

**ORIGINAL ARTICLE****Nasal and Hand Carriage Rate of *Staphylococcus aureus* among Food Handlers Working in Jimma Town, Southwest Ethiopia****Getenet Beyene<sup>1\*</sup>, Girma Mamo<sup>2</sup>, Tesfaye Kassa<sup>1</sup>, Getnet Tasew<sup>1</sup>, Seid Tiku Mereta<sup>3</sup>****OPEN ACCESS**

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**ABSTRACT**

**BACKGROUND:** Food handlers have been recognized to play a major role in the transmission of food borne diseases, contributing significantly to the global incidence and burden of the diseases. This study, therefore, aimed to assess the nasal and hand carriage of *Staphylococcus aureus* among food handlers in Jimma Town.

**METHODS:** A community based cross sectional study was conducted from February to May 2017. Swab specimens from nasopharyngeal and hands of food handlers working in food establishments were collected for isolation and identification of *S. aureus* using standard bacteriological methods. Antimicrobial susceptibility test was done using disc diffusion method. Associations of selected variables for *S. aureus* colonization were determined using SPSS version 20 with  $p \leq 0.05$  taken as statistically significant.

**RESULTS:** Among the 300 food handlers working in hotels and restaurants in Jimma Town, 86(28.7%) were colonized by *S. aureus*. The frequency of isolation of *S. aureus* from nose, hand and both parts (nose and hand) were 27(9%), 34(11.3%) and 25(8.3%), respectively. There was strong association ( $P=0.00336$ ) between carriage rate of *S. aureus* and food handlers' job category. The majority (90.7%) of the isolates were resistant to Penicillin and Ampicillin. Increased levels of sensitivity were observed against Ciprofloxacin (96.5%), Cefoxitin (95.3%) and Amoxicillin-Clavulanic Acid (94.2%).

**CONCLUSIONS:** This study revealed a high prevalence of *S. aureus* carriers among food handlers and high antibacterial resistance towards commonly prescribed drugs, justifying the screening of food handlers to detect and treat carriers and protect restaurant customers from staphylococcal food poisoning.

**KEYWORDS:** Carriage rate; food handlers; *Staphylococcus aureus*; antimicrobial susceptibility; Jimma Town

**INTRODUCTION**

Food-borne related illnesses have increased over the years negatively affecting the health and economic well-being of many developing nations (1). *Staphylococcus aureus* is a gram positive coccus causing severe food borne diseases, resulting in an estimated 241,000

illnesses per year in the United States. However, the incidence of Staphylococcal Food-borne Disease (SFD) could be a lot higher as sporadic food-borne disease caused by *S. aureus* is not reportable in many developed, and developing nations like Ethiopia (2).

*Staphylococcus aureus* is responsible for a variety of cutaneous and systemic infections in addition to SFD. About a third of healthy human populations carry this bacterium in their nose. Strains present in the nose often contaminate the back of hands, fingers and the face. As a result, nasal carriers can easily become skin carriers to act as a major source of cross-contamination in food and drinking establishments. Consequently, food handlers in food establishments are usually regarded as the source of SFD to customers (3,4).

A cross sectional study conducted among 127 food handlers working in cafeteria in Gondar Town of Ethiopia indicated that 16.5% of finger nail contents of the food handlers were culture positive for *S. aureus* (5). Similarly, a study conducted in the same town among food handlers reported an isolation rate of 20.5% nasal carriage of *S. aureus* (6).

On the other hand, *Staphylococcus aureus* have a feature of developing antimicrobial resistance quickly and successfully to antibiotics through various mechanisms that involves the acquisition and transfer of antibiotic resistance plasmids, as well as the possession of intrinsic resistance mechanisms (7). The severe consequences of infection with *S. aureus* increased the importance of prevention and the need for regular investigation for antimicrobial susceptibility pattern. Due to rising concerns over food safety and the lack of adequate research to ascertain the extent of *Staphylococcus aureus* colonization among food handlers, this study was designed to assess its prevalence and antibiotics sensitivity pattern among food handlers working in different food establishments in Jimma Town, Ethiopia.

## MATERIALS AND METHODS

**Study area and period:** A community based cross sectional study was conducted on the prevalence of nasal and hand carriage of *Staphylococcus aureus* and its antimicrobial

susceptibility pattern among food handlers working in hotels and restaurants in Jimma Town, Southwest Ethiopia, from February to May 2017. Jimma Town has a population of 200,000 and is located in Southwest Ethiopia 355km far from Addis Ababa, the capital city of Ethiopia. Currently, there are 79 hotels and 89 restaurants in Jimma Town.

Sample size was calculated using single population proportion formula and nasal carriage prevalence of 21.5% *S. aureus* among food handlers in Samara Town restaurants (8). Accordingly, a total of 300 food handlers working in different food establishments were selected by proportionally allocating at randomly selected hotels and restaurants. Food handlers who were engaged in food preparation, food serving serving and cleaning of utensils were considered as study subjects.

### **Socio-demographic data and swab specimen collection:**

A structured questionnaire was used to collect data on age, sex, job category, work experience and educational status of each food handler. Nasal specimen was taken using swab moistened with sterile normal saline solution. The tips were inserted 1–2 cm inside the anterior nares of both nostrils and rotating six times. Then, the swabs were immediately inserted into a sterilized screw capped tubes containing 5ml normal saline. Another sterile cotton tip applicator stick was used to collect the hand swab samples from their palm, between finger nails and at finger tips/under nails of both hands and transported to Jimma University Medical Center Bacteriology Laboratory for culture.

***S. aureus* isolation and identification:** The nasal and hand swab specimens were inoculated on to Mannitol Salt Agar (Oxoid, Hampshire, England) and Blood agar (Oxoid, Hampshire, England). All plates were incubated at 37°C for 24 hours under aerobic conditions. Presumptively suspected colonies of *S. aureus* from both media were taken and further confirmed by Gram staining, catalase and coagulase tests following standard procedures (9).

**Antimicrobial Susceptibility testing of *S. aureus*:** Susceptibility testing was performed on Muller Hinton agar (Oxoid Ltd, Hampshire, UK) using agar disc diffusion technique recommended

by Kirby Bauer (10). The following drugs with their respective concentrations were used: Ampicillin (AMP,10 µg), Amoxicillin-Clavulanic Acid (AMC,30 µg), Ceftriaxone (CRO,30 µg), Ciprofloxacin (CIP,5 µg), Chloramphenicol (C,30 µg), Erythromycin (E,15µg), Gentamicin (CN,10µg), Kanamycin (K,30µg), Oxacillin (OX1C,1µg), Cefoxitin (CXT,30µg), Tetracycline (TE,30µg), and Trimethoprim-Sulphamethoxazole (TMP-SXT,1.25/23.75µg), Vancomycin (VA,30 µg) and Penicillin G (P10 units). *Staphylococcus aureus* ATCC 25923 and *Escherichia coli* ATCC 25922 were used as a quality control strains for the antimicrobial susceptibility test. The resistance and sensitivity results were interpreted according to the Clinical and Laboratory Standards Institute protocol (11).

**Data analysis procedures:** SPSS version 20 software was used for statistical analysis. Chi square test ( $\chi^2$ ) was used to determine the relationship between selected variables and food handlers for *S. aureus* colonization. A p-value of less than 0.05 was considered to indicate statistical significance.

**Ethical considerations:** This research project was conducted following approval from Jimma University, Institute of Health Research Ethics Committee and from Jimma Town Municipality and Health Office. Data was collected after written consent was obtained from each food handler. Study participants who were positive for MRSA nasal carriers were treated with 2% Mupirocin.

## RESULTS

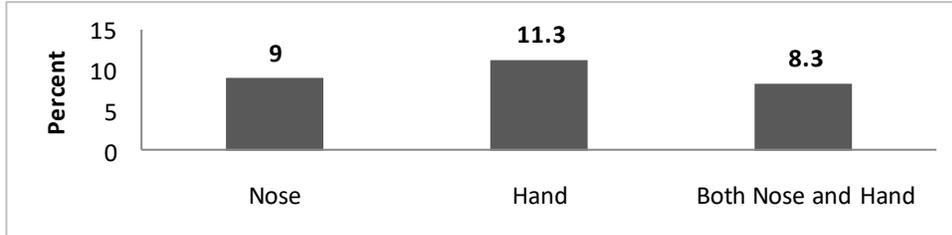
**Socio-demographic characteristics:** A total of 300 food handlers participated in this study with a response rate of 100%. Of these, 197(65.7%) were females, and 160(53.3%) were found in the age range of 20 to 29 years with mean age of 22.5 years. With regard to labour division, 138(46%) were cooks, 122(40.7%) were waiters and 40(13.3%) were utensils cleaner. The majority (55.3%) of the food handlers completed primary school while 32(10.7%) of them had no formal education. Among the total participants, 162(54%) of food handlers had 2 to 5 years of working experience in food establishments (Table1).

Table 1: Distribution of socio-demographic characteristics of food handlers working in hotels and restaurants in Jimma town, February to May, 2017

Characteristics	Frequency (n=300)	Percentage (%)
Sex	Male	103
	Female	197
Age	< 20 year	105
	20-29 year	160
	30-39 year	26
	> 40 year	9
Job category	Cook	138
	Dish cleaner	40
	Waiter	122
Work experience	<2 years	76
	2-5 years	162
	6-9 years	41
	>10 years	21
Educational status	University	3
	College	14
	High school	85
	Elementary school	166
	Can't read and write	32

**Nasal and hand carriage of *S. aureus*:** Among the total 300 food handlers working in hotels and restaurants in Jimma Town, 86(28.7%) were colonized by *S. aureus*. The frequency of isolation

of *S. aureus* from nose, hand and from both (nose and hand) were 27(9%), 34(11.3%) and 25(8.3%), respectively (Figure1).



**Figure 1:** *S. aureus* carriage rate among food handlers in Jimma town, 2017

**Association of socio-demographic characteristics with carriage of *S. aureus*:**

There was a strong association between carriage rate of *S. aureus* and food handlers job category of serving as cook, dish cleaner, and waiter (P=0.00336). Even though there was no significant association between socio-demographic variables

like age, sex, work experience in years and educational status, there was high carriage rate of *S. aureus* (35.5%) among workers whose work experiences were below two years, and low carriage rate was reported among workers whose ages were above 40 years (Table 2).

**Table 2:** Association of Socio-demographic characteristics with nasal carriage of *S. aureus* among food handlers in Jimma town, February to May, 2017

Characteristics	<i>S. aureus</i>		Association $\chi^2$ and p value
	Positive N (%)	Negative N (%)	
<b>Sex</b>			
Male	26(25.2)	77(74.8)	$\chi^2=0.899$ P=0.343
Female	60 (30.5)	137(69.5)	
<b>Age in year</b>			
< 20	32 (30.5)	73(69.5)	$\chi^2=1.604$ P=0.6585
20-29	45(28.1)	115 (71.9)	
30-39	8 (30.7)	18 (69.3)	
> 40	1 (11.1)	8 (88.9)	
<b>Job category</b>			
Cook	50 (36.3)	88 (63.7)	$\chi^2=11.393$ P=0.00336
Dish cleaner	14 (35)	26 (65)	
Waiter	22 (18.1)	100 (81.9)	
<b>Work experience in years</b>			
<2	27 (35.5)	49 (64.5)	$\chi^2=2.946$ P=0.4000
2-5	44 (27.2)	118 (72.8)	
6-9	11 (26.8)	30 (73.2)	
>10	4 (19.1)	17 (80.9)	
<b>Educational status</b>			
University	1 (33.3)	2 (66.7)	Yates' $\chi^2=1.278$ P=0.8651
College	5 (35.7)	9 (64.3)	
High school	20 (23.5)	65 (76.5)	
Elementary school	50 (30.1)	116 (68.9)	
Can't read and write	10 (31.2)	22 (68.8)	

**Antimicrobial sensitivity pattern:** A total of 86 isolates were tested against thirteen commonly used antimicrobials. The majority (90.7%) of the isolates were resistant to Penicillin and Ampicillin. Increased levels of sensitivity were observed against Ciprofloxacin (96.5%), Cefoxitin (95.3%), Amoxicillin-Clavulanic Acid (94.2),

Ceftriaxone (80%) and Vancomycin (80%). Of the total, 6(7%) isolates were methicillin resistant *S. aureus* (MRSA). There was no isolates which were sensitive to all drugs tested (Table 3). Of the total 86 *S. aureus* isolates, 14(16.3%) were multidrug resistant (resistance against three or more different categories of drugs) (data is not shown).

Table 3: Sensitivity pattern of *S. aureus* isolated from food handlers in Jimma town, February to May, 2017 (N=86)

Antimicrobial agent	Resistance No. (%)	Intermediate No.(%)	Sensitive No (%)
Ampicillin	78 (90.7)		8(9.3)
Amoxicillin-ClavulanicAcid	5 (5.8)		81(94.2)
Ceftriaxone	6(7)		80(93.0)
Ciprofloxacin	2(2.3)	1(1.2)	83(96.5)
Chloramphenicol	12(14)		74(86)
Erythromycin	12(14)		74(86)
Gentamicin	3(3.5)	10(11.6)	73(84)
Cefoxitin	4(4.7)		82(95.3)
Tetracycline	32(37.2)		54(62.8)
Trimethoprim-Sulphamethoxazole	18(20.9)		68(79.1)
Vancomycin	6(7)		80(93)
Penicillin G	78(90.7)		8(9.3)
Oxacillin	6(7)		80(93)

## DISCUSSION

Studies from different countries have indicated that food handlers have been one of the major sources of food contamination (12,13). In this study, the overall prevalence of nasal carriage of *Staphylococcus aureus* among food handlers in various establishments of Jimma town was 27%. This finding shows that food handlers play an important role as source of staphylococcal food borne illnesses. The carriage rate observed may not be different from those studies done in US (23%) (14), UK (25%) (15), Turkey (23.1%) (16), Ethiopia (20.5%) (6), and from Samara City in Iraq (28%) (8). However, it is lower than study findings reported from Ekpoma Edo-Nigeria (60%) and Egypt (31%) (17,18) This difference could be attributed to various factors such as personal cleanliness habits of the workers, level of education, the hygiene of utensils/equipment and the environment where the food handlers are working and regulations employed in each

nations. The isolation rate of *S. aureus* from nose and hand were 9% and 11.3%, respectively, which is dissimilar with the study findings reported by David and his colleagues (2016) where the carriage rate of *S. aureus* was higher from nasal cavity (32.8 %) than from hand (24.9%) (19). El-Shenawy and his coworkers in Egypt conducted a cross sectional study of *S. aureus* skin carriage (hands and face swabs) and found that 75(38 %) of the 200 persons were positive for the presence of the bacterium (18). Udo and his coworkers identified 32(18 %) *S. aureus* out of 174 isolates from the hands of healthy food handlers (20).

In this study, the frequency of isolation of *S. aureus* from hand of food handlers (11.3%) was much lower compared to study findings obtained by Loeto *et al* (21) in Botswana and Edit *et al.*, in Kuwait (22) who reported prevalence of hand carriage among food handlers as 57% and 53%, respectively. The carriage rate of *S. aureus* was much less compared with a study result reported by Andargae *et al.*, in Ethiopia (5) where the

prevalence of hand carriage was 16.5%. The differences could be due to variation in the study design such as sample size and method of *S. aureus* identification which may account for the disparity in the carriage rate. In addition, carrier rates might be influenced by poor personal hygiene of study participants, poor sanitation of the areas and difference in sampling techniques.

*S. aureus* prevalence (35.5%) among food handlers having work experiences of less than 2 years was higher than among those who had more service years. This is in line with a study result conducted in Jimma University where more carriage rate was reported among workers with less work experience in food establishment. Moreover, it indicated that food handlers with several years of work experience had less risk of bacterial hand contamination (23). This could be explained as food handlers with more work experience have better personal hygienic practices than inexperienced food handlers. There was a strong association between rate of carriers and job category ( $P= 0.00336$ ). Food cookers were found to be more *S. aureus* carriers than dish cleaners and waiters.

Drug sensitivity patterns of *S. aureus* isolates showed that 78(90%) of the isolates were resistant to Amoxicillin and Penicillin which is in line with a study result reported by Emeakara from Nigeria where the percentages of resistance were 100 and 71.4 to Penicillin and Ampicillin, respectively (24). It is also comparable with the study result done in Jijiga, Ethiopia, where the rates of resistance of *S. aureus* were 100 and 97.2 % to Ampicillin and Penicillin G, respectively (25). This provides information on decision making for selection of antibiotics of choice for the treatment of infection due to *S. aureus* particularly in the study area. The increased resistance of isolates in the current study to commonly used antibiotics could be attributed to widespread and indiscriminate usage of antibiotics. This high rate of resistance among Staphylococci strains can be ascribed, in most cases, to the production of  $\beta$ -lactamase enzyme that destroys the  $\beta$ -lactam ring and inactivates the Penicillin antibiotic; this enzyme is also encoded by plasmid which makes it easier to be transferred among strains (19).

The majority of *S. aureus* isolates were sensitive to Gentamicin, Ciprofloxacin, Cefoxitin and Amoxicillin-clavulanic acid with sensitivity rates of 96.5%, 96.5%, 95.3% and 94.2%, respectively. This is inconsistent with study done in Ekpoma Edo state Nigeria where 100% of the isolates were sensitive to Ciprofloxacin and Gentamicin (17).

In this study, 6(7%) strains of *S. aureus* were resistant to methicillin which is comparable with study findings from Gondar where the prevalence of MRSA (Methicillin Resistant *Staphylococcus aureus*) was 9.8% (6). It is important to note that the emergence and dissemination of MRSA is an increasing global health problem that complicates the therapeutic management of infections due to *S. aureus*. The small variation could be mainly due to sample size and study site. On the other hand, 6(7%) of the isolates were resistant to Vancomycin. In contrary to our findings, a study conducted in Wollo University Referral Hospital in Ethiopia reported no Vancomycin resistant *S. aureus* isolates (26). However, a study conducted in Botswana showed that 27.3% of the isolates were resistant to Vancomycin (21). Multi-drug resistance patterns (resistance to at least three different categories of drugs) were observed in 14(16.3%) of *S. aureus* isolates which is in agreement with previous studies done in Gondar (27) and Dessie (26). The emergence of high MDR isolates could be due to empirical use of broad-spectrum antibacterial drugs, lack of culture and antimicrobial susceptibility tests for selecting most efficacious drugs and non-adherence to hospital antimicrobial policy.

In conclusion, these findings raise again the imperative need for protective measures including increased public awareness programs, regular monitoring of food handlers for food borne pathogens and intensive training on primary health care and hygiene. The use of nose masks by food handlers and restaurant workers and periodical medical examination could help to prevent the spread of resistant strains of *Staphylococcus aureus*. Finally, the current finding clearly highlights the significance of implementation of efficient quality control systems in areas of direct contact with hotel and restaurant food products as regulation to protect the public. Furthermore,

future studies addressing effective methods for sustained eradication of staphylococcal nasal carriage are clearly warranted to reduce the high risk of subsequent infections.

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