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Antimicrobial resistance patterns of *Staphylococcus aureus* isolates in tertiary hospital in Somalia: a retrospective study

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Abstract

Background *Staphylococcus aureus* (*S. aureus*) is a commensal microorganism that is part of the normal human flora but has the potential to cause a wide range of infections, from superficial skin conditions to life-threatening systemic diseases such as bacteremia. The aim of this study was to evaluate the epidemiological characteristics and antimicrobial resistance patterns of *S. aureus* strains isolated between 2019 and 2024 at a tertiary hospital in Mogadishu, Somalia.

Methods In this retrospective study, a total of 1,381 *S. aureus* isolates obtained from various clinical specimens submitted from different departments to the Medical Microbiology Laboratory were analyzed. The isolates were identified using standard microbiological methods, and antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) criteria. Data were statistically analyzed, and a p-value of < 0.05 was considered statistically significant.

Results Of the 1,381 *S. aureus* isolates, 670 (48.51%) were identified as methicillin-resistant *Staphylococcus aureus* (MRSA), while 711 (51.49%) were methicillin-susceptible *Staphylococcus aureus* (MSSA). Of the isolates, 55.03% were obtained from male patients and 44.97% from female patients. The highest isolation rate was observed in the 18–64 year age group. Among clinical specimens, wound samples (47.57%) and blood cultures (37.14%) were the most common. Both MRSA and MSSA isolates were most frequently recovered from outpatient clinics, and a statistically significant difference was observed in distribution across clinical departments ($p = 0.004$). Antimicrobial susceptibility analysis revealed high resistance rates among MRSA isolates to penicillin G (98.61%), erythromycin (71.11%), and tetracycline (66%), while MSSA isolates showed high resistance to penicillin G (91.51%), tetracycline (53.57%), and levofloxacin (49.61%), while MSSA isolates showed high resistance to penicillin G (91.51%) and tetracycline (53.57%). Very low resistance rates were observed for linezolid, vancomycin, and quinupristin–dalfopristin.

Conclusion *S. aureus* remains a significant pathogen in the region, particularly due to the high prevalence of MRSA strains. The elevated resistance rates identified in this study underscore the need to tailor empirical treatment

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strategies based on local antibiogram data. Continuous surveillance and effective antimicrobial stewardship programs are critical for controlling the emergence and spread of antimicrobial resistance.

Keywords Antimicrobial resistance, *Staphylococcus aureus*, MRSA, MSSA, Somalia

Introduction

Staphylococcus aureus (*S. aureus)* is a coagulase-producing, Gram-positive coccus that forms clusters and possesses mechanisms enabling it to evade the host immune response. It can grow under both aerobic and anaerobic conditions and is capable of causing serious clinical conditions such as food poisoning and toxic shock syndrome through the production of exotoxins. The development of antimicrobial resistance, particularly among methicillin-resistant *S. aureus* (MRSA) strains, contributes to increased pathogenicity and limits therapeutic options. Staphylococci are commonly found colonizing human epithelial surfaces [1].

More than 60% of healthy individuals are reported to carry *S. aureus* on the skin and mucosal surfaces of the upper respiratory tract, especially in the nasal vestibule [2, 3]. Approximately 20% of the population are considered long-term carriers [4]. Although clinical manifestations or infections are rarely observed in individuals with intact skin, *S. aureus* can cause severe infections when predisposing conditions are present [5].

Methicillin resistance among *S. aureus* strains represents a growing global public health concern and poses a significant threat to the effective treatment of various infections in humans [6]. MRSA is one of the leading causes of healthcare-associated infections and was identified in 2019 as a major pathogen–drug combination contributing to antimicrobial resistance (AMR). MRSA was recognised as major AMR pathogen in 1980–1990 s when widespread hospital outbreaks occured [7]. In Africa, the prevalence of MRSA has been reported to vary substantially both within and between countries [8].

In Somalia, low levels of antibiotic awareness, limited access to healthcare services, and the frequent use of antibiotics without prior antimicrobial susceptibility testing exacerbate the growing AMR problem. The widespread reliance on pharmacies for obtaining medications often bypasses appropriate diagnostic and therapeutic protocols. Somalia's Global Health Security Index score of 16.6 out of 100 in 2019 highlights significant gaps in preparedness to address AMR, including deficiencies in surveillance systems, laboratory capacity, infection prevention and control measures, antimicrobial stewardship, and policy implementation [9]. Strengthening government commitment, healthcare infrastructure, and international collaboration is therefore essential to effectively combat AMR in Somalia [9].

The aim of this study was to evaluate the antimicrobial resistance patterns of *S. aureus* isolates obtained from clinical specimens at a tertiary teaching hospital in Somalia, with particular emphasis on MRSA prevalence and resistance rates to commonly used antibiotics. The findings are expected to contribute to a better understanding of local AMR trends and to inform the development of antimicrobial stewardship and infection control strategies.

Materials and methods

Study design and study population

This retrospective study included 1,381 *S. aureus* isolates obtained from various clinical specimens submitted from different departments to the Medical Microbiology Laboratory of a tertiary care hospital in Mogadishu, Somalia, between January 2020 and December 2024. The variables analyzed comprised patients' age and sex, antimicrobial susceptibility test results, specimen type, and the clinical departments from which the samples were submitted. To minimize potential bias, only the first isolate of each specimen type obtained from an individual patient was included in the analysis.

Ethical approval

Ethical approval for the study was obtained from the Ethics Committee of the Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital prior to study initiation (decision no: 1022; reference no: MSTH/18788). Due to the retrospective nature of the study and the use of existing patient records with *S. aureus* results, the requirement for informed consent was waived.

Collection, isolation, and identification of *S. aureus*

Clinical specimens submitted to the Medical Microbiology Laboratory from various departments were inoculated onto blood agar, chocolate agar, and eosin–methylene blue (EMB) agar plates (Laborlar, Türkiye) and incubated at 37 °C for 18–24 h. Isolates growing on blood agar were identified using standard microbiological procedures, including colony morphology assessment, Gram staining, catalase testing, and tube coagulase testing.

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing of *S. aureus* isolates was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar, in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. The antimicrobial agents tested included: erythromycin (15 µg), fusidic acid (10 µg), gentamicin (10

μg), clindamycin (2 μg), levofloxacin (5 μg), ciprofloxacin (5 μg), linezolid (30 μg), penicillin G (1 U), quinupristin/dalfopristin (15 μg), cefoxitin (30 μg), trimethoprim/sulfamethoxazole (1.25/23.75 μg), teicoplanin (30 μg), vancomycin (30 μg), tetracycline (30 μg), and tigecycline (15 μg). Susceptibility results were interpreted according to CLSI criteria [10]. Vancomycin susceptibility was further evaluated using the minimum inhibitory concentration (MIC) method. Quality control was ensured using *S. aureus* ATCC 25,923 as the control strain.

Statistical analysis

All data were recorded and analyzed using SPSS version 25.0 (IBM SPSS Statistics, Armonk, NY: IBM Corp.). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Kolmogorov–Smirnov test and histogram analysis. The chi-square test with Bonferroni correction was applied for the analysis of categorical variables. A p-value < 0.05 was considered statistically significant.

Results

A total of 1,381 *S. aureus* isolates were recovered over the six-year study period. The isolation rate was 13% in 2019 and increased to its highest level in 2020 at 21%. In 2021, the proportion of *S. aureus* isolates decreased by 1% to 20%, followed by a further decline to 15% in 2022. The rate subsequently increased to 17% in 2023 and decreased again to 15% in 2024, demonstrating a fluctuating trend in isolation rates over the study years.

Between 2019 and 2024, a total of 1,381 *S. aureus* isolates obtained from various clinical specimens were analyzed, of which 670 (48.51%) were identified as MRSA and 711 (51.49%) as methicillin-susceptible *S. aureus* (MSSA). Of the isolates, 55.03% were recovered from male patients and 44.97% from female patients. The highest isolation rate was observed in the 18–64 year age group (53.94%), followed by the ≤ 17 (35.48%) age groups. The lowest isolation rate was identified in patients aged ≥ 65 years (10.57%). Among clinical specimens, *S. aureus* was most frequently isolated from wound specimens (47.57%) and blood cultures (37.14%) (Table 1).

Table 1 Profile of patients' age, gender, and clinical specimens

Variables		MRSA (*N* = 670), (%48.51)	MSSA (*N* = 711), (%51.49)	TOPLAM (*N* = 1381) (%100)
Gender	Male	372 (55.52)	388 (54.57)	760 (55.03)
	Female	298 (44.48)	323 (45.43)	621 (44.97)
Age groups	≤ 17	254 (37.91)	236 (33.19)	490 (35.48)
	18–64	347 (51.79)	398 (55.97)	745 (53.94)
	≥ 65	69 (10.30)	77 (10.83)	146 (10.57)
Clinical examples	Abscess	16 (2.39)	12 (1.69)	28 (2.03)
	Sputum	7 (1.04)	7 (0.98)	14 (1.02)
	CSF	8 (1.19)	5 (0.70)	13 (0.94)
	Urine	16 (2.39)	24 (3.38)	40 (2.90)
	Blood	270 (40.30)	243 (34.18)	513 (37.14)
	Wound	289 (43.13)	368 (51.76)	657 (47.57)
	Catheter	9 (1.34)	11 (1.55)	20 (1.45)
	Other (vaginal swab, peritoneal fluid, pleural fluid, ear swab)	55 (8.21)	41 (5.77)	96 (6.95)

MRSA: Methicillin-resistant *S. aureus* MSSA: Methicillin-susceptible *S. aureus*

MRSA and MSSA isolates were most frequently recovered from clinical specimens submitted by outpatient clinics (16% and 21%, respectively), followed by internal medicine–related departments (13.3% and 13%, respectively). When the distribution of specimen-sending departments was compared between MRSA and MSSA isolates, a statistically significant difference was observed ($p = 0.004$) (Fig. 2).

Over the six-year period, a total of 1,381 *S. aureus* isolates were recovered, of which 670 (48%) were identified as MRSA and 711 (52%) as MSSA. When MRSA and MSSA isolates were compared by year, a marked increase in MRSA rates was observed between 2019 and 2021, rising from 3% to 11%. In 2022, the MRSA proportion declined to 8%; however, it increased again in 2023, reaching a peak of 12%. In 2024, a subsequent decrease was observed, with the MRSA rate falling to 7%. In contrast, MSSA isolates showed their highest proportion in 2020 (13%), followed by a gradual decline between 2021 and 2023, decreasing from 9% to 5%. In 2024, the proportion of MSSA isolates increased again to 8% (Fig. 3).

Table 2 compares the antibiotic susceptibility profiles of MRSA and MSSA isolates. Resistance to erythromycin, gentamicin, clindamycin, levofloxacin, ciprofloxacin, penicillin G, tetracycline, and tigecycline was significantly higher in MRSA isolates compared with MSSA isolates ($p < 0.001$). High susceptibility to fusidic acid, linezolid, teicoplanin, and vancomycin was observed in both groups, with no statistically significant differences ($p > 0.05$). 670 of all *S. aureus* isolates were found to be resistant to cefoxitin. Although similar resistance rates to trimethoprim–sulfamethoxazole were observed in both groups, the difference was statistically significant ($p = 0.018$).

In this study, the highest resistance rates among the 1,381 *S. aureus* isolates obtained from various clinical specimens were observed for penicillin G and tetracycline. A marked increase in resistance to penicillin G was detected particularly in 2020, 2023, and 2024, while resistance to tetracycline showed a notable rise in 2023 and 2024. In addition, an increase in resistance to cefoxitin was observed in 2023, and to trimethoprim–sulfamethoxazole in 2019. In contrast, very low resistance rates to linezolid, quinupristin–dalfopristin, teicoplanin,

Table 2 Comparison of antibiotic susceptibility rates of strains

Antibiotics		Total MRSA	MRSA *N* (%)	Total MSSA	MSSA *N* (%)	*p*-values
Erythromycin	S	637	184 (28.89)	678	393 (57.96)	< 0.001
	R		453 (71.11)		285 (42.04)	
Fusidic Acid	S	552	417 (75.54)	592	475 (80.24)	0.147
	R		135 (24.46)		117 (19.76)	
Gentamicin	S	667	477 (71.51)	691	630 (91.17)	< 0.001
	R		190 (28.49)		61 (8.83)	
Clindamycin	S	637	505 (79.28)	683	641 (93.85)	< 0.001
	R		132 (20.72)		42 (6.15)	
Levofloxacin	S	647	326 (50.39)	685	575 (83.94)	< 0.001
	R		321 (49.61)		110 (16.06)	
Ciprofloxacin	S	376	255 (67.82)	361	309 (85.60)	< 0.001
	R		121 (23.18)		52 (14.40)	
Linezolid	S	554	548 (98.92)	598	597 (99.83)	0.105
	R		6 (1.08)		1 (0.17)	
Penicillin G	S	503	7 (1.39)	577	49 (8.49)	< 0.001
	R		496 (98.61)		528 (91.51)	
Quinupristin-Dalfopristin	S	284	276 (97.18)	358	357 (99.72)	< 0.001
	R		8 (2.82)		1 (0.28)	
Cefoxitin	S	670	0 (0.00)	711	711 (100.0)	< 0.001
	R		670 (100.0)		0 (0.00)	
Trimethoprim-sulfamethoxazole	S	484	255 (52.69)	464	252 (54.31)	0.018
	R		229 (47.31)		212 (45.69)	
Teicoplanin	S	305	294 (96.39)	411	409 (99.27)	< 0.001
	R		11 (3.61)		2 (0.73)	
Vancomycin	S	670	664 (99.10)	709	708 (99.51)	0.329
	R		6 (0.90)		1 (0.49)	
Tetracycline	S	350	119 (34.00)	366	186 (55.36)	< 0.001
	R		231 (66.00)		180 (53.57)	
Tigecycline	S	135	113 (83.70)	334	327 (97.90)	< 0.001
	R		22 (16.30)		7 (2.10)	

MRSA: Methicillin-resistant *S. aureus* MSSA: Methicillin-susceptible *S. aureus*

S: Sensitive, R: Resistant

and vancomycin were identified throughout the 2019–2024 study period (Fig. 4).

Discussion

In this study, the isolation rates of *S. aureus* were found to exhibit a fluctuating trend over the years (Fig. 1). Similar studies reported in the literature have also demonstrated that *S. aureus* isolation rates may vary over time [4, 11–13]. This fluctuating pattern may be associated with variations in patient admission rates, distribution of clinical specimens, effectiveness of infection control practices, and differences in antibiotic use policies. In addition, periodic changes in the epidemiological characteristics of circulating *S. aureus* strains are considered an important factor influencing isolation rates. These findings indicate the importance of long-term surveillance studies in monitoring *S. aureus* infections.

S. aureus is a common bacterial pathogen affecting both males and females. In the present study, *S. aureus* isolates obtained from clinical specimens were found to be more frequent in samples from male patients compared with those from female patients (Table 1). This finding is consistent with previous studies reporting higher *S. aureus* isolation rates among male patients [11, 14–16]. In contrast, several studies have reported higher *S. aureus* isolation rates in female patients [17, 18], and our findings therefore differ from those reports. Male sex has previously been suggested as a potential risk factor for *S. aureus* infection and colonization; Loreen et al. (2025) [19] demonstrated that male sex is an independent risk factor for *S. aureus* nasal carriage. In addition, Judyta and Barbara (2017) [20] emphasized that risk factors associated with *S. aureus* carriage may vary according to sex.

In our study, *S. aureus* isolation was most frequent in the 18–64 year age group (53.94%). Both MSSA and MRSA isolates were highly prevalent in this age group (Table 1). Our findings contrast with a study from northwestern Ethiopia, where 63.6% of *S. aureus* isolates were obtained from the 0–15-year age group, and MRSA was also notably common in this group [11]. Similarly, a study from China reported higher isolation rates of

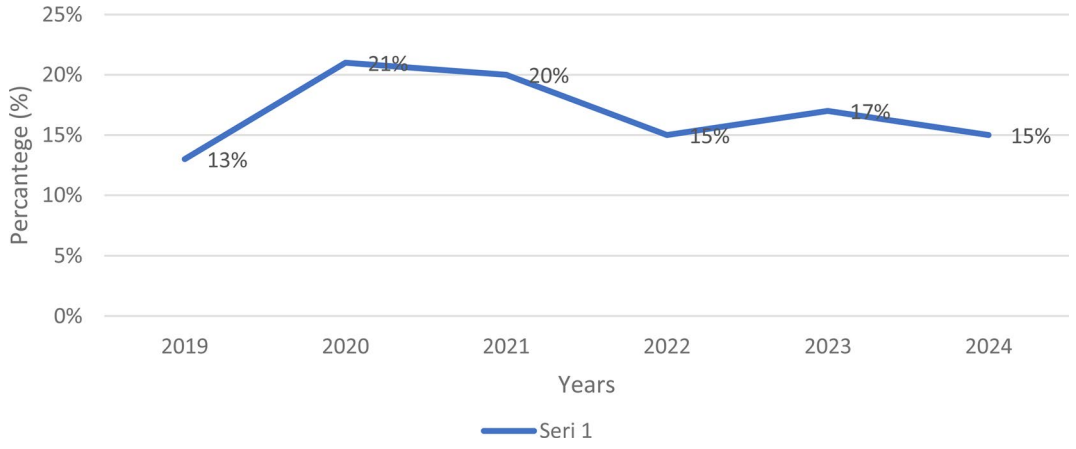

Fig. 1 Yearly distribution of *S. aureus* (2019–2024)

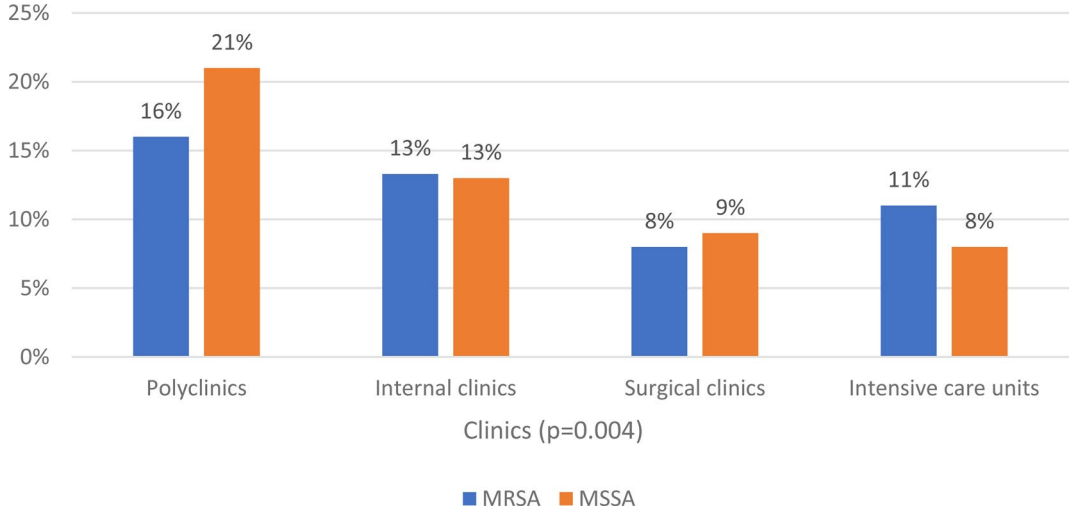

Fig. 2 Frequency of isolates detected by units. MRSA: Methicillin-resistant *S. aureus* MSSA: Methicillin-susceptible *S. aureus*

both *S. aureus* and MRSA in younger age groups [21]. In Eritrea, a study found higher *S. aureus* isolation rates in the ≤ 18-year group, whereas MRSA was more frequently detected in the 19–40-year age group [22]. In Nepal, the highest isolation rates for both types of isolates were observed in the 15–45-year group (53.8%) [23]. Data from Europe show a different distribution pattern; in Denmark, *S. aureus* isolation was more common in individuals over 50 years of age [24], while studies from Saudi Arabia reported higher isolation rates of both *S. aureus* and MRSA in older age groups (> 50 years) [25]. These differences may reflect variations in patient demographics and clinical characteristics, immune system maturity, hospital and ICU exposure, frequency of invasive procedures, patterns of antibiotic use, regional healthcare infrastructure, and the epidemiological characteristics of circulating *S. aureus* clones.

In our study, both MSSA and MRSA isolates were most frequently recovered from outpatient clinics (37%), and among clinical specimens, *S. aureus* was most commonly isolated from wound samples (Table 1; Fig. 2). These findings are consistent with a study conducted in Vietnam, which reported that *S. aureus* was most frequently isolated from outpatient clinics and that pus was the most common clinical specimen [17].

Community-acquired *S. aureus* infections are typically observed in patients without hospital-associated risk factors and are most often identified during outpatient visits [26, 27]. In contrast, isolates obtained from inpatient units are generally associated with hospital-acquired infections [28]. In this context, the fact that 16% of MRSA and 21% of MSSA isolates in our study were obtained from outpatient clinics suggests that these isolates are likely community-acquired. However, further epidemiological data are required to confirm this classification.

In a study from Serbia evaluating microorganisms isolated from post-surgical wound infections and their antibiotic susceptibility patterns, *S. aureus* was reported as the most common isolate (35%); this pathogen was detected in 13.7% of wound specimens from hospitalized

patients and 21.3% of wound specimens from outpatients [29]. These findings indicate that *S. aureus* is a major pathogen in both hospital-acquired and community-associated wound infections. The literature shows considerable variability in terms of the clinical specimens and healthcare settings from which *S. aureus* is isolated. Wound discharge samples in northwest Ethiopia [11], wound specimens and samples submitted from hospital wards in Türkiye [30], urine samples in Sudan [12], hospitalized patients and wound swabs in Nepal [23]. Similarly, in Nigeria, *S. aureus* isolates obtained from outpatients presenting to Abia State University Teaching Hospital, Aba, were most frequently recovered from wound swab specimens [31].

The differences observed between studies may be related to variations in patient populations, distribution of healthcare settings, sampling strategies, and regional infection profiles. The close association of *S. aureus* with skin and soft tissue infections explains its frequent isolation from wound and pus specimens. In our study, the high rate of *S. aureus* and MRSA isolation from outpatient clinics suggests the widespread presence of community-acquired infections and indicates that outpatients may constitute an important reservoir; this finding highlights the need for infection control measures to also encompass outpatient settings.

MRSA is one of the leading causes of both healthcare-associated and community-acquired infections worldwide and contributes substantially to the burden of morbidity and mortality related to antimicrobial resistance. Due to its persistent prevalence and severe clinical outcomes, MRSA remains a major public health concern and is classified by the World Health Organization (WHO) as a high-priority pathogen for the discovery and development of new antibiotics [32]. AMR continues to pose an increasing threat to global health. Indeed, in some regions, up to 94.5% of *S. aureus* infections have been reported to be caused by MRSA, and the treatment of these infections with standard antibiotics has been highlighted as being particularly challenging [33].

In our study, a total of 1,381 *S. aureus* isolates were recovered between 2019 and 2024, of which 48.51% were identified as MRSA (Table 2; Fig. 3). This proportion is comparable to MRSA rates reported from Nepal (46.1%) [23], Debre Markos Referral Hospital, Ethiopia (49.7%) [34], and a systematic review and meta-analysis including low- and lower-middle-income countries, which reported an overall MRSA prevalence of 48.4% [35]. In contrast, substantially higher MRSA rates have been reported from tertiary hospitals in Egypt (85%) [36], Zagazig University Hospitals, Egypt (78.9%) [37], and a tertiary hospital in Lahor, Pakistan (76%) [38]. Similarly, Arba Minch Hospital, southern Ethiopia (82.3%) [39], and a multicenter study conducted in Asmara, Eritrea (72%) [22], all of which exceed the rate observed in the present study. Conversely, the MRSA prevalence identified in our study was markedly higher than those reported from Denmark (1.3%) [24], Mekelle, northern Ethiopia (2.4%) [40], Pakistan (5.26%) [41], China (25.4%) [42], and Türkiye (27.27%) [30]. The wide variation in MRSA prevalence reported across studies may be attributed to differences in demographic and clinical characteristics of patient populations, including intensive care unit admission rates and frequency of invasive procedures, as well as variability in antibiotic use practices and infection control measures. In addition, microbiological diagnostic methods, MRSA definition criteria, sample sizes, and the genetic characteristics of regionally circulating *S. aureus* clones may have contributed to this observed heterogeneity.

In our study, the highest resistance rates among MRSA isolates were observed for penicillin G (98.61%), erythromycin (71.11%), tetracycline (66.0%), levofloxacin (49.61%), and trimethoprim–sulfamethoxazole (47.31%). Among MSSA isolates, the highest resistance rates were detected for penicillin G (91.51%), tetracycline (53.57%),

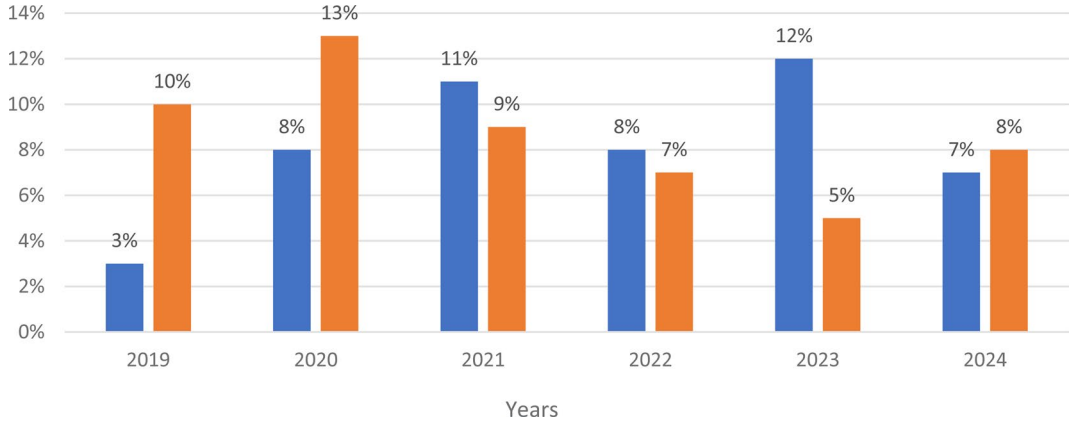

Fig. 3 Annual distribution of MRSA and MSSA isolates (2019–2024)

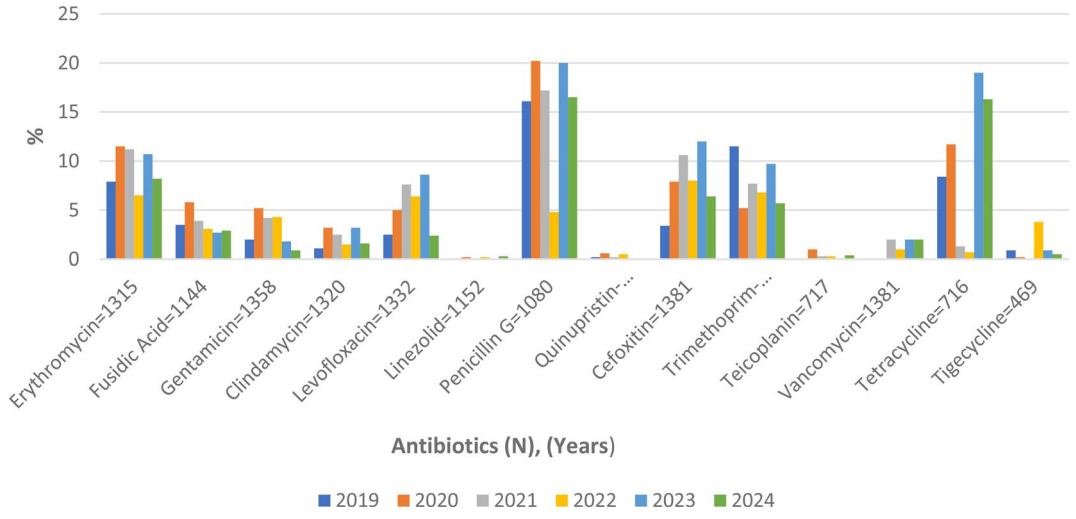

Fig. 4 Antibiotic resistance rates by year

trimethoprim–sulfamethoxazole (45.69%), and erythromycin (42.04%) (Table 2).

These findings are partially consistent with results reported from Türkiye by Gülbay and Doğan (2024) [43], who identified the highest resistance rates among MRSA isolates to penicillin (100%), erythromycin (50.85%), and tetracycline (49.15%), while the highest resistance among MSSA isolates was observed against penicillin G (87.06%). Similarly, a study conducted in Romania reported that penicillin (100%), erythromycin (79.82%), and tetracycline (76.52%) exhibited the highest resistance rates among MRSA isolates, whereas penicillin (79.37%) showed the highest resistance among MSSA isolates [4].

In a study from Vietnam, high resistance rates among MRSA isolates were reported for penicillin (100%), erythromycin (85.23%), tetracycline (61.07%), and clindamycin (84.57%), while penicillin (90.48%) demonstrated the highest resistance among MSSA isolates [17]. Likewise, a study conducted in China reported high resistance rates to penicillin (97.8% in MRSA and 87.9% in MSSA), erythromycin (71.1% and 50.0%, respectively), and clindamycin (71.1% and 49.2%, respectively) in both MRSA and MSSA isolates [42].

In contrast, our study demonstrated that both MRSA and MSSA isolates exhibited the lowest resistance rates to vancomycin, linezolid, quinupristin–dalfopristin, and tigecycline (Table 2). This finding is consistent with several studies reporting that these agents remain highly effective in the treatment of *S. aureus* infections [13, 15, 16, 43].

In our study, teicoplanin resistance among MRSA isolates was 3.61%. Although teicoplanin resistance is generally reported at low levels [13, 43], a study from central India observed intermediate teicoplanin resistance in 5 of 158 MRSA isolates (3.16%), with no full resistance detected; however, a concerning upward trend in MIC values over three years suggested the emergence of resistance [44]. In a study from Poland, 36 isolates (76.6%) in the overall population were resistant only to teicoplanin [45]. More recently, another study reported that 84.3% of isolates were teicoplanin-susceptible, 5.2% resistant, and 10.4% intermediately susceptible [46]. These findings indicate that, although full teicoplanin resistance remains relatively rare globally, resistance rates in certain regions may reach or exceed ~ 3.6%, highlighting the need for continuous surveillance and molecular characterization of resistant strains. This variability may reflect regional differences in antimicrobial use, infection control practices, and laboratory methodologies.

The high resistance rates observed against penicillin, erythromycin, and tetracycline in both MRSA and MSSA isolates may be attributed to the long-standing and often empirical use of these antibiotics, increased selective pressure on both community- and hospital-acquired strains, and the presence of multiple resistance mechanisms, particularly among MRSA isolates. In contrast, the low resistance rates detected against advanced-generation antibiotics such as glycopeptides, oxazolidinones, and streptogramins may be explained by their more limited and controlled use.

In this study, the highest resistance rates were observed for penicillin G and tetracycline; notably, penicillin G resistance increased in 2020, 2023, and 2024, while a marked rise in tetracycline resistance was observed during 2023–2024. In addition, an increase in cefoxitin resistance was detected in 2023, and trimethoprim–sulfamethoxazole resistance increased in 2019. In contrast, resistance rates to linezolid, quinupristin–dalfopristin, teicoplanin, and vancomycin remained consistently low throughout the study period (Fig. 4).

Our findings are consistent with those of Hamadalneel et al. (2025) [12], who reported increasing trends in

tetracycline and erythromycin resistance over the study period; however, some variability in resistance rates to vancomycin and linezolid was also observed, which differs from our findings. Similarly, Lan et al. (2024) [13] reported persistently high erythromycin resistance and tetracycline resistance exceeding 40% across all study years, in agreement with our findings. Tălăpan et al. (2023) [4] also reported high erythromycin resistance, while resistance to trimethoprim–sulfamethoxazole, linezolid, teicoplanin, and vancomycin remained low, consistent with our observations. Likewise, Zhang et al. (2025) [21] documented high resistance rates to penicillin G and erythromycin, alongside low resistance levels to advanced-generation antimicrobial agents, particularly in pediatric intensive care unit isolates.

To sum up, the high and increasing resistance rates to penicillin G and tetracycline likely reflect selective pressure resulting from their long-term and widespread use. Conversely, the sustained low resistance to advanced-generation antibiotics suggests that these agents remain effective therapeutic options for the treatment of *S. aureus* infections.

The main limitations of this study include that the classification of *S. aureus* infections as community-acquired or hospital-acquired was not supported by detailed epidemiological data and was largely based on the unit from which the isolates were obtained; this may have led to potential misclassification. In addition, the D-test was not performed to detect inducible clindamycin resistance among erythromycin-resistant and clindamycin-susceptible isolates, which may have resulted in an underestimation of the prevalence of the iMLSB phenotype.

Conclusion

In this study, the epidemiological characteristics and antimicrobial resistance patterns of *S. aureus* isolates recovered between 2019 and 2024 from a tertiary care hospital in Mogadishu, Somalia, were evaluated. Nearly half of the 1,381 isolates were identified as MRSA, highlighting that this pathogen remains a significant public health and clinical concern in the region. The frequent isolation of *S. aureus* from wound and blood samples, particularly among pediatric and young adult patients, underscores its role in invasive infections.

High resistance rates to penicillin G, erythromycin, and tetracycline among both MRSA and MSSA isolates indicate the need for caution in empirical treatment strategies. In contrast, the sustained low resistance rates to linezolid, vancomycin, teicoplanin, and quinupristin–dalfopristin suggest that these agents remain effective options for the treatment of severe *S. aureus* infections.

Overall, our findings demonstrate that *S. aureus*, particularly MRSA, continues to be an important nosocomial and community-associated pathogen in the region. Continuous surveillance, up-to-date local antibiograms, and the implementation of rational antibiotic stewardship programs are essential to control antimicrobial resistance and optimize patient management.

Abbreviations

S. aureus	*Staphylococcus aureus*
MRSA	Methicillin-resistant *Staphylococcus aureus*
MSSA	Methicillin-susceptible *Staphylococcus aureus*
AMR	Antimicrobial resistance
EMB	Eosin–methylene blue
CLSI	Clinical and Laboratory Standards Institute
WHO	World Health Organization

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Author contributions

SMM contributed to the conceptualization and design of the study. Data acquisition was performed by LAN and SMM. Statistical analysis and interpretation were carried out by SD , ZO , and RYHM .The original manuscript draft was prepared by SMM and HOH , while MMM critically reviewed and revised the final manuscript for important intellectual content. AD contributed to statistical analysis, methodology, study design, and literature review.All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Data availability

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

Ethical approval for the study was obtained from the Ethics Committee of the Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital prior to study initiation (decision no: 1022; reference no: MSTH/18788). Due to the retrospective nature of the study and the use of existing patient records with S. aureus results, the requirement for informed consent was waived. We conducted the study following the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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