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Insight into the Genotypic Prevalence and Clinical Spectrum of *Staphylococcus aureus* in Gombe, Nigeria

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ABSTRACT

Staphylococcus aureus is a major human pathogen that causes various infectious diseases in both community and hospital environments. Its ability to colonize various body sites and acquire resistance genes has made it a global health concern. While many studies in Nigeria have explored the prevalence and clinical significance of *S. aureus*, there is still a paucity of data from the North-East region, especially Gombe State. This information gap complicates the development of effective prevention and control measures in the area. This study aimed to assess the prevalence of *S. aureus* in clinical samples from patients at the Federal Teaching Hospital, Gombe, and to analyze the distribution of isolates across different clinical samples and gender. A prospective cross-sectional study was conducted from January to October 2025, involving the collection of 400 non-repetitive clinical samples from patients. Detection and identification were performed using cultures and biochemical tests, while molecular confirmation was achieved through a *nuc-gene-targeted* polymerase chain reaction (PCR). Of the 400 samples, 70 were confirmed to be *S. aureus*, indicating an overall prevalence of 17.5%. Wound infections accounted for the highest proportion of isolates (28.9%), followed by urine (21.4%), vaginal swabs (17.1%), blood (15.7%), seminal fluid (14.3%), and cerebrospinal fluid (2.9%). These differences were statistically significant. Among the 70 isolates, 39 (55.7%) were from males and 31 (44.3%) from females; however, the gender difference was not statistically significant. The findings of this study have revealed the prevalence and clinical patterns of *Staphylococcus aureus* in Gombe, Nigeria. Also, highlight the need for the relevant authorities to institute health education campaigns, antibiotic stewardship programs and infection prevention strategies to safe guard public health.

Keywords: *Staphylococcus aureus*, Prevalence, Wound Infection, Urinary Tract Infection, Public Health, Nigeria, Gombe.

Introduction

Staphylococcus aureus is a gram-positive bacterium that is highly relevant in medicine (Fisher & Mobashery, 2020). It exists as an innocent commensal and an opportunistic pathogen, colonizing the nares, skin, and mucous membranes of a substantial portion of the population, often without symptoms (Hamza *et al.,* 2021). Despite this silent presence, the organism has been implicated in a wide range of clinical diseases, ranging from mild skin infections to severe, life-threatening pneumonia, septicemia, osteomyelitis, and endocarditis (Stoneham *et al.,* 2021; Berry *et al.,* 2022; Howden *et al.,* 2023). Its adhesins, toxins, biofilm-forming capacity, and mechanisms that help it evade host immune defenses.

These attributes contribute to its success as a pathogen associated with a wide array of human infections (Cheung *et al.,* 2021; Pugazhendhi *et al.,* 2022).

In Nigeria, *S. aureus* is one of the most frequently isolated bacterial pathogens in healthcare facilities. Reports from different parts of the country have revealed considerable variation in its occurrence, ranging between 20% and over 70%, depending on the geographic location, study design, and diagnostic methods employed (Mofolorunsho and Garba, 2022; AbdulAziz *et al.,* 2022). Wound infections are consistently highlighted as the main reservoir of *S. aureus* infection, followed by urinary tract infections and bacteremia (Garba *et al.*, 2024; Chukwueze *et al.,* 2022).

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However, most of these studies were from the South-West, North-Central, and North-West zones of Nigeria (Olorunfemi *et al.,* 2021; Manga *et al.,* 2021), while there is still paucity of data in the North-East, especially in Gombe State.

The North-East region has faced significant healthcare challenges, including neglected infrastructure and limited surveillance systems (Gloria & Rwang 2020; Ibrahim *et al.* 2021). These factors, coupled with socioeconomic challenges, contribute to the lack of research focus on bacterial pathogens in the region. Consequently, the true burden of *S. aureus* infections in the region remains largely undocumented.

Therefore, this study was undertaken to determine both the genotypic and phenotypic prevalence and to characterize the clinical spectrum of *Staphylococcus aureus* infections in Gombe, a Northeastern state in Nigeria. Being among the peculiar research with these characteristics from Gombe, the research addresses an important epidemiological gap and offers evidence that can update antibiotic stewardship programs and infection prevention strategies.

Materials and Methods

Samples Collection

A total of 400 non-repetitive clinical samples were collected from the patients in medical microbiology units of the FTH. These included wound swabs, urine, blood, high vaginal swabs (HVS), seminal fluid, and cerebrospinal fluid (CSF). All the samples were appropriately and aseptically collected by qualified medical laboratory staff and were properly labeled.

To preserve sample integrity, the samples were immediately transported on an ice pack and delivered to the Department of Pharmaceutical Microbiology Laboratory, Gombe State University, for processing.

Isolation and Identification of *Staphylococcus aureus*

Each sample was inoculated on Nutrient Agar (NA) and incubated at 37 °C for 24 h. Discrete colonies from purified cultures were selected and sub-cultured on Mannitol Salt Agar (MSA) selective for *S. aureus* (Hamza *et al.,* 2021).

Gram-staining and microscopy

Gram staining of the isolates was performed as described by Cheesbrough (2000). A smear of the isolate was prepared on a clean, grease-free slide. The smear was heat-fixed and stained with crystal violet, then allowed to stand for 60 seconds, afterward rinsed gently with water. The smear was then mixed with Lugol's iodine solution for 60 seconds, decolorized rapidly with ethanol, washed immediately with distilled water, and counterstained with safranin for 2 min. The stained slide was examined under an oil-immersion lens with microscope and the isolates that appeared as purple cocci in clusters was selected for further biochemical identification procedures.

Biochemical Tests

The biochemical tests such as catalase, coagulase, were carried out on the pure isolates recovered using methods described by Cheesebrough (2000).

Catalase Test

Catalase test was demonstrated by the addition of 1mL of a 3% hydrogen peroxide solution on a 24 hours nutrient agar slope culture of the isolates. This test was performed on all suspected isolates, where production of gas indicated a catalase-positive reaction, while the absence of gas indicated a catalase-negative result.

Coagulase Test

To detect coagulase, a drop of physiological saline was placed at both end of a slide. A colony of the test organisms was emulsified in each drop to make two separate thick suspensions. A drop of plasma was then added to one of the suspensions and mixed gently, the ability or inability to form clumping within 10 seconds was an indication of coagulase positive or coagulase negative respectively

Molecular Confirmation of the Isolates

Genomic DNA was extracted from presumptive *S. aureus* isolates using a Qiagen DNA extraction kit, following the manufacturer's protocol and recommendations. PCR amplification targeted the *nuc* gene, a reliable marker specific to *S. aureus*. Each reaction mixture (25 µL) contained PCR master mix, forward and reverse primers, template DNA, and nuclease-free water.

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The PCR condition involve pre-denaturation at 95 °C for 5 min, followed by 35 cycles of denaturation at 95 °C for 15 s, annealing at 55 °C for 15 s, and extension at 72 °C for 30 s, followed by a final extension at 72 °C for 5 min. The amplified products were separated on 1% agarose gel electrophoresis, stained with ethidium bromide, and visualized under UV illumination at 270BP. The forward and reverse primer sequences used were GCGATTGATGGTGATACGGTT and AGCCAAGCCTTGACGAACTAAAGC respectively (Juwita et al., 2022)

Results

The result of the prevalence *Staphylococcus aureus* from the study is presented in Figure 1, Out of the 400 samples, only 70 isolates were identified as *Staphylococcus aureus*, representing a prevalence of 17.5%

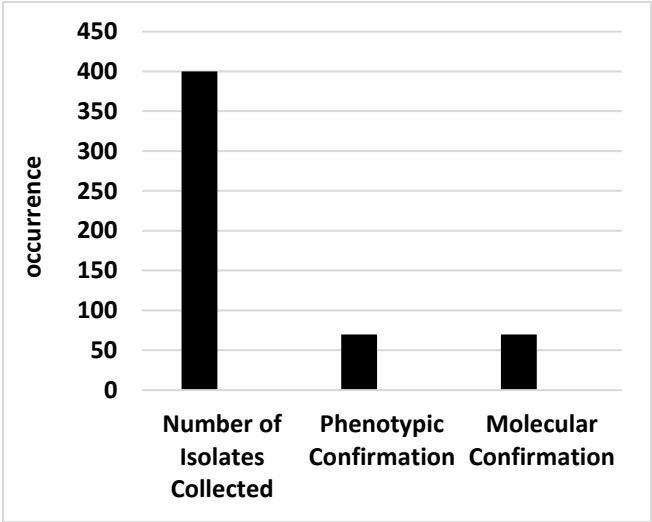

Fig. 1: Identification and Molecular Confirmation of *Staphylococcus aureus* Isolates

The 70 isolates identified as *S. aureus* were further confirmed as *S. aureus* based on the genotypic confirmation as shown in Figures 2- 6 using the *Staphylococcus nuc gene*.

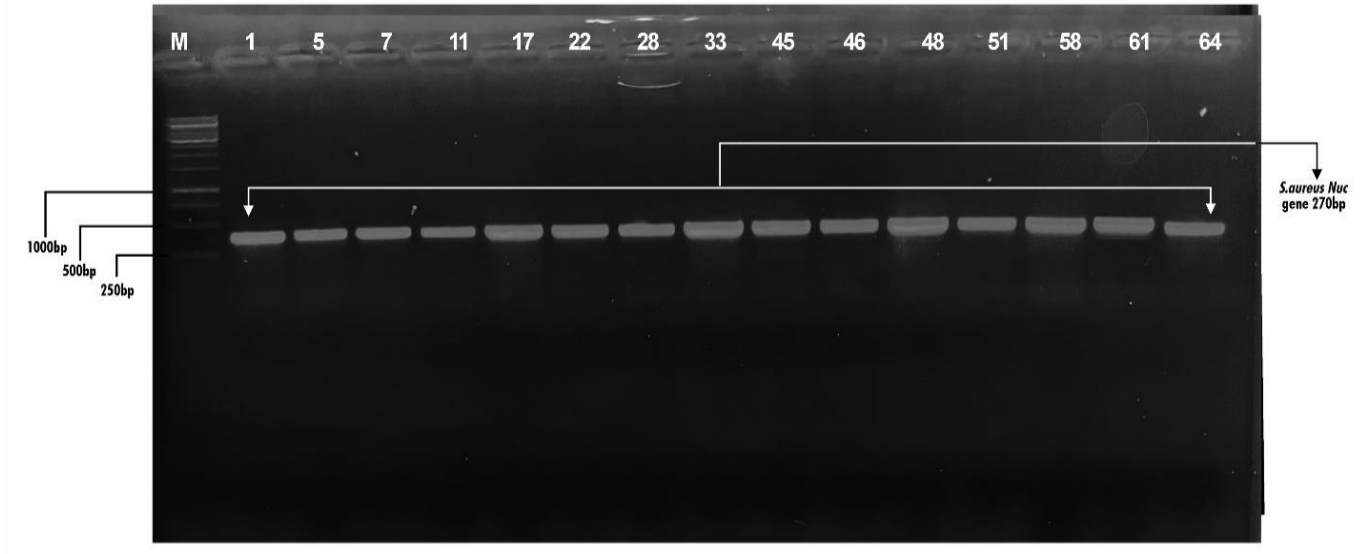

Figure 2: Nuc gene (270bp) of S. aureus on 1% (w/v) agarose gel
Lane M: Molecular Lader, Lane 1, 5, 7, 11, 17, 22, 28, 33, 45, 46, 48, 51, 58, 61,64: *Staphylococcus aureus* Isolates

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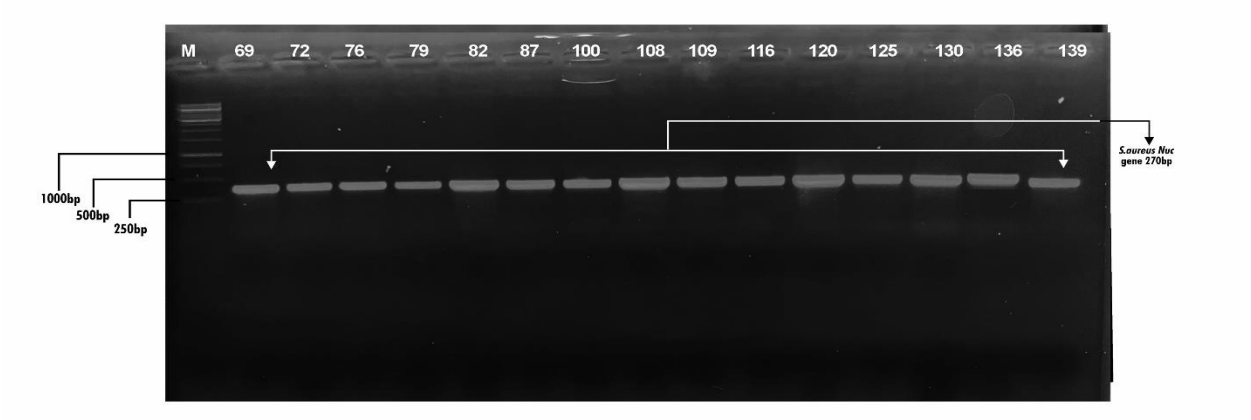

Figure 3: Nuc gene (270bp) of S. aureus on 1% (w/v) agarose gel

Lane M: Molecular Lader, Lane: 69, 72, 76, 79, 82, 87, 100, 108, 109, 116, 120, 125, 130, 136,139: *Staphylococcus aureus* Isolates

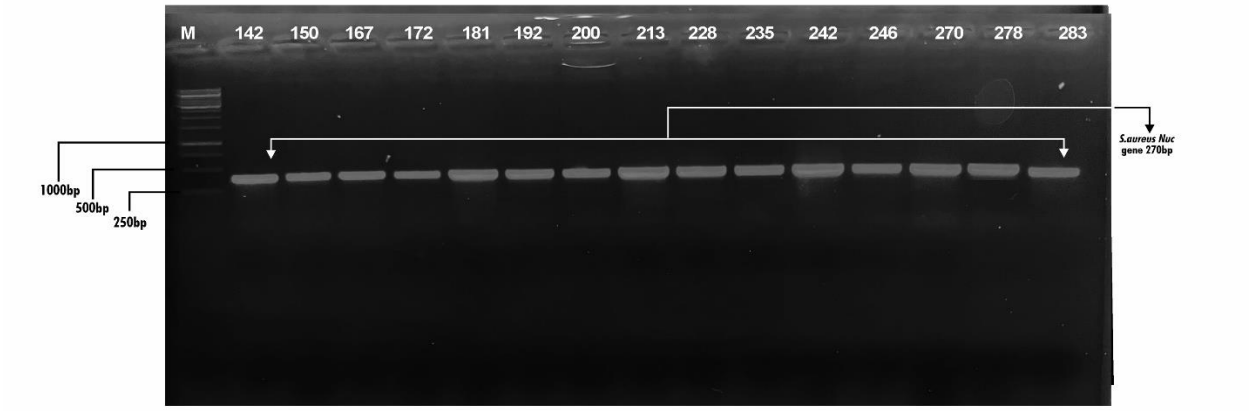

Figure 4: Nuc gene (270bp) of S. aureus on 1% (w/v) agarose gel

Lane M: Molecular Lader, Lane: 142, 150, 167, 172, 181, 192, 200, 213, 228, 235, 242, 270, 278, 283: *Staphylococcus aureus* Isolates.

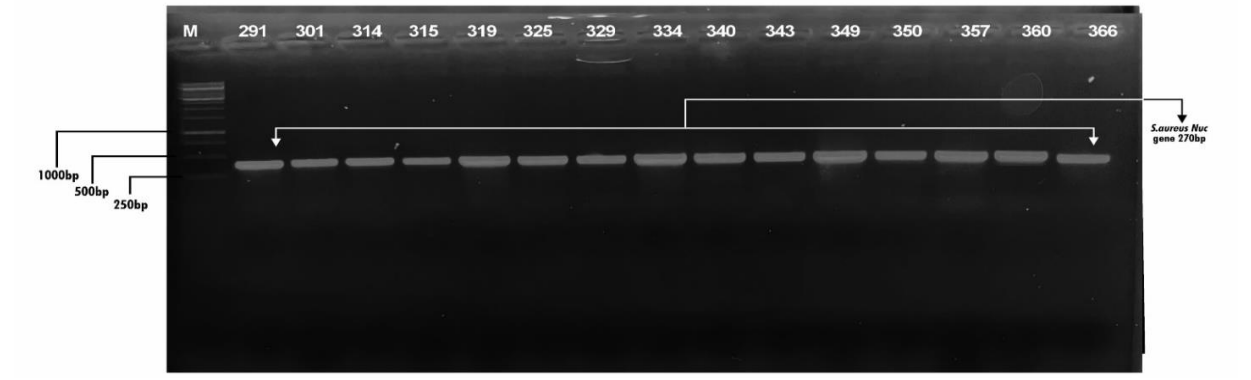

Figure 5: Nuc gene (270bp) of S. aureus on 1% (w/v) agarose gel

Lane M: Molecular Lader, Lane: 291, 301, 314, 315, 319, 325, 329, 334, 340, 343, 349,350, 357, 360, 366 : *Staphylococcus aureus* Isolates

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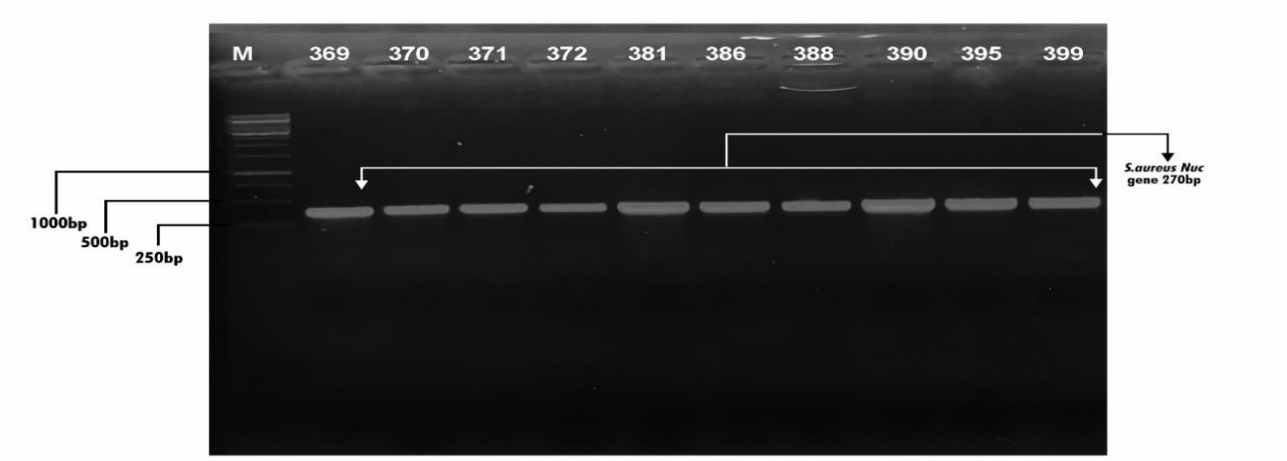

Figure 6: Nuc gene (270bp) of S. aureus on 1% (w/v) agarose gel
Lane M: Molecular Lader, Lane: 369, 370, 371, 372, 381, 386, 388, 390, 395. 399: *Staphylococcus aureus* Isolates

The distribution or occurrence of *S. aureus* varied significantly across the different clinical specimen types ($\chi^2 = 18.24$, $p = 0.03$). As summarized in Table 1, wound swabs accounted for the highest proportion of isolates (28.9%), followed by urine (21.4%) and high vaginal swabs (17.1%). Blood samples accounted for 15.7% of the total samples, while seminal and cerebrospinal fluid samples accounted for 14.3% and 2.9%, respectively.

Table 1: Distribution of *Staphylococcus aureus* Isolates in Different Clinical Samples

S/N	Sources of the Isolates	Number (Percentage Occurrence)
1	Wound	20(28.9%)
2	Urine	15(21.4%)
3	High vaginal swap	10(14.3%)
4	Seminal fluid	12 (17.1%)
5	Blood	11(15.7%)
6	Cerebrospinal fluid	2 (2.9%).
Total		**70 (100%)**

P-value = 0.03, $X^2 = 18.24$

Distribution of *S. aureus* by gender revealed that, of the 70 confirmed isolates, 39 (55.7%) were obtained from male patients and 31 (44.3%) from female patients (Table 2). Though infections appeared more predominant in males, statistical analysis showed no significant difference between the two groups ($\chi^2 = 1.83$, $p = 0.18$)

Table 2: Distribution of *Staphylococcus aureus* Isolates by Gender

S/N	Gender	Number (Percentage)
1	Male	39 (55.7%)
2	Female	31 (44.3%)
Total		**70 (100%)**

P-value = 0.18, $X^2 = 1.83$

Discussion

This study provides data on the genotypic prevalence and clinical distribution of *Staphylococcus aureus* at the Federal Teaching Hospital (FTH) Gombe, North-East Nigeria. The study identified 70 isolates of *S. aureus* from 400 clinical samples types, indicating a prevalence of 17.5%. The reported prevalence of 17.5% was also confirmed by molecular analysis using *Staph nuc* genes, highlighting the accuracy of the pre-molecular detection method. The prevalence in this study is closely similar to the findings by Ifediora *et al.* (2019), who reported a prevalence of 16.2% in Abia State, South-East Nigeria, and showed a slight difference from the 21.5% prevalence rate reported by Garba *et al.* (2024). However, the prevalence observed in our study is considerably lower than the striking 82.7% reported in Kogi State by Mofolorunsho *et al.* (2022). These variations across regions may reflect differences in sampling methods, study populations, healthcare practices, and local patterns of antibiotic use (Thuy, 2018).

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The distribution of isolates by clinical sample sources revealed that wound infections (28.9%) were the principal contributors. These findings echo previous reports from Zaria, where AbdulAziz *et al.* (2022) observed that wounds accounted for nearly half of all *S. aureus* isolates, many of which were methicillin resistant. Similarly, Chukwueze *et al.* (2022) recorded a 48.8% isolation rate from wound infections in Enugu. This varied prevalence across different parts of Nigeria highlights the continuing role of *S. aureus* in wound and surgical-site infections, making wounds a critical focus for infection prevention and control.

Urine samples accounted for 21.4% of isolates in our study which is similar with the finding by Olorunfemi *et al.* (2021) in Jos, where he reported a prevalence of 19% in urinary specimens. However, results from this present study differ from of a study conducted in Ekiti, South-West Nigeria, where Okiki *et al.* (2020) reported lower urinary isolation rates. The relatively high proportion of urinary isolates in this study suggests a potentially increasing role of *S. aureus* in urinary tract infections at the study location, which calls for closer surveillance. *S. aureus* isolated from blood samples accounted for 15.7% of isolates, a prevalence that was extremely higher than the 1.5% reported by Ifediora *et al*. (2019) in Abia, but similar to the 14.8% observed by Garba *et al.* (2024) in Kaduna. The ability of *S. aureus* to cause bacteremia is well documented, and its presence in blood samples remains concerning due to the high morbidity and mortality associated with staphylococcal bacteremia (Souli et al., 2019; McGuire et al., 2020).

Gender distribution showed a higher prevalence in males (55.7%) than females (44.3%), though the difference was not statistically significant. This observation is similar to the male predominance reported in Zaria, with 61.6% vs. 38.4% prevalence (AbdulAziz *et al.,* 2022). While biological factors may play a role, it is also possible that men in this region are more exposed to risk factors, such as a wide range of occupational injuries. Nonetheless, further studies are needed to clarify whether is a true determining factor of *S. aureus* infection risk.

The clinical significance of these results cannot be ignored. The predominance of *S. aureus* in wound and urinary samples emphasizes the need for strict infection prevention strategies in surgical and urology units.

The presence of bloodstream isolates further underscores the importance of early detection and prompt treatment to reduce the burden of this condition. Although this study focused on prevalence and clinical distribution, future analyses of antimicrobial susceptibility and resistance gene profiles (*mec*A, *mec*C, *van*A, *and van*B) are essential to fully understand the resistance landscape in Gombe. Taken together, these findings highlight the need for region-specific surveillance, as epidemiological trends can differ within the same country.

Conclusion and Recommendations

This study presents a comprehensive assessment of the prevalence of *Staphylococcus aureus* and its clinical sources in Gombe, northeastern Nigeria. Both phenotypic and genotypic methods, confirmed 17.5% of 400 clinical samples analyzed to be *S. aureus* with wound and urine samples identified as the primary sources of infection. Although males showed a slightly higher rate of infection than females, the difference was not statistically significant. The findings from this study highlight the ongoing role of *S. aureus* as a major opportunistic pathogen, particularly in wound and urinary tract infections. Importantly, the findings fills a critical gap in Nigeria's surveillance landscape by generating baseline data from regions that have been underrepresented in national surveillance efforts; thus, highlights the need for the relevant authorities to institute health education campaigns, antibiotic stewardship programs and infection prevention strategies to safe guard public health.

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