffusion technique. Bacterial inoculum equivalent to the opacity of 0.5 McFarland standards were prepared, swabbed over the Muller

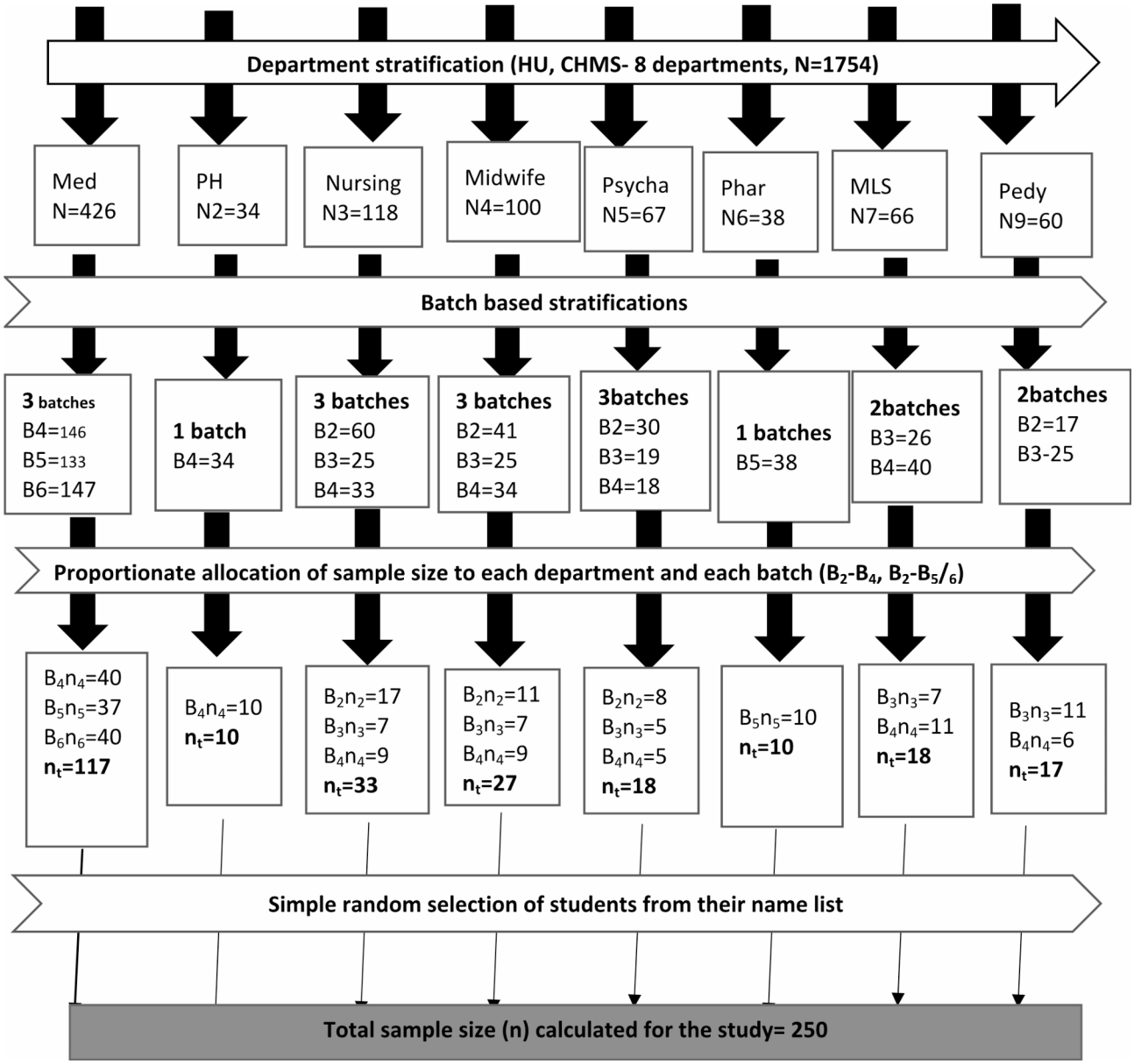

Fig. 1. A flow diagram illustrating sampling procedure to recruit participants among clinically affiliated students at Haramaya University, college of health and medical sciences, Harar, Eastern Ethiopia, 2022 ($n = 250$). *Key*: Med: Medicine, PH: Public Health, Psycha: Psychiatry, Pharma: Pharmacy, MLS: Medical Laboratory Sciences, Pedy: Pediatrics. *Source*: CHMS, Registrar office.

Hinton Agar (MHA) surface, exposed to antibiotic disks, and then incubated at 37 °C for 24 h. The diameters of the zones of inhibition were measured and categorized as susceptible, intermediate, or resistant according to the methods described in the CLSI[13]. The standard antimicrobial disks (oxoid, UK) used were penicillin (10 mg), ciprofloxacin (5 mg), clindamycin (2 mg), gentamicin (10 mg), erythromycin (15 mg), chloramphenicol (30 mg), ampicillin (10 mg), tetracycline *(30 mg)*, trimethoprim-sulfamethoxazole (25 mg) and cefoxitin *(*30 mg*)*[13]. Finally, MRSA was detected by placing 30 µg of cefoxitin per disk on Mueller-Hinton agar. The zone of inhibition was determined after 24 h of incubation at 35 °C. All isolates ≤ 24 mm of cefoxitin were considered to be MRSA[14].

Data and laboratory quality control

The questionnaire was pretested (5% of the sample size or 13 sample) on health science students at other nearby universities (Diredawa University). The findings from the pretesting were utilized for modifying and adjusting the instrument. Two days of training were provided to the data collectors and supervisors on the data collection tool and the data and sample collection procedures. For daily activities, the data collectors were supervised closely by the supervisors and the principal investigator. The completeness of each questionnaire was checked by the principal investigator and the supervisors on a daily basis. *Staphylococcus aureus* ATCC 25,923 and

Escherichia coli (ATCC 25922) were used as positive and negative controls, respectively, to maintain laboratory quality and investigations. All culture media were prepared according to the manufacturer's instructions, and sterility was checked by incubating 5% of each batch of the prepared culture media at 37 °C overnight. All culture plates and antibiotic discs were stored at the recommended refrigeration temperature (2–8 °C).

Data processing and analysis

After the data were collected, each questionnaire was thoroughly reviewed for completeness and consistency by the data collectors, supervisors and principal investigators. Then, the data were coded and entered into IBM SPSS version 25 software. Every participant had a unique identification number. Descriptive statistical analysis was used to summarize the findings of the studies using frequency, mean, and proportion. The results were presented in figures, tables and text. Bivariable analysis was carried out using the chi-square test to determine potential factors associated with the MRSA carriage rate. Finally, variables with a p value less than 0.05 were considered to indicate statistical significance.

Results

Sociodemographic, behavioral and clinical characteristics of the participants

A total of 250 clinically attached students were at health institutions involved in this study. The response rate of the participants were 100%. The majority of the students were male (158, 63.2%). Ages ranged from 19 to 29 years with mean 20.6, standard deviation (SD) ± 2.2 years. Among the participants, almost half (121/250, 48.4%) of the students were medicine students. The majority of participants were (174, 69.6%) were in their fourth and above year of study (Table 1).

With respect to behavioral characteristics, the majority (91.2%, 228/250) were nonsmokers, and almost two-thirds (64.0%, 160/250) had a habit of washing their hands after every contact with patients. In addition, most of them (97.6%, 244/250) had a habit of washing their hands before and after meals, and the majority (220, 88%) of them washed their hands while leaving the hospital. from the study participants. Regarding clinically related issues, the majority (59.6%, 149/250) of participants had less than two years of exposure to clinical learning caring for patients in hospitals at health care institutions. Fewer (16%, 40/250) of the students had previous hospitalizations in the past year, and a small number (24.4%, 61/250) of participants had a history of admission to the intensive care unit. In addition, a large fraction of them (60.8%, 152/250) used used to take full course of antibiotics whenever prescribed for them (Table 2).

Nasal carriage rate of *MRSA* and factors associated with it

Among 250 study participants, the around 8% (20/250, 95% CI: 4.6%, 11.3%) carriage rates of *S. aureus* were identified. From this, 4.8% (12/250, 95% CI: 2.1%, 7.4%) were MRSA, while the rest (8/20, 40%) were identified as MSSA. The majority (66.7%) of MRSA was isolated among male participants. The MRSA carriage rate was particularly common among medical students (33.3%), followed by nursing students (25%) (Table 3).

Among the factors associated with the MRSA carriage rate, nose picking habit ($X^2 = 16.7$, $P = 0.001$) and dorm occupancy ($X^2 = 3.6$, $P = 0.045$) were significantly associated with the nasal carriage rate of MRSA (Table 3).

Variable		Number	Percent (%)
Gender	Male	158	63.2
	Female	92	36.8
Age	< 22	88	35.2
	>=22	162	64.8
Department	Medicine	121	48.4
	Midwifery	25	10.0
	Medical Laboratory Sciences	18	7.2
	Nursing	31	12.4
	Pediatrics	18	7.2
	Pharmacy	10	4.0
	Psychiatry	17	6.8
	Public health	10	4.0
Year of study	2nd	43	17.2
	3rd	33	13.2
	4th	83	33.2
	5th	51	20.4
	6th	40	16.0

Table 1. Socio-demographic characteristics among clinically affiliated undergraduate students at Haramaya University, College of Health and Medical Sciences, Harar, Eastern Ethiopia ($n = 250$).

Variables		Frequency	Percent (%)
Mean exposure to hospital	< 2 years	149	59.6
	≥ 2 years	101	40.4
Admitted to ICU	Yes	61	24.4
	No	189	75.6
Presence or history of having an indwelling medical device	Yes	24	9.6
	No	226	90.4
Previous hospitalization in the past year	Yes	40	16.0
	No	210	84
History of chronic disease	Yes	7	2.8
	No	243	97.2
Ways of antibiotic usage	Full course	152	60.8
	Incomplete course	98	39.2
Participate in an invasive procedure	Yes	77	30.8
	No	173	69.2
Cigarette smoking	Yes	22	8.8
	No	228	91.2
Washing hands upon arriving at the hospital	Yes	158	63.2
	No	92	36.8
Washing hands after every patient contact	Yes	160	64
	No	90	36
Hand washing before and after meal	Yes	244	97.6
	No	6	2.4
Alcohol use	Always	10	4
	Sometimes	82	32.8
	No	158	63.2
Frequency of hand washing with soap	Frequently	180	72
	Occasionally	65	26
Use of gloves while handling patients	Always	142	56.8
	Sometimes	94	37.6
	Rarely	14	5.6
Nose picking habit	Yes	38	15.2
	No	212	84.8
Sharing of clothing	Yes	70	28
	No	180	72
Number of students in the dormitory	< 4	136	54.4
	≥ 4	114	45.6

Table 2. Behavioral and clinical characteristics among clinically affiliated undergraduate students at Haramaya University, College of Health and Medical Sciences, Harar, Eastern Ethiopia ($n = 250$).

Antibiotic susceptibility patterns of MRSA isolates

An antimicrobial susceptibility test was performed on 20 *S. aureus* isolates. Among the 20 isolates, the majority (60%, 12/20) were identified as MRSA, while the rest (8/20, 40%) were identified as MSSA. In this study, MRSA strains demonstrated a significant resistance profile against several antibiotics. Notably, all the MRSA strains were resistant to ampicillin and penicillin. In addition, two-thirds (8/12, 66.7%) of the strains were resistant to tetracycline. However, all the MRSA isolates were susceptible to clindamycin and chloramphenicol. Moreover, one-fourth (25%) of all the isolates were multidrug-resistant (resistant to at least three antimicrobial classes) (Table 4).

Discussion

In the present study, the nasal carriage rate of *S. aureus*among students at HU-CHMS was 8% (20/250, 95% CI: 4.6%, 11.3%). This percentage was lower than that of previous studies by Abroo et al. (2017) in Urmia, Iran (19.6%)[1], Saudi Arabia (25.3%)[15], and Ethiopia (27.1%) in Arbaminch, Ethiopia[9]. These differences could be due to variations in sample size and sampling strategy. In addition, the carriage rate might be influenced by variations in study populations, including demographics, geographical locations, and environmental factors, which could contribute to differences in prevalence rates.

The prevalence of MRSA in this study was 4.8% (95% CI: 2.1%, 7.4%). This finding is almost consistent with a study in which the MRSA incidence was reported to be 7.4% among generally healthy university students at Texas University[6]. However, it was notably higher than the reported rates in Jordan (2.8%) and Saudi Arabia

Variables	Categories	*MRSA*		Chi-square result	P-value
		Positive (%)	Negative (%)		
Gender	Male	8 (5.1%)	150 (94.9%)	0.046	0.830
	Female	4 (4.3%)	88 (95.7%)		
Age	< 22 years	7 (8%)	81 (92%)	1.00	0.317
	>=22 years	5 (3.1%)	157 (96.9%)		
Department	Medicine	4 (3.3%)	117(96.7%)	3.41	0.844
	Midwifery	1 (4%)	24 (96%)		
	MLS	1(5.6%)	17 (94.4%)		
	Nursing	3 (10.7%)	25 (89.3%)		
	Other (Pediatrics, Pharmacy Psychiatry, Public health)	3 (5.2%)	55 (94.8%)		
Year of study	2nd	1(2.3%)	42(97.7%)	4.316	0.365
	3rd	2(6.1%)	31(96.9%)		
	4th	6(7.2%)	77(92.8%)		
	>=5th	3(5.9%)	48(94.1%)		
Cigarette smoking	Yes	2(9.1%)	20(90.9%)	1.005	0.316
	No	10(4.4%)	218 (95.6%)		
Washing hands upon arriving at the hospital	Yes	7(4.4%)	151(95.6%)	0.207	0.649
	No	5(5.4%)	87(94.6%)		
Washing hands after every patient contact	Yes	4(2.5%)	156(97.5%)	0.072	0.788
	No	8(8.9%)	82(91.1%)		
Hand washing before and after meal	Yes	10(4.1%)	234(95.1%)	0.256	0.613
	No	2(33.3%)	4(66.7%)		
Alcohol use	Always	2(20%)	8(80%)	0.598	0.741
	Sometimes	4(4.9%)	78(95.1%)		
	No	6(3.8%)	152(96.2%)		
Frequency of hand washing with soap	Frequently	5(2.8%)	175(97.2%)	3.21	0.200
	Occasionally	5(7.7%)	60(92.3%)		
Use of gloves while handling patients	Always	5(3.5%)	137(96.5%)	1.094	0.579
	Sometimes	5(5.3%)	89(94.7%)		
	Rarely	2(14.3%)	12(85.7%)		
Nose picking habit	Yes	8(21.1%)	30(78.9%)	16.7	**0.001**
	No	4(1.9%)	208(98.1%)		
Sharing of clothing habit	Yes	6(8.6%)	64(91.4%)	0.744	0.388
	No	6(3.3%)	174(96.7%)		
Number of students in the dormitory	< 4	3(2.2%)	133(97.8%)	3.6	**0.045**
	≥ 4	9(7.9%)	105(92.1%)		
Mean exposure to hospital	< 2 years	7 (4.7%)	142(95.3%)	3.662	0.300
	≥ 2 years	5(5.0%)	96(95.0%)		
Admitted to ICU	Yes	3(4.9%)	58(95.1%)	1.171	0.279
	No	9(4.8%)	180(95.2%)		
History of having indwelling medical devices	Yes	3(12.5%)	21(87.5%)	0.002	0.965
	No	9(4.0%)	217(96.0%)		
Previous hospitalization in the past 1 year	Yes	5(12.5%)	35(87.5%)	1.519	0.218
	No	7(3.3%)	203(96.7%)		
History of chronic disease	Yes	2(28.6%)	5(71.4%)	1.984	0.159
	No	10(4.1%)	233(95.9%)		
Ways of antibiotic usage	Full course	4(2.6%)	148(97.4%)	1.891	0.169
	Incomplete course	8(8.2%)	90(91.8%)		
Participate in invasive procedures	Yes	8(10.4%)	69(89.6%)	2.114	0.146
	No	4(2.5%)	159(97.5%)		

Table 3. Analysis of Associated factors (Chi-Square test) of nasal carriage rate of *MRSA* among clinically affiliated undergraduate students at Haramaya University, College of Health and Medical Sciences, Harar, Eastern Ethiopia ($n = 20$).

Interpretation	Antibiotic discs								
	Penicillin *N* (%)	Ampicillin- *N* (%)	Ciprofloxacillin *N* (%)	Erythromycin- *N* (%)	Clindamycin- *N* (%)	Gentamycin *N* (%)	Cothrimoxazole *N* (%)	Tetracycline *N* (%)	Chloramphenicol- *N* (%)
Susceptible	-	-	9 (75%)	9 (75%)	12 (100%)	7 (58.3%)	10 (83.3%)	1 (8.3%)	12 (00%)
Intermediate	-	-	-	-	-	3 (25%)	-	3 (25%)	-
Resistant	12(100%)	12 (100%)	3 (25%)	3 (25%)	-	2 (6.7%)	2 (16.7%)	8 (66.7%)	-

Table 4. Antibiotic susceptibility testing of MRSA isolates carried by clinically affiliated undergraduate students at Haramaya University, College of Health and Medical Sciences, Harar, Eastern Ethiopia ($n = 12$).

(3.3%). Conversely, it was substantially lower than the MRSA prevalence reported in Nigeria (61.8%)[16], state-run universities in Urmia, Iran (13.14%)[1] and Malaysia (13.9%)[17]. The variation in MRSA prevalence among college students in different countries can be influenced by factors such as living conditions on campuses, hygiene practices, healthcare systems, community transmission rates, and the molecular epidemiology of MRSA strains circulating within educational settings.

In the present study, the habit of nose picking and living in a dormitory environment with more than four students were found to be potential contributing factors to MRSA nasal carriage. This finding was supported by a study performed in Arbaminch, Ethiopia[9] but contradicted by another study[18]. This could be because picking one's nose might transmit MRSA from one's nasal mucosa to one's hands, which can contaminate surfaces. Similarly, the risk of MRSA increases when there are so many individuals living in dorms, as tight quarters and shared amenities facilitate the spread of MRSA among individuals. In addition, factors such as limited personal space and frequent social interactions provide many opportunities for MRSA to spread among residents.

Regarding susceptibility patterns, the findings demonstrated that all the MRSA strains were resistant to ampicillin and penicillin. This highlights a critical issue in the region concerning the emergence and increase of resistance to these medications by MRSA. In addition, the resistance rates to other antibiotics, such as tetracycline, erythromycin, ciprofloxacin, and cotrimoxazole, varied, ranging from 16 to 66.7%. This variability suggests that different antibiotics may still be effective against certain strains of bacteria, while others exhibit higher levels of resistance. A previous study conducted at Jimma University, Ethiopia[19], revealed resistance rates similar to those of erythromycin and tetracycline in our study. However, another study at Arba Minch University reported similar resistance rates for tetracycline, ampicillin and penicillin but lower resistance to ciprofloxacin compared to the current findings[9]. The variation in antibiotic resistance rates among different studies may be due to differences in infection prevention practices, irrational drug prescription cultures, and indiscriminate antibiotic usage.

In our study, a resistance rate of 16% was observed for both cotrimoxazole and gentamicin. Interestingly, while the resistance to cotrimoxazole was consistent with previous findings from a study conducted at Jimma[19], the resistance to gentamicin appeared to be greater in this study. This difference in resistance levels may stem from factors such as genetic mutations or horizontal gene transfer among bacteria. Discrepancies in the accessibility and utilization of alternative antibiotics can impose selective pressure on bacterial communities, resulting in fluctuations in resistance patterns to specific antibiotics over time.

Notably, chloramphenicol and clindamycin displayed full susceptibility across all the patients tested, indicating their efficacy in treating the MRSA isolates under study. This finding was in contrast to the results of other works reported by Kitti et al. conducted in Thailand[20] and Neela et al. studied in Malaysia[21]. This information is crucial when selecting appropriate antibiotic treatments to ensure effective patient care and combat the challenge of antibiotic resistance. Unlike the other study in which showed MRSA isolates were resistant to clindamycin, clindamycin demonstrated susceptibility against MRSA strains.

Moreover, one-quarter of the MRSA strains were multidrug resistant. The development and spread of drug resistance in MRSA is a complex process that involves genetic mutations, the acquisition of resistance genes, and individual and environmental factors.

Strength of the study

This study provides important information on MRSA prevalence in a particular group by measuring nasal carriage rates. This information is essential for determining the need for infection management in educational healthcare settings.

Limitations of the study

The authors because of a lack of resources did not determine the vancomycin minimum inhibitory concentration. It was not possible to identify the species and strain type of MRSA using more accurate and sensitive molecular methods. To further assist future researchers, it is necessary to identify and clarify the genetic pathways underlying antibiotic susceptibilities through phenotypic and genotypic studies.

Conclusion

This study revealed a significant rate of MRSA and concerning rates of antibiotic resistance, underscoring a significant public health challenges. This findings highlight that behaviors like nose-picking habit shared dormitory occupancy are significant risk factors for MRSA nasal carriage rate. This emphasizing the need for robust and important infection prevention and control measures to mitigate the risk of MRSA transmission among students.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

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Author contributions

K.U., S.M. and F.A. conceptualized the study, T.T., F.T. and W.W designed the study tools, M.A. and K.B., implemented the study, and collected data; T.S., S.D., and F.W drafted the manuscript. All authors reviewed, commented on and approved the final version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Consent for publication

Not applicable.

Ethical approval and consent

Ethics approval for the study was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University College of Health and Medical Science. This study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all subjects and/or their legal guardian(s). Anonymity and confidentiality were ensured for information obtained from the study participants. Finally, the results were reported to the participants for appropriate measurement, particularly for MRSA.

Additional information

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