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ANTIBIOTIC SUSCEPTIBILITY PATTERN OF METHICILLIN RESISTANCE STAPHYLOCOCCUS AUREUS (MRSA) AMONG PEDIATRIC AND YOUNG ADULT PATIENT

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Abstract

Staphylococcus aureus, a gram-positive bacterium, poses significant health risks due to its methicillin-resistant strain (MRSA), which is resistant to many antibiotics. MRSA can cause various infections, including skin infections, pneumonia, and sepsis, with differing impacts on children and adults. Over 90% of S. aureus strains carry plasmids encoding beta-lactamase, and some are resistant to beta-lactam antibiotics like methicillin due to alterations in penicillin-binding proteins (PBPs). MRSA is widespread in hospitals, and treatment strategies depend on local resistance patterns. The objectives of this study were to determine the prevalence of MRSA infections in pediatric and young adult patients and to analyze the antibiotic susceptibility patterns of MRSA isolates. This cross-sectional study utilized convenience sampling with 107 participants divided into two groups: pediatric (0-12 years) and young adults (12-30 years), conducted at City Medical Hospital. Microbiological techniques, including bacterial culture, Gram staining, and biochemical tests, were employed. Antibiotic susceptibility was assessed using the Kirby-Bauer method, and data were analyzed using SPSS software version 25 with descriptive statistics.

The prevalence of MRSA was 75% in adults and 91% in pediatric patients, with higher rates observed in children around one month old. Females showed a higher prevalence in both groups. In pediatrics, MRSA was predominantly found in blood specimens, while pus specimens were more common in adults. Cefoxitin demonstrated 100% sensitivity in adults, followed by ciprofloxacin (92.3%). High resistance was noted for erythromycin, chloramphenicol, linezolid, and penicillin. Pediatric isolates showed 100% sensitivity to cefoxitin, tigecycline, chloramphenicol, and linezolid, with gentamicin, co-trimoxazole, and doxycycline showing 80% sensitivity. Resistance rates were highest for penicillin (97.6%), ciprofloxacin (84.6%), and erythromycin (79.6%) in pediatrics. Linezolid and chloramphenicol were effective in both age groups, while doxycycline showed better results in adults. This study highlights significant differences in the prevalence

and antibiotic susceptibility patterns of MRSA between pediatric and young adult patients, with higher prevalence in infants and a greater impact on females. Pus was the primary source of MRSA in adults, while blood was predominant in pediatrics. Doxycycline, linezolid, and chloramphenicol emerged as effective treatment options, while erythromycin and penicillin showed high resistance in both groups.

INTRODUCTION

Staphylococcus aureus, a gram-positive bacterium, is a significant pathogen responsible for various infections, ranging from mild skin conditions to severe diseases such as pneumonia and sepsis. Identified first by Sir Alexander Ogston in 1880, S. aureus has evolved to become a major health concern due to its ability to develop antibiotic resistance, particularly in its methicillin-resistant form (MRSA) (1, 2). Approximately 30% of healthy individuals carry S. aureus, with about 20% being persistent carriers, while 60% may carry it intermittently throughout their lives (3).

S. aureus is characterized by its grape-like clusters, ranging from 0.5 to 1.5 µm in size. Its pathogenicity is enhanced by various virulence factors, including toxins and surface proteins that facilitate immune evasion (4). The transmission of MRSA primarily occurs through direct contact with infected individuals or contaminated surfaces, posing a significant risk in healthcare settings (5). The emergence of MRSA was first documented in the 1960s, with strains increasingly associated with both hospital-acquired (HA-MRSA) and community-acquired (CA-MRSA) infections (6). MRSA infections are linked to higher morbidity and mortality rates, especially among vulnerable populations such as children and the elderly (7). The global rise in antibiotic resistance, particularly against beta-lactam antibiotics, underscores the urgent need for ongoing surveillance and effective treatment strategies (8). Understanding the prevalence and antibiotic susceptibility patterns of MRSA in pediatric and young adult populations is crucial for developing targeted interventions and improving clinical outcomes (9).

The increasing prevalence of MRSA poses a significant challenge to public health, necessitating a comprehensive understanding of its transmission dynamics and resistance mechanisms. Recent studies have highlighted the role of environmental factors, healthcare practices, and antibiotic usage patterns in the spread of MRSA (10). Children and young adults represent a unique demographic, often exhibiting different susceptibility patterns and infection outcomes compared to older populations (11). This age group may face distinct exposure risks due to factors such as communal living environments, participation in contact sports, and varying immune responses (12). As MRSA continues to evolve and adapt, it is imperative to evaluate local epidemiological trends and antibiotic resistance profiles to inform effective treatment protocols and infection control measures (13).

Methodology

Materials and Methods

This research utilized a cross-sectional study design to assess the prevalence and antibiotic susceptibility patterns of MRSA among pediatric and young adult patients. Non-probability convenience sampling was employed to select participants for the study. A total of 107 participants were included, divided into two groups: pediatric patients (0-12 years) and young adults (12-30 years). The study was conducted at city Medical Hospital in Rawalpindi which also served as the research laboratory.

Selection Criteria

Inclusion Criteria: Participants were eligible if they were pediatric (0-12 years) or young adult patients (12-30 years) with a known Staphylococcus aureus infection and available medical records.

Exclusion Criteria: Patients outside the specified age range, those with infections other than S. aureus, or those with incomplete medical records were excluded.

Data Collection Procedure

Appropriate specimens were collected based on suspected infection sites, including swabs from skin

lesions, blood cultures for suspected bloodstream infections, urine for urinary tract infections, and pus from abscesses. All samples were collected using sterile techniques to prevent contamination.

Laboratory Processing: Collected specimens were inoculated onto suitable agar plates (mannitol salt agar or blood agar) and incubated at 37°C for 24 hours.

Colony Identification: Colony morphology was examined, and Gram staining was performed to confirm the presence of Gram-positive cocci in clusters.

Biochemical Tests: Various biochemical tests were conducted to identify S. aureus:

Catalase Test: A positive result was indicated by bubble formation upon adding hydrogen peroxide.

Coagulase Test: Both tube and slide methods were employed to assess coagulase production.

Oxidase Test: This test was negative for S. aureus, confirming the absence of cytochrome oxidase.

DNA-ase Test: The presence of deoxyribonuclease was determined by observing clear zones around colonies after hydrochloric acid treatment.

Antimicrobial Susceptibility Testing
The Kirby-Bauer disk diffusion method was utilized to evaluate antibiotic susceptibility. The diameter of the zone of inhibition around antibiotic disks was measured after 18 hours of incubation at 37°C. MRSA strains were assessed for resistance to various antibiotics, including beta-lactams, due to the presence of the mecA gene.

Results
This study aimed to determine the prevalence and antibiotic susceptibility patterns of MRSA among pediatric and young adult patients in tertiary care hospitals in Rawalpindi and Islamabad. A total of 107 samples were analyzed, comprising 55 pediatric patients and 52 young adults. The data indicate a predominance of pediatric patients in the study population.

Prevalence of MRSA
In adults, 75% tested positive for MRSA (39 out of 52), while in pediatric patients, the prevalence was significantly higher at 91% (50 out of 55). This suggests a substantial burden of MRSA, particularly among children, exceeding the global pooled prevalence of 5%.

Age Distribution
The age distribution revealed that the highest frequency of MRSA cases occurred in infants, particularly around one month old, with additional peaks in the 20-30 year age range.

Gender Distribution
Among young adults, 64.7% of males and 80% of females tested positive for MRSA, indicating a higher prevalence in females. In pediatric patients, 85.2% of males and 96.4% of females were positive, again showing a greater prevalence in females.

Specimen Analysis
For adult patients, the highest MRSA isolation rates were found in pus (26.9%) and blood (21.2%). In pediatric patients, blood samples showed a striking 81.8% positivity rate, while urine and pus samples had lower positivity rates (3.64% and 1.82%, respectively).

Antimicrobial Susceptibility Patterns
The susceptibility patterns differed between adults and pediatric populations. In adults, cefoxitin exhibited 100% sensitivity, with notable resistance to erythromycin (84.6%) and ciprofloxacin (92.3%). In contrast, pediatric isolates showed 100% sensitivity to cefoxitin and tigecycline, with lower resistance rates across other antibiotics. In MRSA isolates, both adult and pediatric patients demonstrated 100% resistance to cefoxitin, highlighting its ineffectiveness. Penicillin resistance was particularly high at 96%, with similar trends observed for erythromycin (80%) and co-trimoxazole (80%). Conversely, linezolid (76%) and chloramphenicol (77%) showed promising sensitivity rates, indicating potential effective treatment options.

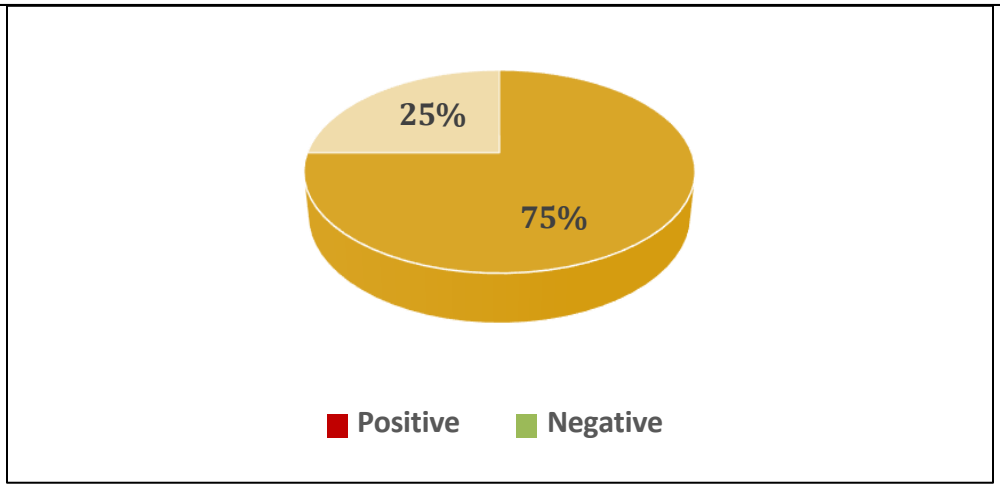

Fig 1 Distribution of patients

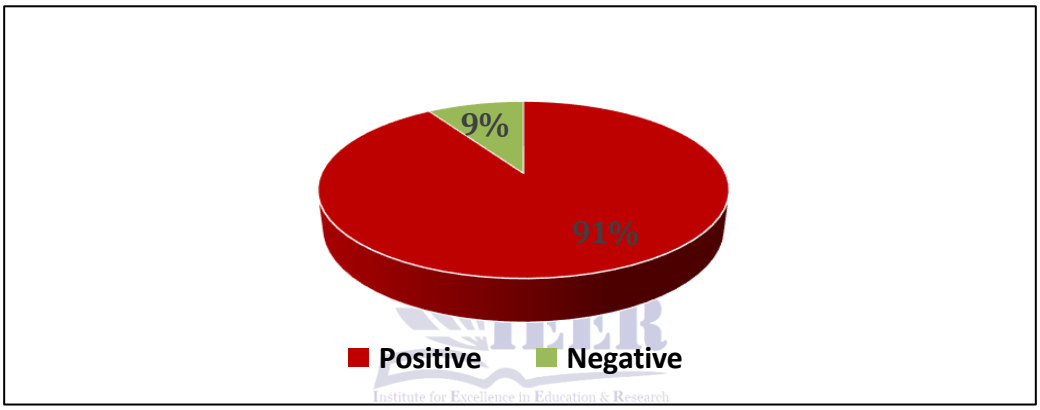

Figure 2: Prevalence of *MRSA* in Pediatrics patients

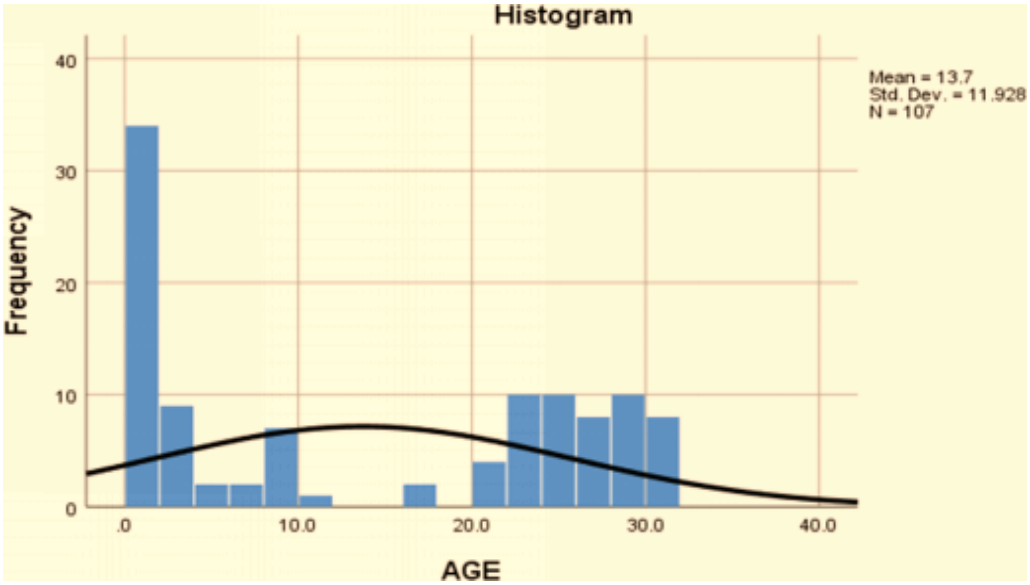

Fig 3 Age wise distribution

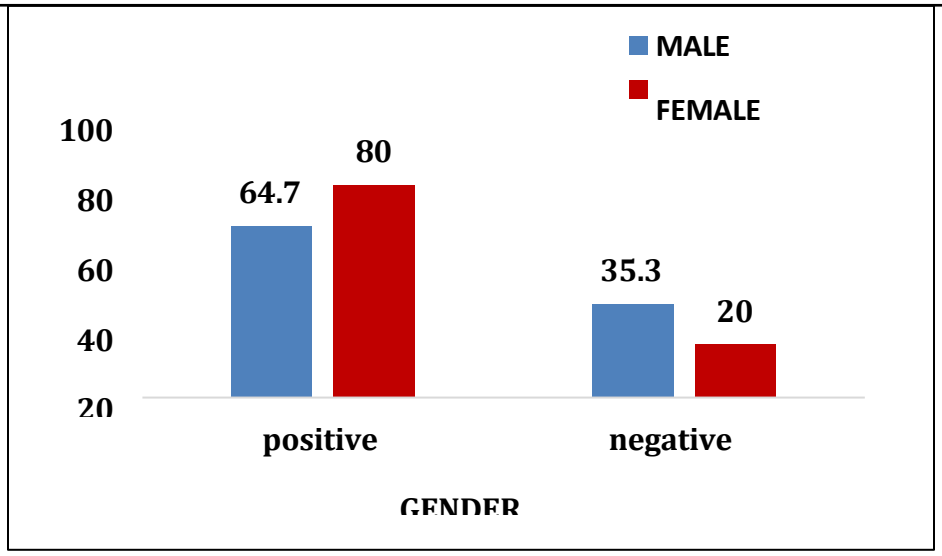

Fig 4 Gender distribution in young Adult patients

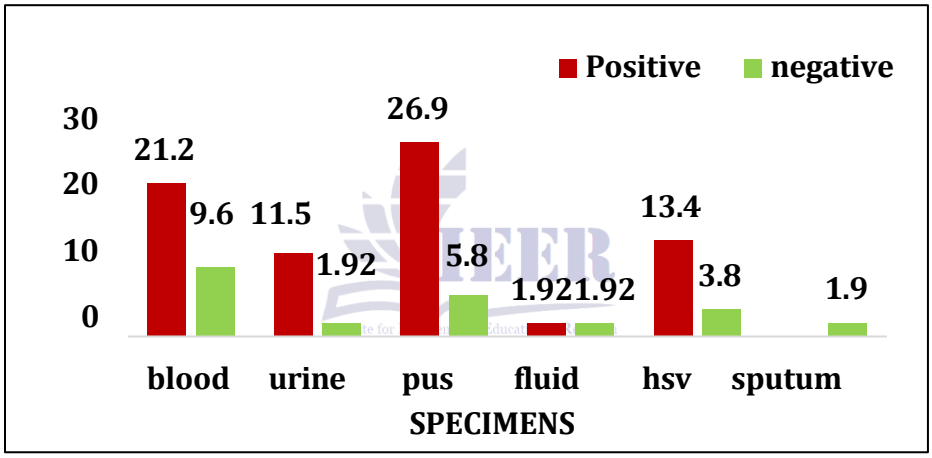

Fig 5 Specimen of *MRSA* isolated from young Adult patients

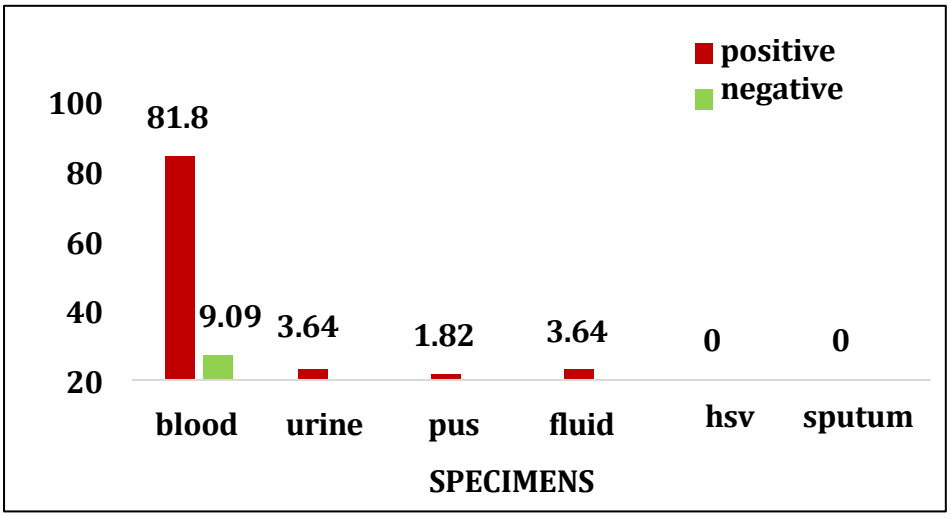

Figure 6 Specimen of *MRSA* isolated from pediatrics patient

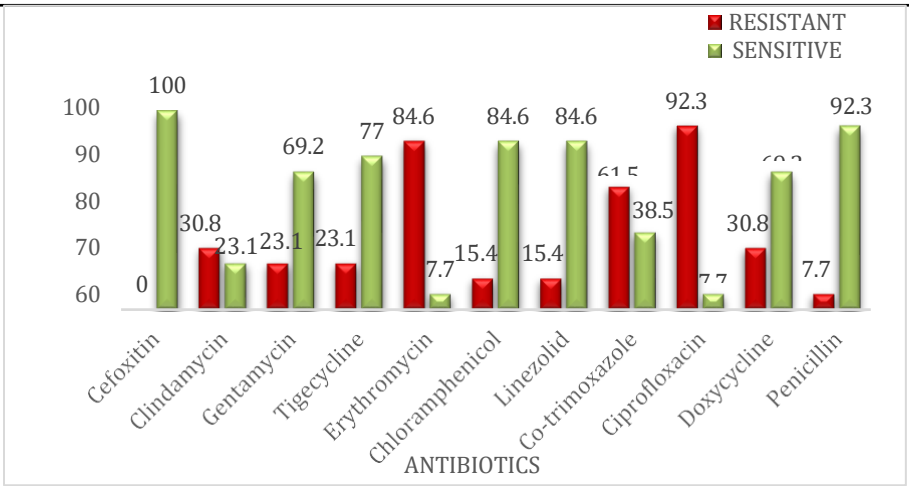

Figure 7 Antimicrobial susceptibility pattern of *Staphylococcus aureus* in adults.

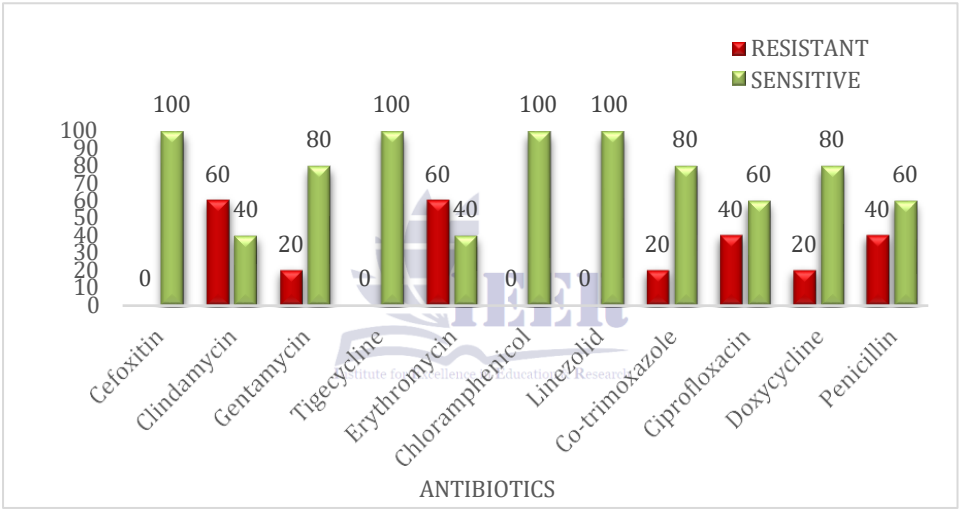

Figure 8 Antimicrobial susceptibility pattern of *Staphylococcus aureus* in paeds.

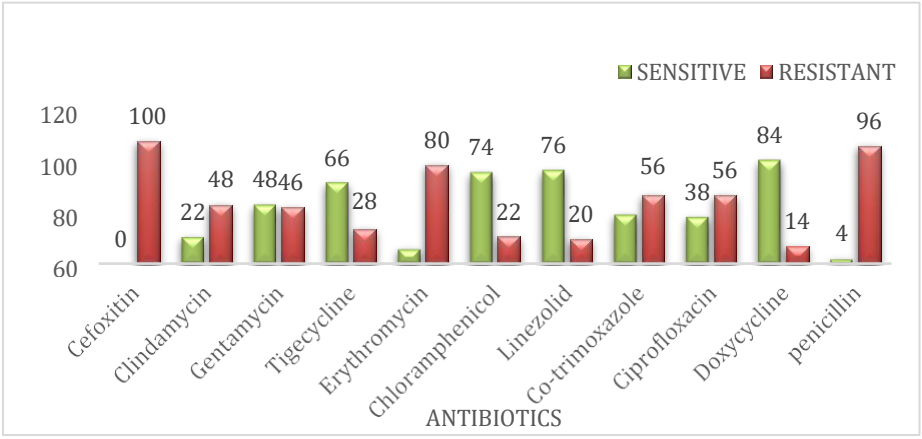

Figure 9: Antimicrobial susceptibility pattern of *MRSA* in adults.

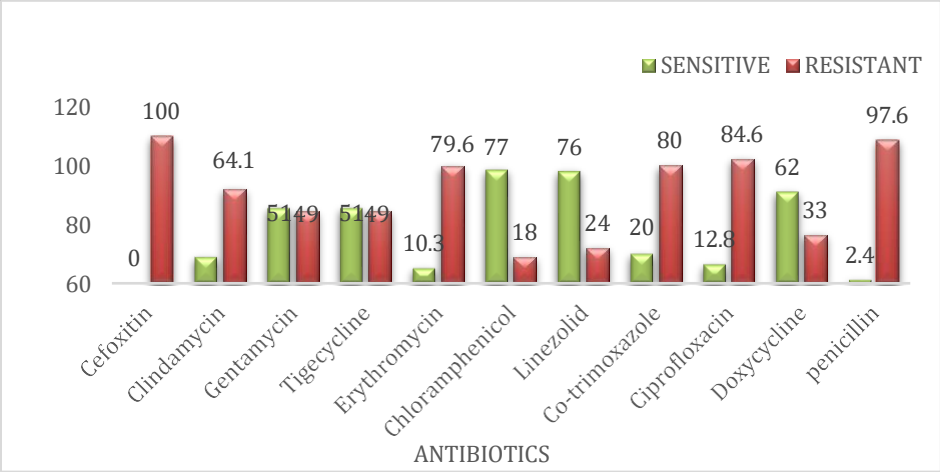

Figure 10: Antimicrobial susceptibility pattern of *MRSA* in paeds.

Discussion

Staphylococcus aureus (S. aureus) is a gram-positive bacterium that commonly colonizes human skin and mucous membranes, leading to serious infections, particularly in immunocompromised individuals. The emergence of methicillin-resistant Staphylococcus aureus (MRSA) has become a significant public health concern, primarily due to the mecA gene that confers resistance to beta-lactam antibiotics. The widespread use of antibiotics has facilitated the rise of MRSA, complicating treatment options and increasing the burden of healthcare-associated infections. In our study, we analyzed 107 samples from pediatric and young adult patients, revealing a predominance of MRSA in the pediatric population, particularly among infants aged one month. This finding aligns with previous research indicating higher MRSA rates in younger age groups (Hadiah Almutairi et al., 2024). Our results showed a 75% overall positivity rate for MRSA, significantly higher than the 3.8% colonization rate reported in Taiwanese adults (Jann-Tay Wang et al., 2009). In pediatric patients, the prevalence was notably high at 91%, contrasting with global estimates.

Gender differences in MRSA prevalence were observed, with females exhibiting a higher rate of infection in both age groups. This finding contrasts with earlier studies that reported higher prevalence in males. Potential factors include gender differences in healthcare-seeking behavior and exposure to healthcare environments. The distribution of MRSA across specimen types indicated that blood and pus samples had the highest positivity rates, suggesting that bloodstream and skin infections are the primary clinical manifestations.

The antimicrobial susceptibility patterns of S. aureus isolates revealed high sensitivity to cefoxitin, linezolid, and chloramphenicol in pediatric patients, while resistance was notably high against erythromycin and penicillin. These patterns are consistent with findings from other studies indicating varying resistance levels across different populations. For instance, while our study reported 92.3% sensitivity to penicillin in adults, other studies have shown higher resistance rates. The comparison between adults and pediatric populations highlighted significant differences in antibiotic resistance profiles, emphasizing the need for tailored treatment strategies. The high rates of resistance to commonly used antibiotics such as ciprofloxacin and co-trimoxazole further underscore the necessity for ongoing surveillance and appropriate antibiotic stewardship.

In conclusion, our study highlights a concerning prevalence of MRSA, particularly among pediatric patients, and underscores the importance of effective infection control measures. The findings reinforce the need for continuous monitoring of antibiotic resistance patterns to guide clinical practices and improve patient outcomes.

Limitations of the study

The study's limitations include a relatively small sample size of 107 participants, which may affect the generalizability of the findings. The use of non-

probability convenience sampling could introduce selection bias, and the cross-sectional design limits the ability to establish causal relationships. Additionally, conducting the research in only two hospitals may not fully represent broader population dynamics, and the focus on specific antibiotics might overlook emerging resistance patterns.

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