JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Is nasal MRSA carriage a concern among African people and local communities in North Cyprus?

Ayse Arikan[1,2,3], Noor Nassar[2], John O Awosanya[2], Meryem Güvenir[4], Özlem Ünaldi[5], Zekiye Bakkaloğlu[5], Serap Süzük Yildiz[6]

[1] Near East University, DESAM Research Institute, Nicosia, TRNC Mersin 10, Turkey
[2] Near East University, Department of Medical Microbiology and Clinical Microbiology, TRNC Mersin 10, Turkey
[3] Kyrenia University, Department of Medical Microbiology and Clinical Microbiology, Kyrenia, TRNC Mersin 10, Turkey
[4] Cyprus Health and Social Sciences University, Faculty of Medicine, Department of Medical Microbiology, Güzelyurt, TRNC, Mersin 10, Turkey
[5] Ministry of Health General Directorate of Public Health, Department of Microbiology Reference Laboratory and Biological Products, Ankara, Turkey
[6] University of Health Sciences Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Department of Clinical Microbiology, Ankara, Turkey

Abstract

Introduction: The long-standing epidemic of antimicrobial resistance (AMR) has proven to be a challenging problem to solve and is becoming even more complex in a globalized world where there is little evidence of AMR patterns among multinational communities. This study aimed to determine the frequency of methicillin resistant *Staphylococcus aureus* (MRSA) carriage among African and local students in Northern Cyprus.

Methodology: Nasal swabs were collected from African and local students between October 2023 and December 2023. The clinical samples were screened for the presence of MRSA. AMR bacterial isolates were tested by phenotypic and genotypic analysis to determine the MRSA status.

Results: A total of 300 participants were included in the study: One hundred and fifty of them were African students (50%) and 150 were local students (50%), The prevalence of nasal MRSA carriage in African and local students was determined as 3% and 6%, respectively.

Conclusions: This study is a population-based study investigating the prevalence and distribution of MRSA in Africa and is the first to be conducted in the local population of Northern Cyprus. It highlights the presence of MRSA in the community and the impact of global migration on AMR, highlighting the need for public health measures.

Key words: African; Northern Cyprus; MRSA; students.

J Infect Dev Ctries 2026; 20(6):816-821. doi:10.3855/jidc.21710

(Received 10 April 2025 – Accepted 12 November 2025)

Introduction

Staphylococcus aureus (*S. aureus*) is a common opportunistic pathogen that causes community-acquired and hospital-acquired infections, ranging from mild skin infections to soft tissue infections, endocarditis, sepsis, and death [1]. It colonizes the skin, nose, throat, and gastrointestinal tract, causing serious infections in more than 50% of carriers [2]. It is estimated that approximately 1 in 3 people (33%) carry *S. aureus* bacteria primarily in their noses without causing any illness. Although this varies in different populations, approximately 2 in every 100 people (2%) carry methicillin-resistant *S. aureus* (MRSA) [3]. Asymptomatic MRSA carriage was reported at a high percentage in some groups, which may pose a threat to immunocompromised populations: 25% among bakery workers, 46% among swinery workers, 21% among firefighters, and 43.3% among healthcare workers [4].

MRSA strains are resistant to methicillin and many beta-lactam antibiotics. Various virulence factors of the bacteria, such as capsular polysaccharide, surface-associated proteins (Staphylococcal protein A, clumping factor), toxins (hemolysins, enterotoxins, Panton-Valentine leukocidin, toxic shock syndrome toxin, staphylococcal exfoliative toxin), and enzymes (coagulase, staphylokinase, nucleases (DNase), proteases, hyaluronidases) have been associated with chronic and recurrent infections [5]. MRSA transmission can occur in the community and hospital settings. University students spend most of their time in crowded environments such as dormitories, classrooms, and gyms; therefore, the risk of spreading bacterial infection in these areas is high. On the other hand, asymptomatic students studying in the health field may be at increased risk of transmission in hospital settings. In the case of populations with weakened immune

systems, such as patients in intensive care units, MRSA carriage may pose a risk, and this transmission may contribute to invasive MRSA infections, increased antibiotic use, prolonged patient stays, and increased costs and mortality rates in hospital settings accordingly [6].

Northern Cyprus experiences human mobility from many countries of the world for many purposes, such as education, tourism, and the employment sectors. In particular, the many universities located in Northern Cyprus make it a center of education. A total of 103,748 students were educated in the universities in Northern Cyprus during the 2019–2020 academic year. Based on the distribution of the total number of students coming to the island by nationality, the rate of foreign students is reported as 41,219/103,748 (40%), while the rate of Northern Cypriot students and Turkish students is given as 12,243/103,748 (12%) and 50,286/103,748 (48%), respectively [7]. Students from many countries, such as Zimbabwe, Nigeria, Kenya, Libya, Iran, Jordan, Lebanon, the Netherlands, Ukraine, Germany, Syria, Iraq, Palestine, India, Pakistan etc., receive higher education in many fields besides the healthcare field, such as medicine, dentistry, and nursing in Northern Cyprus every year. However, limited studies have been conducted on nasal MRSA carriage of these populations, especially in the African population with a high number of incoming students and in the local student population. Therefore, this study aimed to determine the rate of nasal MRSA carriage due to *nuc* and *mec* genes among African and Turkish students living in Northern Cyprus and to determine strategies for prevention if necessary.

Methodology

Study design

The study was conducted between October 2023 and December 2023. Nasal swabs were collected from the participants who met the inclusion criteria and agreed to be included in the study voluntarily. While collecting samples, participants' heads were tilted back 70 degrees. The swab was inserted into the nostril approximately 2 cm (1 inch) deep, parallel to the palate, and gently rotated. Samples were collected by rotating the swab several times against both nasal walls. A total of 300 nasal swabs were collected from two different groups of participants: The first group consisted of African students living in Northern Cyprus. The countries of origin included Congo, Nigeria, Guinea, Ethiopia, Liberia, Rwanda, Cameroon, Somalia, and Sudan (n = 150). The second group consisted of local students living in Northern Cyprus (n = 150). The inclusion criteria were: no signs of infection, not having received chemotherapy, not having been diagnosed with cancer, not having been hospitalized in the last 6 months, and residing in Northern Cyprus in the previous 6 months.

MRSA screening

The nasal swab samples were directly inoculated on HiCrome MRSA agar (HiMedia Laboratories, Kennet Square, USA) and incubated at 37 °C for 24–48 hours. The morphological characteristics were reported, including colony morphology, pigmentation, and colony color. Based on the manufacturer's recommendations, the microbial colonies with green color indicated MRSA strains and blue colonies represented *Staphylococcus epidermidis*. The green colonies were kept for further analysis.

Antibiotic susceptibility testing

All strains were tested for cefoxitin resistance. The Kirby-Bauer disk diffusion test was performed on Mueller Hinton agar using cefoxitin (30 µg) disks (ROSCO, Co., Albertslund, Denmark) to identify MRSA isolates. Afterwards, the plates were incubated at 35 ºC for 24–48 hours. The inhibition zone diameters were interpreted according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines, and strains with an inhibition zone of 14–20 mm were considered methicillin-resistant [8]. The cefoxitin-resistant strains with green colonies on HiCrome agar were kept at – 30°C to identify the *mec*A and *mecC* genes.

Identification of mecA and mecC genes

The boiling method was used for extracting DNA from cefoxitin-resistant strains. The bacterial suspension was prepared with 4 McFarland units and boiled for 10 minutes. It was then clarified by centrifugation at 10,000 rpm g for 5 minutes. The prepared bacterial suspension was boiled in the heat block at 100 degrees for 10 minutes. Bacterial waste was precipitated by centrifugation at 14,000 rpm g for 5 minutes. The supernatant was used as a DNA source. The supernatant was stored at – 20 °C until use.

Multiplex polymerase chain reaction (PCR) was designed using DNA extracts of MRSA isolates to amplify the *S. aureus*-specific nuclease (*nuc*; 279 bp), the MRSA-specific methicillin-resistant A (*mecA*; 162 bp), and the methicillin-resistant C (*mecC*; 138 bp) genes. The PCR conditions were 94 °C for 5 min; followed by 35 cycles of 30 s at 94 °C, 30 s at 55 °C, 45 s at 72 °C; and a final extension step of 72 °C for 7 min.

PCR products were separated by 3% agarose gel electrophoresis and visualized with 0.5 g/mL ethidium bromide. NCTC 12493 (*mec*A-positive *S. aureus*), NCTC 13552 (*mec*C-positive *S. aureus*), ATCC 25923 (*mec*A-negative *S. aureus*), and water (negative control) were used as controls.

Ethical approval

The study was approved by the Near East University Ethics Committee with decision number (NEU/2024/121-1823), and detailed informed consent forms were collected from both African and local students.

Results

The participants were evaluated in two groups: local students and African students living in North Cyprus. The average age for both groups was 24.1 years. All *S. aureus* isolates from both groups included the *nuc* gene.

In the case of the African community, MRSA was detected in n = 40/150 (27%) of the samples on HiChrome agar, while n = 6/150 (4%) of isolates were resistant to cefoxitin. In addition, 4% of the strains were both cefoxitin-resistant and demonstrated green colonies, and MRSA-specific *mecA* were detected in n = 4/6 (67%) of the strains following PCR amplification. Among these positive strains, 2/4 (50%), were from female students, and n = 2 (50%) were from male students. The rate of MRSA positivity was detected as 4/140. In the case of the local students, MRSA was detected in n = 49/150 (33%) of the samples on HiChrome agar, and n = 11/150 (7%) based on cefoxitin resistance. While 7% of the strains were both cefoxitin-

Figure 1. Gel image of PCR amplification of *S. aureus*-specific *nuc* (279 bp), and methicillin resistant *Staphylococcus aureus* (MRSA)-specific *mecA* (162 bp) and *mecC* (138 bp) genes. 1. *mecA* positive, 2. *mecA* positive, 3. *mecA*/*mecC* negative, 4. *mecA* positive, 5. *mecA* positive, 6. *mecA* positive, 7. *mecA* positive, 8. *mecA*/*mecC* negative, 9. *mecA* positive, 10. *mecA* positive, *mecA* positive, 12. *mecA*/*mecC* negative, *mecA*/*mecC* negative, 14. *mecA* positive, 15. *mecA* positive, 16. *mecA* positive, 17. *mecA* positive,18. *mecA*-positive *S. aureus* (NCTC 12493) (positive control), 19. *mecC*-positive *S. aureus* (NCTC 13552) (positive control), M1, 100 bp DNA Ladder, M2. 50 bp DNA Ladder, NTC: H2O (negative control).

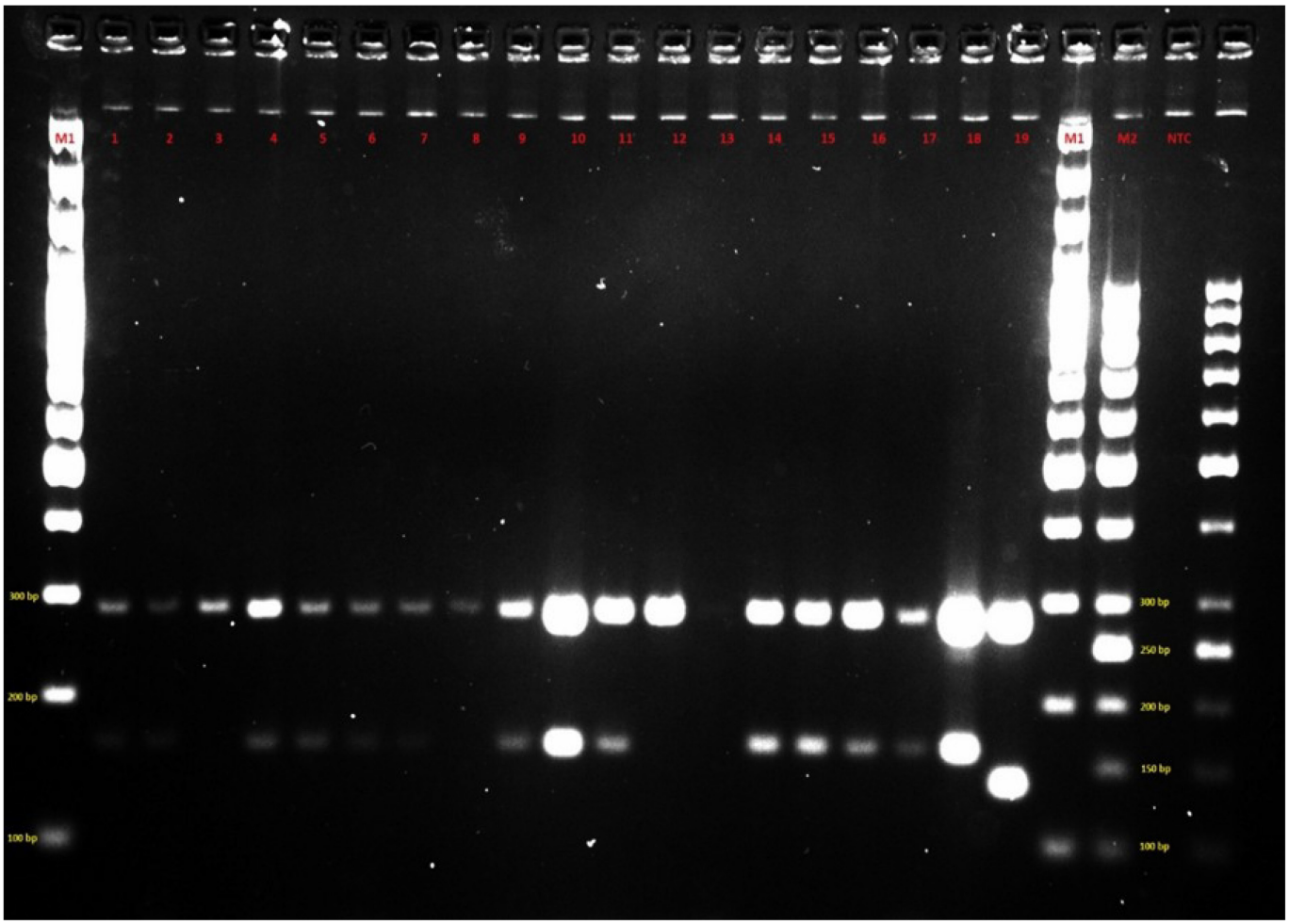

Table 1. Rates of MRSA positivity among local and African students

Participants	HiChrome Agar n (%)	Cefoxitin resistance n (%)	PCR n (%)
Local students			
MRSA	49 (150, 33)	11 (150, 7)	9 (11, 82)
MSSA	88 (150, 59)	139 (93)	2 (11, 18)
Non-carriers	13 (150, 9)	–	–
African students			
MRSA	40 (150, 27)	6 (150, 4)	4 (6, 67)
MSSA	106 (150, 71)	144 (150, 96)	2 (6, 33)
Non-carriers	4 (150, 3)		

MRSA: methicillin-resistant *Staphylococcus aureus*; MSSA: methicillin-sensitive *Staphylococcus aureus*: PCR: polymerase chain reaction.

resistant and demonstrated green colonies, MRSA-specific *mecA* was detected in n = 9/11 (82%) of the strains in the PCR reaction (Figure 1). Among these positive strains, n = 4 (44%) were female, and n = 5 (56%) were male. Based on the PCR reaction, the rates of MRSA positivity among African and Turkish students were detected as 4/150 (3%) and 9/150 (6%) respectively (Table 1). Two strains from each group were detected as negative for *mecA* and *mec C*.

Discussion

In recent years, the high percentage of MRSA strains has become a cause of concern and a serious global threat as it limits treatment alternatives in the hospital setting [9,10]. According to the antimicrobial resistance surveillance in the Europe 2023 report, 11 out of 44 countries (25%) of the World Health Organization (WHO) European regions had an MRSA rate below 5%, while 13 (30%) had an MRSA rate of ≥ 25% in 2021 [10]. In the United States, MRSA infections occur at the rate of 15% of infections in hospital settings, 62% of community-acquired infections, and 2% of community-associated infections, with a mortality rate of 3.2 per 100,000 people [11]. However, due to the surveillance and prevention strategies for MRSA infections implemented by the Centers for Disease Control and Prevention (CDC) in the United States, a significant decrease (74%) in healthcare-associated blood infections was reported between 2015 and 2016 [12,13].

Global data are limited on community nasal carriage of MRSA in North Cyprus. According to the data of the Turkish Republic of Northern Cyprus (TRNC) Ministry of National Education, Department of Higher Education and Foreign Relations, it was reported that there was a total of 103,748 students in 2019–2020, and 41,219 of them were foreign students [7]. Therefore, Northern Cyprus hosts a large number of foreign students, and this is the first study to compare the prevalence of MRSA nasal carriage between African students living in Northern Cyprus and Turkish Cypriot citizens.

The present study reveals information on determining the nasal MRSA carriage rate in African and local students in Northern Cyprus, which plays a decisive role in preventing future infection. In this study, the prevalence of nasal MRSA carriage was 3% in the African students and 6% in the local students. There are no studies in the literature regarding the rate of nasal carriage and risk factors of people from different countries in Northern Cyprus. However, the following studies on nasal MRSA carriage in Northern Cyprus are included in the literature. In the study conducted by Şanlıtürk *et.al*, community-acquired MRSA carriage in the Turkish Cypriot community was determined as 6.98% [14]. Baddal *et. al.* reported that among 449 *S. aureus* isolates collected between 2016 and 2020 in a major hospital in North Cyprus, 40.5% (n = 182) were MRSA [15]. Şanlıtürk *et. al*. also reported that the nasal MRSA carriage rate detected in a descriptive study on a population size of 20,000 students was 11.3%. However, there were no details about the nationalities of the students [6]. Moreover, a rise in community and hospital-acquired MRSA infections was noted according to the analysis of 7 years of data obtained from a university hospital [16].

This trend highlights the need for continued monitoring of MRSA carriage and monitoring of the effectiveness of the implemented control measures. Population-based screening for AMR across different nations and host communities may help understand the dynamics of AMR in these populations. Additionally, improving protocols for infection prevention and control can support the health needs of people of different nationalities [16]. Therefore, isolates with high carriage frequency in the community may be an important causal factor in a future AMR pandemic. A community-based study by Süzük Yıldız *et. al.* on the frequency and distribution of AMR among Syrian refugees and the local population in Türkiye reported that a significantly greater proportion of refugees (6.7%) carried MRSA compared to the local community (3.2%) [18].

Limitations of the study include not collecting

samples from all provinces in Northern Cyprus and not having data on the arrival dates of the participants to Northern Cyprus. Additionally, as the study aimed to evaluate the rates of asymptomatic students with different origins in the population, no specific data was collected regarding the faculty of the students and the education years. A more detailed evaluation of demographic characteristics, such as student academies and years of study, could provide more information for determining the rate of carriers.

Conclusions

This study revealed that MRSA carriage is present among both African and local students in Northern Cyprus. The rate of MRSA carriers was above 2% and suggests an increased risk of community-acquired spread. These findings suggest that stronger public health policies should be developed to prevent the spread of infectious diseases, hygiene practices should be encouraged, and awareness activities for rational antibiotic use should be increased among the students. Regular screening and monitoring, especially of student groups with low awareness, and raising awareness of MRSA carriage in society are critical to controlling the spread of resistant bacteria.

Authors' contributions

All authors read and approved the final version of the manuscript.

Corresponding author

Meryem Güvenir, PhD.
Cypus Health and Social Sciences Unniversity, Faculty of Medicine, Department of Medical Microbiology,
Güzelyurt, TRNC Mersin 10, Turkey
Email: meryemguvenir@hotmail.com

Conflict of interest

No conflict of interest is declared.

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