



Nasal Carriage of *Staphylococcus aureus* among staff and Students of University of Sciences and Technology, Aden-Yemen

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ABSTRACT:

Background: Colonization of human nose by *Staphylococcus aureus* represent up to 30% of the human population. *S. aureus* must defeats the host's defense mechanisms in order to colonize the nasal epithelial cells of human. Some factors such as bacterial interaction in human nose can prevent such colonization.

Aim: The aim of current study was to determine the prevalence of nasal colonization by *S. aureus* among the staff and students of University of Science & Technology, Aden; as well as the associated risk factors for nasal carriage.

Subjects and Methods: The type of study was an institution-based cross-sectional study which performed during the period from January to March 2020. The total samples were 1030 nasal swabs obtained from all the staff and students, the specimens were transported to the laboratory and the swabs were processed within 4 hrs. of collection.

Results: The mean age of the study sample was 21.4 (± 5.8 SD). The prevalence *S. aureus* isolated from nasal carriages was 31%. *S. aureus* nasal carriage show high frequency among age group 27-36 (32.4%) followed by those at age of 17-26 years (31%), however, there was no a statistically significant association in relation to the age groups ($P=0.9$). Regarding gender, it was considered a risk factor. *S. aureus* more common in male than female. The pattern of sleep, smoking, and frequent touching the nose were statistically associated with the *S. aureus* nasal colonization. Those who had nasal sensitivity was considered risk factor (RR=1.3) but with non-significant association with *S. aureus* nasal colonization ($P=0.4$).

Conclusion: The current study revealed that community acquired was the potential colonizers of *S. aureus*. With the prevalence of 31% of the study sample, age, gender, and smoking, and other were potential risks. Regular screening of carriers is required for prevention of community acquired infections.

Keywords: Nasal carriage, *Staphylococcus aureus*, colonization, Coagulase positive, Aden.

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1. Introduction:

Staphylococcus aureus constantly colonizing 20-30% of the adult population, and also act as an invasive pathogen. Infection was often preceded by *S. aureus* nasal carriage. The emergence and spread of antimicrobial resistance as well as the increasing numbers of immunocompromised patients make treatment of the infection increasingly difficult. Factors predisposing to *S. aureus* nasal carrier may give new clues to host-microbe-environmental interactions of importance to the carrier state, thus contributing significantly to reducing *S. aureus* disease burden. ⁽¹⁾

Staphylococcus aureus frequently infect the community & hospital. The increased resistance of *S. aureus* to various antibiotics make the treatment of such pathogen more complicated. Therefore, urgent & effective measures are needed to prevent *S. aureus* infections. Nasal carriers of *S. aureus* act as a source of spreading of infection to others within the community or hospitals and eradication of *S. aureus* from such site prevents infection mainly in specific patients e.g., hemodialysis and general surgical patients. However, randomized clinical trials in non-surgical and orthopedic patients were failed to show the effectiveness of eliminating *S. aureus* from the nose in order to prevent subsequent infection. ⁽²⁾

S. aureus nasal carriage and infection by this pathogen having a causal relationship, this was supported by the fact that strain of nasal *S. aureus* and the infecting strain share the same phage type or genotype. ^(3, 4) The use of anti-staphylococcal drug lead to decolonization of this pathogen from the nose and other body sites so infection could be prevented. ⁽⁵⁾

In our study the prevalence of *S. aureus* nasal carriage was evaluated among the study

sample. The specimens were obtained from the staff and students of the university. Demographic and clinical data were collected using a preformed and structured questionnaire.

Justification of the study:

The risk proportion of *S. aureus* infection was increased in nasal carriers with this pathogen. To develop preventive measures, it is important to study the prevalence of *S. aureus* nasal carriage.

Aim of the study: The aim of the current study was to determine the prevalence of nasal carriers of *S. aureus* among the students and staff of the University of Science and Technology, Aden; as well as to determine the associated risk factors for nasal carriage. The study protocol was approved by the Medical Research Ethics Committee of the University of Sciences and Technology, Aden, (No. MEC/AD001).

2. Subjects and Methods:

The type of study was institution based cross sectional study which performed during the period from January to March 2021. The total samples were 1030 nasal swabs obtained from all the staff and students of the University Science and Technology, Aden. Antibiotics users within the last 2 weeks were excluded from the study. The swabs were moistened with a sterile normal saline, carefully inserted into each nostril and gently rolled for 5-6 times. The specimens were transported to the laboratory and the swabs were processed within 4 hrs. of collection. ⁽⁶⁾ The swabs were inoculated onto different media such as: Blood agar (with 5 - 7% defibrinized blood), Nutrient agar, Mannitol salt agar, Deoxyribonuclease (DNase) agar, and incubated aerobically for 18 to 24 hours at 37°C. Colonial morphology, microscopic appearance on gram stained smears and biochemical tests were used for the identification of the isolates. ^(7, 8)



Statistical analysis:

Data were collected, revised, entered and analyzed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistical analysis was performed to present the sample characteristics. The association was studied by Pearson’s Chi-square test. P. value was considered significant when the test result was ≤ 0.05 .

3. Results:

The total staff and students of the University of Sciences and Technology, Aden were 90 and 1755, respectively. The total samples were all the staff and the students at the University of Sciences and Technology, Aden; represented 1845; out of them 191 those were used antibiotics at the last 2 weeks, and 210 of them were refused to participate in the study and 414 were not found during obtaining of the specimen. However, the final nasal swabs obtained was 1030.

Out of 1030 staff and students of the University of Sciences and Technology, Aden, the mean age was 21.4 (± 5.8 SD), **Table (1)**.

Table 1: Descriptive Statistics of Age (Years):

	Mean	SD	Minimum	Maximum	Range
Age (Years)	21.4	± 5.8	17	54	37

The frequency and percentage of gender was represented in the pie chart below.

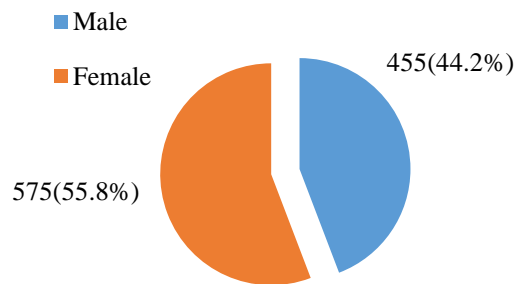


Figure 4.1: Percentage of Gender.

The prevalence of isolated *S. aureus* and other bacteria has been evaluated. Out of 1030, the prevalence of *S. aureus* isolated from nasal

carriages was 31%, the prevalence of the other categories is presented in Table (2).

Table 2: The Frequency and Percentage of isolated *S. aureus* and other bacteria.

Isolated Bacteria	Frequency	Percent
Coagulase Positive <i>S. aureus</i>	319	31%
Coagulase Negative Staphylococcus	434	42.1%
Gram Negative bacilli	159	15.4%
No bacteria Isolated	118	11.5%
Total	1030	100%



All the bacteria that are Gram positive cocci (GPC), Coagulase negative and those are gram negative bacteria as well as the cases which

show no bacteria as one group to compare their frequency with the GPC, Coagulase positive *S. aureus* in Table (3).

Table 3: The Frequency and Percentage of bacterial groups among the study sample.

	Frequency (%)
All Bacteria other than Coagulase Positive <i>S. aureus</i> or No Bacteria	711 (69%)
Coagulase Positive <i>S. aureus</i>	319 (31%)
Total	1030 (100%)

The frequency of the associated variables was evaluated, the frequency of risk factors such as

marital status, hospital admission, smoking, etc., are shown in Table (4).

Table 4: The Frequency of Various Variables (Evaluated Risk Factors).

Marital state	Frequency (%)	DW-HCWs	Frequency (%)	Admitted in Hospital	Frequency (%)
Single	912 (88.5%)	Yes	211 (20.5%)	Yes	148 (14.4%)
Married	118 (11.5%)	No	819 (79.5%)	No	882 (85.6)
Sleeping Pattern	Frequency (%)	Smoking	Frequency (%)	Touching Nose	Frequency (%)
Sleep alone	678 (65.8%)	Yes	23 (2.2%)	Yes	779 (75.6%)
Sleep with Others	352 (34.2%)	No	1007 (97.8%)	No	251 (24.4%)
Sensitive Nose		Frequency (%)			
Yes		64 (6.2%)			
No		966 (93.8%)			

DW-HCWs: Deal with Health Care Workers.

The association of various risk factors with *S. aureus* was evaluated, the association of age groups with the GPC-Coagulase Positive *S. aureus* and the frequency of each age groups are

shown in Table 5 and 6. The association of the all other risk factors with Coagulase Positive *S. aureus* are shown in Table (7).

Table 5: The Frequency of Age Group:

Grouped Age (Years)	Frequency (%)
17-26	973 (94.5%)
27-36	34 (3.3%)
37-54	23 (2.2%)
Total	1030 (100%)

Table 6: The Association of Age Group with Coagulase Positive *S. aureus*.

Age Groups (Years)	All Bacteria other than CoP <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
17-26	671 (69%)	302 (31%)	973(100%)
27-36	23 (67.6%)	11 (32.4%)	34(100%)
37-54	17 (73.9%)	6 (26.1%)	23(100%)
Total	711 (69%)	319 (31%)	1030(100%)

χ^2 -test value=0.289; df=2; P=0.9

Type of statistical test: Chi-Square (χ^2). CoP=Coagulase Positive.



Table 7: The Association of the All Other Risk Factors with Coagulase Positive *S. aureus*.

Gender	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Male	309 (67.9%)	146 (32.1%)	455 (100%)
Female	402 (69.9%)	173 (30.1%)	575 (100%)
Total	711 (69.0%)	319 (31.0%)	1030 (100%)
<i>X²-test value=0.476; df=1; P=0.5. RR=1.0, 95% CI= (0.698-1.188)</i>			
Marital state	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Single	627 (68.8%)	285 (31.2%)	912 (100%)
Married	84 (71.2%)	34 (28.8%)	118 (100%)
Total	711(69%)	319(31%)	1030(100%)
<i>X²-test value=0.290; df=1; P=0.6. (RR=1.0, 95% CI= (0.584-1.358)</i>			
Deal with HCWs	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Yes	149 (70.6%)	62 (29.4%)	211 (100%)
No	562 (68.6%)	257 (31.4%)	819 (100%)
Total	711 (69.0%)	319 (31%)	1030 (100%)
<i>X²-test value=0.313; df=1; P=0.6. (RR=1.1, 95% CI=0.789-1.530)</i>			
Adm. in Hospital	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Yes	104 (70.3%)	44 (29.7%)	148 (100%)
No	607 (68.8%)	275 (31.2%)	882 (100%)
Total	711 (69%)	319 (31%)	1030 (100%)
<i>X²-test value=0.125; df=1; P=0.7. (RR=1.1, 95% CI=0.732-1.566)</i>			
Sleeping Pattern	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Sleep alone	431 (63.6%)	247 (36.4%)	678 (100%)
Sleep with Others	280 (79.5%)	72 (20.5%)	352 (100%)
Total	711 (69%)	319 (31%)	1030 (100%)
<i>X²-test value=27.633; df=1; P=0.000. (RR=0.5, 95% CI= (0.33-2607)</i>			
Smoking	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Yes	3 (13%)	20 (87%)	23 (100%)
No	708 (70.3%)	299 (29.7%)	1007 (100%)
Total	711 (69%)	319 (31%)	1030 (100%)
<i>X²-test value=34.491; df=1; P=0.000. (RR=0.1, 95% CI= (0.019-0.215)</i>			
Touching Nose	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Yes	506 (65%)	273 (35%)	779 (100%)
No	205 (81.7%)	46 (18.3%)	251 (100%)
Total	711 (69%)	319 (31%)	1030 (100%)
<i>X²-test value=24.818; df=1; P=0.000. (RR=1.1, 95% CI= (0.736-0.860)</i>			
Nasal Sensitivity	Bacteria other than Coagulase Positive <i>S. aureus</i> n (%)	CoP <i>S. aureus</i> n (%)	Total
Yes	47 (73.4%)	17 (26.6%)	64 (100%)
No	664 (68.7%)	302 (31.3%)	966 (100%)
Total	711 (69%)	319 (31%)	1030 (100%)
<i>X²-test value=0.620; df=1; P=0.4. (RR=1.3, 95% CI=(0.710-2.226)</i>			

Type of statistical test: Chi-Square (X^2). df= Degree of Freedom. RR=Relative Risk. 95%CI= 95% Confidence Interval. HCWs: Health Care Workers. Adm. in Hospital: Admitted in Hospital. CoP=Coagulase Positive *S. aureus*.



4. Discussion:

Most invasive *S. aureus* infections are arising from nasal carriage as it inhabits primarily the moist squamous epithelium of the anterior nares.⁽⁹⁾ The rate of nasal carriage among hospital personnel and patients were much higher than those in community carriers; (60-70%) and (30-50%), respectively.⁽¹⁰⁾ In a study reported by Brown;⁽¹¹⁾ the human population colonized by *S. aureus* in the anterior nares represent 20%-80%.

The increasing emergence of drug-resistant strains such as methicillin-resistant *S. aureus* (MRSA) lead to higher incidence of community-acquired and hospital-acquired *S. aureus* infections.^(12, 13)

In the present study, the nasal carriage of *S. aureus* among staff and students of the university was 319/1030 (31%). Our result was unlike with that reported by Al-Humaidan, et al.,⁽¹⁴⁾ at King Khalid University Hospital, in Saudi Arabia, where they found that the prevalence of *S. aureus* nasal carriage was 40%.

Biber⁽¹⁵⁾ conducted a study in Gaza city, they were revealed a widespread of community-acquired methicillin-resistant *S. aureus* (CA-MRSA) carriage, whereby 30% of healthy children and their parents carried *S. aureus*, and this was agreed with that reported in our study. Another study found that the prevalence of nasal carriage of *S. aureus* in the US population was 32.4%, this study was more or less near to that found in the present study.⁽¹⁶⁾ The prevalence in different populations varied with each report, the reason may be due to the socio-economic situation, gender variability, and age group in each study sample.

The present study also identified that age groups for *S. aureus* carriage show high frequency of coagulase positive *S. aureus* among

age group 27-36 years (32.4%) followed by those at age of 17-26 years (31%). However, we did not find a statistically significant association in relation to the age groups ($P=0.9$). Mainous, et al,⁽¹⁶⁾ found a statistical significant association in relation to the age groups ($P=0.01$), as nasal carriage of *S. aureus* was present a 30.67% among adults aged 20 and older, this was unlike that of our study. Abdelmonem et. al.,⁽¹⁷⁾ conducted a similar study in Taiz city, Yemen and reported that *S. aureus* nasal carriage was not showing a statistically significant association in relation to the age, this was in agreement with our study.

The relationship of the other various risk factors such as gender, marital state, smoking, etc. was evaluated with *S. aureus*. Regarding gender, it was considered a risk factor ($RR=1.0$, 95% $CI= 0.698-1.188$), but there was no statistically significant association ($P=0.5$). However, *S. aureus* was more common in male than female, 32.1%, and 30.1% respectively. This was agreed with that reported in the study conducted by Abdelmonem.⁽¹⁷⁾

Ahmad et. al.,⁽¹⁸⁾ from Saudi Arabia reported that the prevalence of *S. aureus* among female health care workers (HCWs) was higher (44.6%) than males (22.5%); whereas our results were far different. A study from India that conducted by Rongpharpi, et al.,⁽¹⁹⁾ in which found that the prevalence of *S. aureus* nasal carriage was higher among males health care workers (HCWs) (54.28%) compared with that of females HCWs (45.71%). Olsen et. al.,⁽²⁰⁾ reported that the overall prevalence of *S. aureus* nasal carriage was 26.2 % in HCWs and 26.0 % in non-HCWs. The corresponding sex-specific rates were 22.5% and 18.4 % in women ($P = 0.1$), and 43.7% and 34.1% in men ($P = 0.1$), respectively. This was similar to our result as



high frequency of *S. aureus* among male than female.

It is not known why there was a higher *S. aureus* transmission rate among males compared to females as reported from different populations. This difference may be attributed to the fact that men's maneuvers and the size of their social circle of contacts, especially in Arab countries and the Middle East, are much higher than those of females.

Regarding marital state, a high percentage was seen in single participants than married ones. However, marital state shows no statistically significant association with the *S. aureus* nasal colonization. Moreover, the relative risk was 1, this means risk in single was equal to the risk in married cases.

Those not dealing with HCWs show a high percentage of coagulase *S. aureus* than those dealing with HCWs. The relative risk was slightly more than 1 (RR=1.1), which means those dealing with HCWs were considered as a risk or possible cause for *S. aureus* nasal colonization. However, there was no a statistically significant association.

The pattern of sleep and frequent touching the nose was evaluated by Chi-Square test and we found a statistically significant association with the *S. aureus* nasal colonization. Hence, the pattern of sleep was protective when sleep alone (RR=0.5) and there a statistical significant association with the *S. aureus* nasal colonization (P=0.000). No similar studies to compare with our result.

Frequent touching the nose was shown a high percentage of coagulase *S. aureus* than those not frequently touching their nose. There was a highly statistical significant association (P=0.000). A double-blind randomized placebo-controlled trial by Reagan, et al.,⁽²¹⁾ they demonstrated that nasal decolonization with

mupirocin applied to health-care workers resulted in a decrease of nose and hand carriage.

In a cohort study conducted by Wertheim et al.,⁽²⁾ including outpatients and healthy hospital employees, nasal carriage was evaluated by a single or several swabs. Participants completed a questionnaire about their nose picking behavior, a positive correlation between this habit and nasal carriage of *S. aureus* was found. However, it is unknown whether nose-picking patients were more frequently colonized at extra nasal sites or not.

The nasal sensitivity considered as a risk factor but not show a statistically significant association with the *S. aureus* nasal colonization. Up to our knowledge in this regard, there were no such study to compare with our result.

The association between smoking and nasal carriage was evaluated in our study, it was found that, smoking was protective factor (RR=0.1) with a statistically significant association with the *S. aureus* nasal colonization (P=0.000). Data concerning the association between smoking and nasal carriage seems to be controversial. In a study conducted by Olsen, et al.,⁽¹⁾ they reported that active smoking in healthy adults was found to be a protective factor for nasal carriage of *S. aureus*, with a hypothesized bactericidal activity of cigarette smokers. Conversely, a study conducted by Cole, et al.,⁽²²⁾ showed that smokers were more frequently colonized than non-smokers, and cessation from smoking improved clearance of nasal *S. aureus* in an experimental inoculation study.



5. Conclusion:

The current study revealed that the minor community, were potential nasal colonizers of *S. aureus* (31%). These carriers may serve as a reservoir for dissemination of infection, and therefore must be promptly treated. *S. aureus* nasal carriage show high frequency among age group of 27-36 (32.4%) followed by those at age 17-26 years (31%). The gender was considered a risk factor, but there was no a statistically significant association, *S. aureus* is more common in male than female. The reason of high *S. aureus* carriage among males compared with females reported from different countries was unknown. In our study we found that active smoking in healthy adults were found to be a protective factor for nasal carriage of *S. aureus*. However, such association show a conflicting data. In our study we found frequent touching the nose was statistically association with the *S. aureus* nasal colonization, and considered as risk factors. Moreover, nasal allergy was risk factor but statistically not association with *S. aureus* nasal colonization. Regular screening of carriers is required for prevention of community acquired infections.

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