NASAL CARRIAGE OF *STAPHYLOCOCCUS AUREUS* AND THE ANTIBIOTIC RESISTANCE PROFILES AMONG HEALTH PROFESSIONS STUDENTS AT A NIGERIAN UNIVERSITY: COMPARING THE PRECLINICAL AND CLINICAL TRAINING PHASES.

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ABSTRACT

Background: **Health professions students with nasal carriage of *Staphylococcus aureus,* particularly Methicillin-resistant *Staphylococcus aureus* (MRSA), have an increased risk of endogenous infections. They could also be a source of transmission from infected patients to susceptible patients. This study compared the prevalence *Staphylococcus aureus* and MRSA nasal carriage among preclinical and clinical health professions students to assess the association of nasal carriage with exposure to the healthcare environment.**

Methods: **This was a comparative cross-sectional study where nasal swabs were collected from 151 health professions students at a Nigerian university and processed to identify *S. aureus* and perform antimicrobial susceptibility testing. Carriage among the various categories of student was determined. Demographic, clinical and personal factors associated with carriage were identified.**

Results: **The overall *Staphylococcus aureus* and MRSA nasal carriage rates were 13.9% and 6% respectively. There was a significant difference between the prevalence of *S. aureus* among preclinical students (4.9%) and clinical students (24.3%), p<0.001. The carriage rate increased significantly in relation to duration of stay in clinical school. The prevalence of MRSA though not significant, was also higher among clinical students than preclinical, 8.6% and 3.7% respectively. Nasal carriage rates were higher among students with prior history of nasal symptoms such as boils and nasal discharge, antibiotics use and suboptimal hygiene practices. Resistance to the commonly prescribed antibiotics was high.**

Conclusion: **This study demonstrates a positive association of *Staphylococcus aureus* nasal carriage with exposure to the hospital environment. Early education on adherence to infection prevention and control measures and antimicrobial stewardship is recommended coupled with consideration of students when implementing infection control activities.**

Keyword: Methicillin resistant *Staphylococcus aureus*, Antimicrobial stewardship, Infection control, Antimicrobial resistance, Colonization

INTRODUCTION

Staphylococcus aureus is commonly found in many healthy humans as commensal organism.[1] However, it has remained one of the most important pathogens, involved in a wide spectrum of conditions ranging from localized skin infections to fatal meningitis.[2] *Staphylococcus aureus* is a leading cause of healthcare-associated infections including surgical wound infections, hospital-associated pneumonia, catheter-associated infections and bacteraemia resulting in increased morbidity, mortality, healthcare expenses.[3-5] The anterior nares serve as the main and reservoir for *Staphylococcus aureus*, with an estimated 20-60% of individuals colonized by this organism.[5-7] In up to 20% of healthy individuals *Staphylococcus aureus* nasal colonization is persistent and carriage can last for days, and some cases lasts for several years.[6,8] The colonization of *Staphylococcus aureus* is influenced by the host immune response, competitive inhibition by other microbes, and selection pressure from use of antimicrobials.[8,9]

Although nasal colonization is usually asymptomatic in healthy persons, it is a major risk factor for endogenous infections. Studies have demonstrated definite links between *S. aureus* nasal carriage and subsequent infections such as skin infections and blood stream infections.[6,10] Nasal carriage is also a major vehicle for the transmission of *S. aureus* and associated infections within the community and healthcare setting where carriers can be a source of the organism to their patients leading to healthcare associated infections.[11]

This is further compounded by the emergence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) strains which are resistant to most β-lactam antibiotics.[2,12] Methicillin resistant *Staphylococcus aureus* (MRSA) is known for its potential to spread in the hospital areas and even in the community.[12] Acquisition of MRSA may result in surgical wound infections, pneumonia, urinary tract infections and life-threatening conditions such as meningitis, bloodstream infections and infective endocarditis.[13,14]

The main carriers of MRSA are healthcare workers mainly due to exposure to hospital settings and proportion of *Staphylococcus aureus* resistant to Methicillin could be as high as 90%.[15,16] Longer stay in the hospital environment increases the chance of being colonized by MRSA.[17,18] Healthcare professionals who are asymptomatic MRSA nasal carriers can become a source of hospital acquired infections which may occur as MRSA breakouts.[7,19,20] Students in the health professions represent a special group in the epidemiology of nasal carriage in health settings. As they progress from the preclinical phase of learning which is mainly classroom-based to the clinical phase of training their exposure to the hospital environment increases considerably. They receive training in different wards and units of the hospital; the intensive care unit, the surgical ward, emergency wards etc where they encounter various categories of patients, thus they can easily acquire *Staphylococcus aureus* from these patients or be the source of pathogen transmission.[21,22]

Several studies have been conducted on nasal carriage among full time health workers.[15,16] Generally, research has shown that the prevalence of *S. aureus* nasal carriage often rises as medical students progress through their training with a reported a pooled prevalence 25% among preclinical and 33% among clinical students.[23] However, despite the substantial contact that other health trainees have with the healthcare environment and the associated risks for both parties, there is scarcity of data on *S. aureus* and MRSA nasal carriage as these students transit from theoretical to clinical training. Insights into these patterns is crucial for implementing targeted infection control and antimicrobial stewardship strategies to protect both the students and the patient population. This study was carried out to assess how hospital exposure might affect nasal carriage of *Staphylococcus aureus* and MRSA among students. Thus, this study compared the prevalence *Staphylococcus aureus* and MRSA nasal carriage among preclinical and clinical health professions students to assess the association of nasal carriage with exposure to the healthcare environment.

METHODS

This was an analytical cross-sectional study conducted the University of Ibadan, a public tertiary University, located in Southwestern Nigeria. It is one of the largest Universities in the country and offers both undergraduate and post-graduate medical training. The study population were preclinical and clinical undergraduate students of Medicine and surgery, Physiotherapy, Biomedical Laboratory Science and Dentistry. The students spend the first 2-3 years of preclinical studies at the main campus of the University while the subsequent years constitute the clinical stage which takes place at the affiliated training hospital, the University College Hospital, (UCH), Ibadan.

A sample size of one hundred and fifty-two was calculated using the formula for comparing two proportions, based on a reported prevalence of nasal carriage of 37.4% and 17.6% among hospital-exposed versus non-exposed medical students.[24,25] To ensure representative distribution, proportional allocation was applied across a sampling frame that was categorized by course and level of study. Thereafter, students were randomly selected from their respective categories.

Information on demographic, clinical history and personal habits that could be associated with *Staphylococcus aureus* nasal carriage was collected by using a structured questionnaire. Nasal swabs of the participants were obtained from both nostrils by rubbing the anterior nares with the swab stick. These were transported in Trypticase Soy Broth to the Medical Microbiology laboratory, University College Hospital, Ibadan. The swab samples were inoculated onto chocolate agar and 5% sheep blood agar and processed following standard microbiology procedures[26]. Bacterial growth was identified by their colonial morphology, gram staining, catalase test and coagulase test. Antimicrobial susceptibility testing of the isolates was performed by the Kirby–Bauer disc diffusion method using Ciprofloxacin(5μg), Erythromycin (15μg), Clindamycin(2μg), Gentamicin (10μg), and Levofloxacin (5μg). Methicillin resistant *Staphylococcus aureus* (MRSA) was identified by resistance to cefoxitin (30 μg) defined as isolates with

a zone size of d"21mm on disc diffusion method.[27] Data entry and analysis was done using the SPSS version 25 software package. Descriptive analysis of the data was presented in frequency tables and charts while and Chi- square test was done to assess association between participants characteristics and *Staphylococcus aureus*/ MRSA nasal carriage. Level of significance of p ≤0.05 was considered as statistically significant.

Ethical considerations

This research was approved by the University of Ibadan/University College Hospital (UI/UCH) Ethics review board with approval number UI/EC/21/0652. Informed consent was obtained from all participating students.

RESULTS

A total of 151 students participated in this study with an age range of 17-27 years while the mean age was 21.6 +/-2.1 years. Of these, 113 (74.8%) were male and 38 (25.2%) were female. The highest proportion of students were in their first year of study (28.5%) and least in the 6th year (6.6%) in accordance with student distribution (Table 1). The study population had 81 (53.6%) preclinical students and 70 (46.7%) clinical students. Of the clinical student population, the proportions in the first, second, third and fourth year of clinical studies were 22.9%, 37.1%, 25.7% and 14.3% respectively. Majority of the students were studying Medicine and Surgery (87, 57.7%) while the others were Biomedical Laboratory Science students (32, 21.2%), Dentistry students (12, 7.9%) and Physiotherapy students (20, 13.2%). Table 1 shows the sociodemographic characteristics of study participants (Table 1).

The overall carriage rate of *Staphylococcus aureus* in this study was 13.9% (21/151). Four (4.9%) nasal carriages were detected from preclinical students while the remaining 17 (24.3%) were from clinical students X_2 11.74, $p < 0.001$ (Table 2). The highest rate of carriage was found among the medical students (18.4%) followed by physiotherapy students (10%) then Biomedical laboratory science students (9.4%) whereas among the dental students, no nasal carriage was detected (Table 2). Methicillin resistance was identified in 9 of the 21 (42.9%) *Staphylococcus aureus* isolates giving an overall 6% prevalence of MRSA nasal carriage among all students. MRSA nasal carriage among medical students was 6.9% closely followed by the BMLS students 6.3%. The prevalence of MRSA among preclinical and clinical students was 3.7% and 8.6% (6/75) respectively, however this was not statistically significant X^2 1.59, p= 0.304 (Table 2).

Table 1: Sociodemographic characteristics of participants (n =151)

Characteristics	n	%		
Age				
≤18	7	4.6	Mean 21.5	SD 2.1
19	24	15.9		
20	20	13.2		
21	31	20.5		
22	17	11.3		
23	17	11.3		
24	20	13.2		
≥25	15	9.9		
Sex				
Male	113	74.8		
Female	38	25.2		
Marital status				
Single	146	96.7		
Married	5	3.3		
Occupation				
Full time student	111	73.5		
Self Employed	34	22.5		
Employed	6	4.0		
Religion				
Christianity	124	82.1		
Islam	23	15.2		
Others	2	1.3		
Course of study				
BMLS	32	21.2		
Dentistry	12	7.9		
Medicine	87	57.7		
Physiotherapy	20	13.2		
Level of study				
100	43	28.5		
200	38	25.2		
300	16	10.6		
400	26	17.2		
500	18	11.9		
600	10	6.6		
Stage of study				
Preclinical	81	53.6		
Clinical	70	46.4		
Duration as clinical student (n=70)				
Year 1	16	22.9		
Year 2	26	37.1		
Year 3	18	25.7		
Year 4	10	14.3		
Total	**151**			

Tables 3-5 show the various characteristics of the students and explores their associations with *Staphylococcus aureus* nasal carriage. There was a general rise in prevalence of nasal carriage with age and as the academic level increased, peaking at 600 level. This association was statistically significant for academic level ($p<0.0001$); however, it was not so with the age of participants ($p=0.240$) (Table 3). There was no difference in *S. aureus* nasal carriage between the male and female gender (74.8 vs 75.2). Although isolation

Table 2: Prevalence of *staphylococcus aureus* and methicillin-resistant *staphylococcus aureus* (MRSA) nasal carriage among preclinical and clinical students

Course	Preclinical		Clinical		Total		X^2	p-value
	Yes n, %	No n, %	Yes n, %	No n, %	Yes n, %	No n, %		
Staphylococcus aureus								
Nasal carriage								
BMLS	0, 0	12, 100	3, 15	17, 85	3, 9.4	29, 90.6		
Dentistry	0, 0	5, 100	0, 0	7, 100	0, 0	12, 100		
Medicine	4, 7.3	51, 92.7	12, 37.5	20, 62.5	16, 18.4	71, 81.6		
Physiotherapy	0, 0	9, 100	2, 18.2	9, 81.8	2, 10	18, 90		
Total	4, 4.9	77, 95.1	17, 24.3	53, 75.7	21, 13.9	130, 86.1	11.74	<0.001
MRSA Nasal carriage								
BMLS	0, 0.0	12, 100	2, 10	18, 90	2, 6.3	30, 93.8		
Dentistry	0, 0.0	5, 100	0, 0.0	7, 100	0, 0.0	12, 100		
Medicine	3, 5.5	52, 94.5	3, 9.4	29, 90.6	6, 6.9	81, 93.1		
Physiotherapy	0, 0.0	9, 100	1, 9.1	10, 90.9	1, 5.0	19, 95.		
Total	**3, 3.7**	78, 96.3	6, 8.6	64, 91.4	9, 6.0	142, 94.0	1.59	0.304

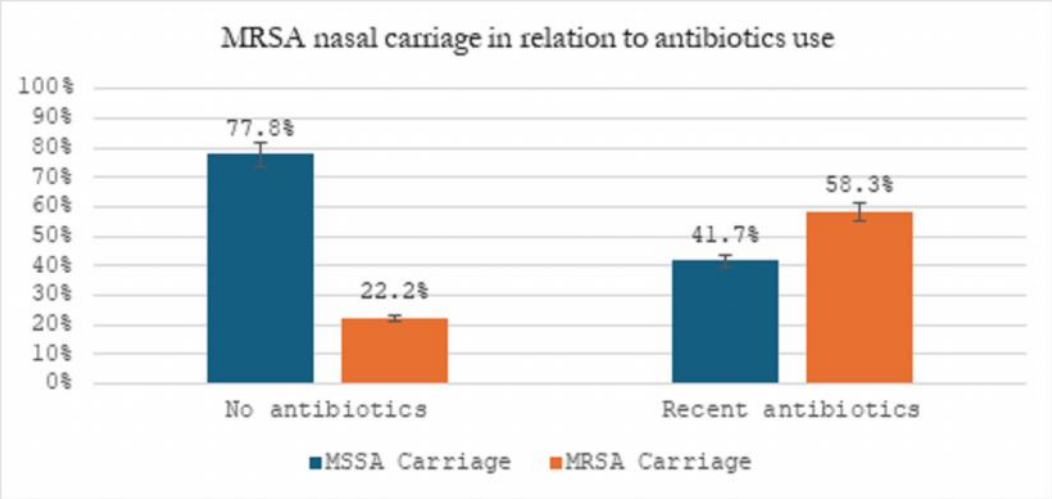


Figure 1: MRSA nasal carriage in relation to antibiotics use among students

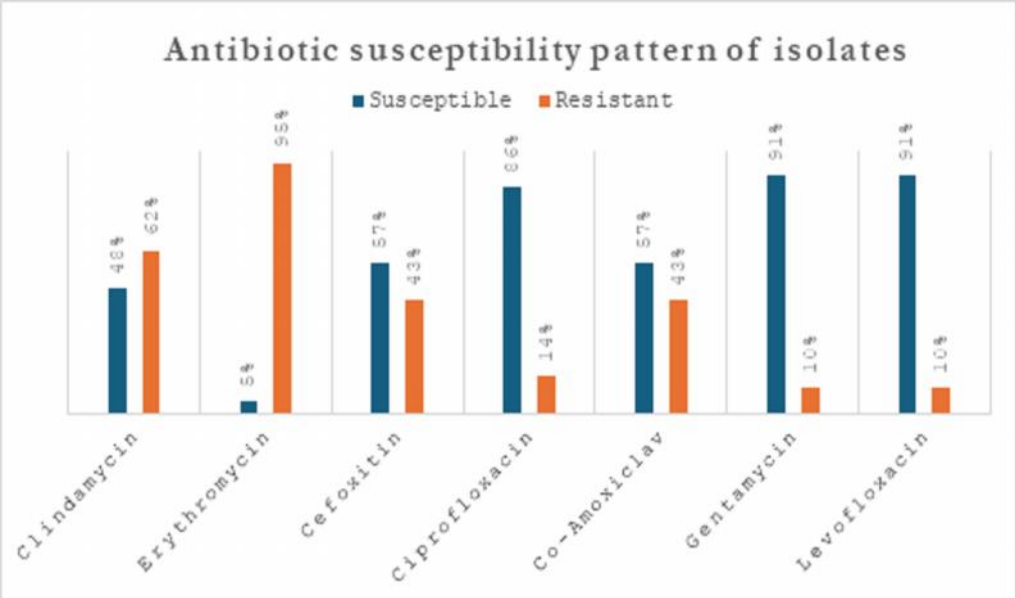


Figure 2: Antibiotic susceptibility pattern of *Staphylococcus aureus* nasal carriage isolates

Table 3: Demographic factors and association with *staphylococcus aureus* nasal carriage.

Characteristics	No (n, %)	Yes (n, %)	Total (n, %)	X^2	p-value
Age of participants					
18	7, 100	0, 0	7, 4.6	9.176	0.240
19	22, 91.7	2, 8.3	24, 15.9		
20	18, 90.0	2, 10.0	20, 13.2		
21	26, 83.9	5, 16.1	31, 20.5		
22	17, 100	0, 0 .0	17, 11.3		
23	14, 82.4	3, 17.6	17, 11.3		
24	15, 75.0	5, 25.0	20, 13.2		
≥25	11, 73.3	4, 26.7	15, 9.9		
Gender					
Male	98, 86.7	15, 13.3	113, 74.8	0.150	0.787
Female	32, 84.2	6, 15.8	38, 75.2		
Department					
BMLS	29, 90.6	3, 9.4	32, 21.2	4.203	0.24
Dentistry	12, 100.0	0, 0.0	12, 7.9		
Medicine	71, 81.6	16, 18.4	87, 57.7		
Physiotherapy	18, 90.0	2, 10.0	20, 13.2		
Stage of study					
Preclinical	77, 95.1	4, 4.9	81, 53.6	11.739	0.001
Clinical	53, 75.7	17, 24.3	70, 46.4		
Level					
100	41, 95.3	2, 4.7	43, 28.5	34.165	0.00
200	36, 94.7	2, 5.3	38, 25.2		
300	15, 93.8	1, 6.3	16, 10.6		
400	21, 80.8	5, 19.2	26, 17.2		
500	14, 77.8	4, 22.2	18, 11.9		
600	3, 30.0	7, 70.0	10, 6.6		
Duration as a clinical student (n=70)					
Year 1	15, 93.8	1, 6.3	16, 22.9	14.59	0.002
Year 2	21, 80.8	5, 19.2	26, 37.1		
Year 3	14, 77.8	4, 22.2	18, 25.7		
Year 4	3, 30.0	7, 70.0	10, 14.3		

Table 4: Clinical factors and association with *staphylococcus aureus* nasal carriage.

Characteristics	No (n, %)	Yes (n, %)	Total (n, %)	X^2	p-value
Recent nasal swelling					
No	118, 86.1	19, 13.9	137, 90.7	0.002	0.966
Yes	12, 85.7	2, 14.3	14, 9.3		
Recent boil in the nose					
No	121, 88.3	16, 11.7	137, 90.7	6.129	0.013
Yes	9, 64.3	5, 35.7	4, 9.3		
Recent crusting in the nose					
No	114, 87.0	17, 13.0	131, 86.8	0.715	0.398
Yes	16, 80.0	4, 20.0	20, 13.2		
Recent oozing nasal lesions					
No	101, 84.9	18, 15.1	119, 78.8	0.697	0.404
Yes	29, 90.6	3, 9.4	32, 21.2		
Recent fever					
No	35, 83.3	7, 16.7	42, 27.8	0.370	0.543
Yes	95, 87.2	14, 12.8	109, 72.2		
Recent diagnosis of respiratory infection					
No	119, 86.9	18, 13.1	137, 90.7	0.729	0.393
Yes	11, 78.6	3, 21.4	14, 9.3		
Recent antibiotics use					
No	62, 87.3	9, 12.7	71, 47.0	0.170	0.680
Yes	68, 85.0	12, 15.0	80, 53.0		
Recent hospital admission					
No	101, 84.9	18, 15.1	119, 78.8	0.697	0.404
Yes	29, 90.6	3, 9.4	32, 21.2		
Total	**130, 86.1**	**21, 13.9**	**151, 100**		

Table 5: Personal hygiene and living condition factors and association with *Staphylococcus aureus* nasal carriage

Characteristics	No (n, %)	Yes (n, %)	Total (n, %)	X^2	p-value
Nose picking					
Frequent	20, 80.0	5, 20.0	25, 16.6	0.929	0.335
Occasional/Rarely	110, 87.3	16, 12.7	126, 83.4		
Excessive nose blowing					
Frequent	31, 79.5	8, 20.5	39, 25.8	1.916	0.166
Occasional/Rarely	99, 88.4	13, 11.6	112, 74.2		
Plucking of nostrils hair					
Frequent	19, 82.6	4, 17.4	23, 15.2	0.275	0.600
Occasional/Rarely	111, 86.7	17, 13.3	128, 84.8		
Hand hygiene before leaving room					
Occasional/Rarely	73, 83.0	15, 17.0	88, 58.3	1.735	0.188
Frequent	57, 90.5	6, 9.5	63, 41.7		
Hand hygiene on return to room					
Occasional/Rarely	86, 84.3	16, 15.7	102, 67.5	0.831	0.362
Frequent	44, 89.8	5, 10.2	49, 32.5		
Hand hygiene after handshake					
Occasional/Rarely	99, 85.3	17, 14.7	116, 76.8	0.234	0.629
Frequent	31, 88.6	4, 11.4	35, 23.2		
Hand hygiene after sneezing					
Occasional/Rarely	90, 85.7	15, 14.3	105, 69.5	0.041	0.839
Frequent	40, 87.0	6, 13.0	46, 30.5		
Participation in sporting activities					
No	44, 84.6	8, 15.4	52, 34.4	0.145	0.704
Yes	86, 86.9	13, 13.1	99, 65.6		
Living in a hostel					
No	35, 92.1	3, 7.9	38, 25.2	1.53	0.216
Yes	95, 84.1	18, 15.9	113, 74.8		
Living with roommates					
No	14, 82.4	3, 17.6	17, 11.3	0.224	0.636
Yes	116, 86.6	18, 13.4	134, 88.7		
Multiple roommates					
No	98, 84.5	18, 15.5	116, 76.8	1.083	0.298
Yes	32, 91.4	3, 8.6	35, 23.2		
Total	**130, 86.1**	**21, 13.9**	**151, 100**		

rates varied by department the differences were not statistically significant. The clinical students had almost five times the carriage rate of preclinical students and the association was significant (X^2-11.74, p=0.001) (Table 3). The clinical feature associated with *S. aureus* nasal carriage in this population was a history of recent boil in the nose X^2-6.129, p=0.013. Students with history of other symptoms such as nasal swelling, nasal discharge and fever, generally had a higher prevalence of carriage, however, these were not significant (X^2 - 0.393 p=0.996) (Table 4). Students who habitually picked their nostrils and those who engaged in excessive nose blowing had a higher nasal carriage rate though these associations were not significant. Also, students who practiced regular hand hygiene had a generally lower rate of S. aureus nasal carriage (Table 5). The prevalence of MRSA nasal carriage was higher among those who reported a history of recent antibiotics use (Figure 1).

DISCUSSION

This study evaluated the influence of exposure to the hospital environment on the prevalence and *Staphylococcus aureus* and MRSA nasal carriage by comparing preclinical and clinical students at a university. The overall carriage rate of *Staphylococcus aureus* among all participants was 13.9% which is a relatively low prevalence considering that the general population globally has 20- 60% rate of nasal carriage.[5,7] Studies in Nigeria have focused on participants in healthcare settings thus there is paucity of data specific to the Nigerian general population. In support of our finding, Taqveem *et al* also reported a similar low prevalence of 14% among their medical students.[28] However, most articles have reported much higher rates while only a few had lower prevalences showing a wide variation in carriage rates from 8 – 34.6%.[29-32]

We observed a significant increase in the burden of *Staphylococcus aureus* nasal carriage as the students

transited from the preclinical to clinical phase of training with the clinical students having almost 5 times the nasal carriage rate of preclinical students (24.3% vs 4.9%). The hospital environment serves as a reservoir for various pathogens including *S. aureus* thus exposure to such settings is a high risk for acquisition of microorganisms.[9] In addition, the clinical phase is marked by high contact with patients who often harbour infectious agents, and the students also have regular interactions with healthcare workers, who are recognised vectors of healthcare associated pathogens.[15] On the other hand, the nasal carriage of preclinical students is expected to reflect the community carriage rate which is usually lower than the healthcare rates. An earlier study in the same region among only medical students reported similar observation that clinical students had about two and half time the nasal carriage of preclinical students (14% vs 6%) which was much lower than ours.[31] Prior reports such as that by Zakai *et al.* and others have linked frequent hospital exposure with *S. aureus* nasal colonization.[9,21,33] Our observation thus aligns with local and global studies on colonization of hospital exposed versus hospital naïve healthcare students, corroborating the role of the exposure to healthcare environment in promoting nasal carriage among students. It was not surprising to discover that the highest rate of carriage was found among the medical students compared to other professions and this might be due a higher contact rate with patients and the healthcare environment. A similar finding was reported by Okamo *et al.,* among their study population.[29] Another striking observation in our study was a directly proportional increase colonization as the number of clinical years increased and this was statistically significant. By the sixth year of medical school, nasal carriage was a very high rate of 70%. Our finding is consistent with the perception that an important predictor of *Staphylococcal aureus* nasal colonization is the duration of time in the clinical environment.[17,18]

Among our participants, *S. aureus* nasal carriage was significantly higher in those with a history of recent boil in the nose. We also observed that prevalence of carriage was higher among students with history of nasal swelling, nasal crusting, respiratory tract infection, hospitalization. Although these differences were not significant, our findings support some of the risk factors for carriage.[7] We were unable to demonstrate any differences in carriage rates for other for other symptoms investigated, likely because of our limitation of small sample size. Students who habitually picked their nostrils and those who engaged in excessive nose blowing had a higher nasal carriage rate. On the contrary, students who practiced regular hand hygiene had lower nasal carriage rates. Although these associations were not significant, they support studies that have linked behavioural and personal hygiene factors such as poor hand hygiene practices and inadequate wound care with *S. aureus* nasal carriage.[15,34] Regular education on adopting good personal hygiene habits and the importance of hand hygiene in the prevention and control of infections can therefore not be overemphasized. Various studies have observed difference in nasal carriage between genders and while some such as Hogan *et al.* report a higher female predisposition, others report a male dominance.[33,35] Our study however did not observe any difference in *S. aureus* nasal carriage between the male and female genders.

We detected Methicillin resistance in close to half of the *Staphylococcus aureus* isolates giving an overall prevalence of MRSA nasal carriage among all students to be 6%. This was not surprisingly highest among medical students (6.9%) and closely followed by the BMLS students 6.3% who likely to be exposed to clinical samples sent for laboratory investigation. Reyes *et al.* and Juneja *et al.,* reported MRSA carriage of 8.4% and 9% respectively among their medical students while much lower rates have been reported by Chen *et al.,* (1.9%) in Taiwan, Bellows *et al.,* (3.2%) in New Orleans and 2.4% by Al-Tamimi.[22,30,33,36,37] The observed trend in data is reflective of the global rising antimicrobial resistance rates as more recent studies generally reported higher resistance rates than the earlier studies. In keeping with this trend, an earlier study in Nigeria conducted over 15 years ago, did not find any MRSA in their study population.[38]

Our study showed a significantly higher prevalence of MRSA among clinical students who had a prevalence of 8.6% compared to the 3.7% rate among preclinical students. Our finding agrees with Bellows and colleagues who observed that exposing students to a hospital clinical rotation increased the prevalence of MRSA nasal carriage from 0 to 3.2% while Slifka *et al.* in the United States observed a prevalence of 3.4% MRSA carriage among students with healthcare associated exposure against the 2.1% among those without such exposure.[22,39] Another study reported a high prevalence of 21% carriage of MRSA among clinical students, but no preclinical students harboured MRSA[40]. Our observed rate is high when compared with a similar study within the country which reported 1% and 4% among the preclinical students and the clinical students respectively.[31]

One study found MRSA nasal carriage in only one of their participants who was surprisingly a preclinical student. However, this student had worked in a hospital before enrolling for medical training and could have

acquired the resistant pathogen in the healthcare environment.[29] This report reiterates the role of healthcare exposure in MRSA nasal carriage.

Antibiotic use has been constantly linked with antibiotic resistance mainly as a result of selective pressure.[41] Our study findings support this as the prevalence of MRSA nasal carriage among those who reported a history of recent antibiotics use was almost three times that of students who did not have such history. A limitation to our study was the inability to explore factors associated with MRSA nasal carriage due to the small size of the positive cases. Further studies with much larger sample sizes are recommended.

We found a high prevalence of resistance to the tested antibiotics particularly erythromycin and clindamycin as also noted by Shih *et al.*[18] Erythromycin and clindamycin which are antibitics usually given in cases of penicillin sensitivity, furthermore clindamycin is an option for some MRSA infections thus the high resistance observed limits treatment options.[42] The isolates were however mostly susceptible to Levofloxacin.

CONCLUSION

This study demonstrates a strong association between nasal carriage of *Staphylococcus aureus* and MRSA in the clinical phase of training among health professions students. We therefore recommend early education of these students by incorporating trainings on adherence to infection prevention and control (IPC) practices and the importance of antimicrobial stewardship in limiting the spread of antibiotic-resistant organisms into the undergraduate curriculum. The role of students as potential reservoirs should be considered when planning infection control activities that target the workforce in the healthcare environment.

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Conflict of interest

All authors declare that there is no conflict of interest with respect to the preparation and publication of this article.

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