

RESEARCH ARTICLE

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Survey of nasal carriage of *Staphylococcus aureus* and intestinal parasites among food handlers working at Gondar University, Northwest Ethiopia

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Abstract

Background: Food borne disease are major health problems in developing countries like Ethiopia. Food handlers with poor personal hygiene working in food establishments could be potential sources of disease due to pathogenic organisms. However; information on disease prevalence among food handlers working in University of Gondar cafeterias are very scarce. The aim of this study is to assess the prevalence of nasal carriage of *Staphylococcus aureus*, their drug resistance pattern and prevalence of intestinal parasites among food handlers working in University of Gondar student's cafeterias.

Method: A cross sectional study was conducted among food handlers working in University of Gondar student's cafeterias. A pretested structured questionnaire was used for collecting data. Nasal swab and stool were investigated for *S. aureus* and intestinal parasites; respectively as per the standard of the laboratory methods.

Results: Among 200 food handlers, females comprised 171(85.5%). The majority (67.5%) of the food-handlers were young adults aged 18–39 years. One hundred ninety four (97%) of the food handlers were not certified as a food handler. Forty one (20.5%) food handlers were positive for nasal carriage of *S. aureus*, of these 4(9.8%) was resistant for methicilin. *Giardia lamblia* was the most prevalent parasites 22 (11%), followed by *Ascaris lumbricoides* 13(6.5%), *Entamoeba histolytica* 12 (6%), *Strongyloides stercoralis* (0.5), *Taenia species* 1(0.5%) and *Schistosoma mansoni* 1(0.5%).

Conclusion: The finding stressed that food handlers with different pathogenic micro organisms may pose significant risk on the consumers. Higher officials should implement food handler's training on food safety, periodic medical checkup and continuous monitoring of personal hygiene of food handlers.

Keywords: Food handlers, *S. aureus*, Intestinal parasites

Background

Food borne diseases are major health problems in developed and developing countries. The World Health Organization (WHO) estimated that in developed countries, up to 30% of the population suffer from food borne diseases each year, whereas in developing countries up to 2 million deaths are estimated per year [1,2].

The spread of food borne diseases via food handlers are a common and persistent problem worldwide [3,4]. Many diseases are communicable and caused by micro-

organisms that enter into the body via food [5]. Numerous outbreaks of gastroenteritis have been associated with ingestion of raw foods, foods incorporating raw ingredients or foods obtained from unsafe sources [6,7].

Food poisoning has been reported to be a result of infection with enterotoxigenic strains of *staphylococcus aureus* [8-13]. It accounts for 14–20% of outbreaks involving contaminated food in the USA [14], and in the United Kingdom restaurants are the second most important place for acquiring staphylococcal food poisoning [15]. This organism may exist on food handler's nose or skin, from which it may be transmitted to cooked moist protein-rich foods, and become intoxication agent, if these foods are then kept for several hours without refrigeration or stored in containers.

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Antibiotic resistant staphylococci are major public health concern since the bacteria can be easily circulated in the environment. Infections due to methicilin-resistant *S. aureus* (MRSA) have increased world-wide during the past twenty years [16,17]. Multiple drug-resistant *S. aureus* have been frequently recovered from foodstuffs [18], nasal mucosa of humans [19].

Likewise intestinal parasitic infections remain important public health problems in developing countries. Infection of intestinal parasites usually occurs primarily by ingestion of eggs and cysts via a fecal-oral route or directly from human to human through poor personal hygiene [20,21]. In Ethiopia amoebiasis and giardiasis are common causes of intestinal protozoa infections throughout the nation. The prevalence of amoebiasis ranges from 0–4% and that of giardiasis is 3–23% [22]. Food-handlers with poor personal hygiene working in food-serving establishments could be potential sources of infections of many intestinal helminthes, protozoa, and entero pathogenic bacteria [23]. Food-handlers who harbour and excrete intestinal parasites may contaminate foods from their faeces via their fingers, then to food processing, and finally to healthy individuals [21].

Though there are no or few indicative studies in hospital and university food catering service regarding food safety in the study area. There is no doubt food borne illnesses resulted from improper food handling. Therefore; this study aimed at assessing prevalence of nasal carriage of *S. aureus*, its drug resistance pattern and prevalence of intestinal parasites among food handlers.

Methods

Study design and area

A cross sectional study was conducted among food handlers working in University of Gondar students cafeterias from January 1, 2011 to June 30, 2011. Gondar town is one of the tourist destinations in Northwest Ethiopia 739 km away from Addis Ababa.

Study population

All food handlers working in University of Gondar student cafeterias.

Inclusion and exclusion criteria

Inclusion

Food handlers working in the University of Gondar student cafeterias and given informed consent were included in the study.

Exclusion criteria

Food handlers who had taken antibiotics and antihelminthics within the three weeks prior to the study were excluded.

Sample size and sampling procedure

All food handlers working in University of Gondar student cafeterias namely in Gondar College of Medicine and Health Sciences, Maraki campus and Tewodros campus cafeteria. Two hundred food handlers were included in the study.

Data collection procedure and sample collection

A pretested structured questionnaire was used for collecting information on age, sex, marital status, service years, educational status, status of training and habits of hand washing of each food-handler. Nasal swab was collected aseptically from food handlers' nostrils rolling six times by applicator stick tipped with cotton and moistened with normal saline. Stool specimen was collected from food handlers by leak proof plastic stool cup.

Culture and identification

A single nasal swab was obtained from each food handler inoculated onto Manitol salt agar (MSA) and Blood agar plate (BAP) incubated for 24 hours in 35–37°C in incubator. Isolates were identified as *S. aureus* by growth characteristics on blood agar plate, MSA, Gram stain and biochemical test such as catalase test and slide coagulase were done following standard procedures [24].

Antimicrobial susceptibility testing

Susceptibility testing was performed on Muller Hinton agar (Oxoid, Hampshire, UK) using agar disc diffusion technique recommended by Bauer *et al.* [25]. The drugs that were tested include methicilin (10 µg), penicillin (10 µg), erythromycin (15 µg), ampicilin (30 µg), ciprofloxacin (10 µg), tetracycline (30 µg), cotrimoxazole (25 µg), and vancomycin (30 µg) (Oxoid, UK). *Staphylococcus aureus* ATCC 25922 was used as a quality control organism for the antimicrobial susceptibility test. The resistance and sensitivity were interpreted according to the National Committee for Clinical Laboratory Standards [24].

Microscopic examination of stool

Intestinal parasites were investigated microscopically from each stool samples using both direct smears mount in saline and formol-ether concentration sedimentation procedures as per the standards [24].

Data processing and analysis

Statistical analysis was done using SPSS version 16.00 soft ware. The chi-square test was employed to assess the association between variables. A p-value of less than 0.05 was considered to indicate statistical significance.

Ethical consideration

The data were collected after written informed consent obtained from all study participants, and the study was

Table 1 Sociodemographic characteristics of food handlers working at University of Gondar in students cafeterias from January 1 to June 30, 2011

Characteristics	Total	CMHS N = 70	Tewodros N = 75	Maraki N = 55
Age in years	No.(%)	NO.(%)	No.(%)	No.(%)
18-28	85(42.5)	25(35.7)	31(41.3)	29(52.7)
29-39	50(25)	20(28.6)	21(28.0)	9(16.4)
40-49	31(15.5)	10(14.2)	11(14.7)	10(18.2)
50-59	31(15.5)	14(20.1)	11(14.7)	6(10.9)
60+	3(1.5)	1(1.4)	1(1.3)	1(1.8)
Sex				
Female	171(85.5)	63(90)	68(90.7)	40(72.7)
Male	29(14.5)	7(10)	7(9.3)	15(27.3)
Education				
Illiterate	11(5.5)	10(14.3)	1(1.3)	0
Grade 1-8	84(42)	31(44.3)	31(40)	22(40)
Grade 9-12	86(43)	23(32.9)	33(44)	30(54.5)
Certificate	19(9.5)	6(8.6)	10(13.3)	3(5.5)
Service Years				
<1 years	24(12)	8(11.4)	10(13.3)	6(10.9)
1-10 years	146(73)	48(68.6)	55(73.3)	43(78.2)
11-20 years	12(6)	6(8.6)	4(5.3)	2(3.6)
21+	18(9)	8(11.4)	6(8.1)	4(7.3)
Total	200(100)	70(100)	75(100)	55(100)

CMHS = College of Medicine and Health Sciences.

approved by the Research Ethics Committee of the University of Gondar. Study participants found positive for intestinal parasites were treated and MRSA carriers were decolonized.

Results

Sociodemographic characteristics

A total of two hundred food-handlers, (171 of females and 29 males) were included in the study. Their mean age were 34.54 years, ranging from 18–64 years. The majority 135 (67.5%) of the food handlers were young adults aged 18–39 years. Only 105 (52.5%) of the food-handlers had education above primary school. The educational levels, age category, sex and work experiences were shown in (Table 1).

In hand washing practices, 179 (89.5%) food handlers had a habit of hand washing after toilet while 21(10.5%) of food handlers had no habit of hand washing after toilet. While 148 (74%) of food handlers had the habit of hand washing with soap and water, the rest 52(26%) did not use soap for their hand after toilet. However, 92(46%) food handlers had a habit of hand washing after touching nose between handling of food items. Almost half of food handlers 93(46.5%) had no medical check-up previously including stool examination. Only 6(3%) the 200 of food

handlers were certified for training in food handling and preparation (Table 2).

Sociodemographic in relation to carriage of *S. aureus* and intestinal parasites

In this study the rate of colonization of *S. aureus* related to age greater than 60 was 100%. However, infection to parasite age greater than 60 was 0%. The lowest rate of colonization of *S. aureus* was 15.8% in educational status of certificate. The amount of service years <1 yrs observed the lowest rate of colonization by *S. aureus* which was 8.3%. Though there were no significance association between sociodemographic variables and carriage of *S. aureus* and intestinal parasite infection (Table 3).

There is no significance association between certified in food preparation training and the presence of intestinal parasites ($P = 0.810$). However; there is significance association between poor hand washing practice after toilet with soap and water and the presence of intestinal parasites ($P = 0.001$) (Table 4).

Nasal carriage of *S. aureus*

Among the 200 healthy food handlers, the overall prevalence of nasal carriage of *S. aureus* was 41(20.5%). Considering the drug susceptibility pattern, all isolates of *S. aureus* were sensitive to vancomycin. However, half of

Table 2 Hygienic practice of food handlers working at the university of Gondar students cafeterias from January 1 to June 30, 2011

Variables	No.(%)
Certified in food preparation and handling	
Yes	6(3)
No	194(97)
Medical check up	
Yes	107(53.5)
No	93(46.5)
Hand washing after using toilet by water	
Yes	179(89.5)
No	21(10.5)
Hand washing after using toilet with soap and water	
Yes	148(74)
No	52(26)
Hand washing after touching nose	
Yes	92(46)
No	108(54)
Hand washing before preparing food	
Yes	188(94)
No	12(6)
Total	200(100)

Table 3 Sociodemographic characteristics in relation to *S. aureus* and intestinal parasites detected in food handlers at University of Gondar students cafeterias from January 1 to June 30, 2011

Characteristics	<i>S. aureus</i>		Asso. X ² &P value	Intestinal parasites		Association X ² &P value
	Negative n(%)	Positive n(%)		Negative n(%)	Positive n(%)	
Age in years						
18-28	69(81.2)	16(18.8)		70(82.4)	15(17.6)	
29-39	37(74)	13(26)	X ² = 1.898	36(72)	14(28)	X ² = 5.119
40-49	25(80.6)	6(19.4)	P = 0.754	22(71)	9(29)	P = 0.225
50-59	25(80.6)	6(19.6)		19(61.3)	12(38.7)	
60+	0	3(100)		3(100)	0	
Sex						
Female	134(78.4)	37(21.6)	X ² = 0.936	128(74.9)	43(25.1)	X ² = 0.013
Male	25(86.2)	4(13.8)	P = 0.333	22(75.9)	7(24.1)	P = 0.908
Education						
Illiterate	9(81.8)	2(18.2)		8(72.7)	3(27.3)	
Grade 1-8	63(75)	21(25)	X ² = 3.528	57 (67.9)	27(32.1)	X ² = 3.87
Grade 9-12	71(82.6)	15(17.4)	P = 0.474	71(82.6)	15(17.4)	P = 0.107
Certificate	16(84.2)	3(15.8)		14(73.7)	5(26.3)	
Year of service						
<1 years	22(91.7)	2(8.3)		20(83.3)	4(16.7)	
1-10 years	118(80.8)	28(19.2)	X ² = 5.093	108(74)	38(26)	X ² = 4.09
11-20 years	4(33.3)	8(66.7)	P = 0.165	9 (75)	3(25)	P = 0.323
21+	15(83.3)	3(16.7)		13(72.2)	5(27.8)	
Total	200			200		

X² = chi-square.

the isolates of *S. aureus* 21(51.2%) and 19(46.3%) were resistant to penicillin and ampicillin; respectively. Sixteen (39%) of the isolates were resistant to amoxicillin. Thirteen (31.7%) and 11 (26.8%) of the isolates were

resistant to tetracycline and cotrimoxazole; respectively. Six (14.6%) of the isolates were resistant to erythromycin, whilst 4 (9.8%) of the isolates were resistant to methicillin and ciprofloxacin; respectively (Table 5).

Table 4 Hygienic practice of food handlers in relation to positivity of nasal carriage of *S. aureus* and intestinal parasites at the University of Gondar students cafeteria from January 1 to June 30, 2011

Variables	<i>S. aureus</i> n(%)		Association X ² and P value	Intestinal Parasite n(%)		Association X ² and P value
	Negative	Positive		Negative	Positive	
Certified in food training						
Yes	5(83.3)	1(16.7)	X ² = 0 .056	4(66.7)	2(33.3)	X ² = 2.987
No	154(79.4)	40(20.6)	P = 0.813	46(75.3)	48(24.7)	P = 0.810
Hand washing after toilet by water						
Yes	144(80.4)	35(19.6)	X ² = 0 .938	135(75.4)	44(24.6)	X ² = 2.686
No	15(72.4)	6(28.6)	P = 0.333	15(72.4)	6(28.6)	P = 0.847
Hand washing after toilet with soap						
Yes	119(81.4)	29(19.6)	X ² = .286	122(82.4)	26(17.6)	X ² = 24.024
No	40(76.9)	12(23.1)	P = 0.593	28(53.8)	24(46.2)	P = 0.001
Medical check up						
Yes	81(75.7)	26(24.3)	X ² = 2.778	81(75.7)	26(24.3)	X ² = 7.038
No	78(83.9)	15(16.1)	P = 0.249	69(74.2)	24(25.8)	P = 0.855
Hand washing before preparing food						
Yes	150(79.8)	38(20.2)	X ² = 0 .159	141(75)	47(25)	X ² = 1.510
No	9(75)	3(25)	P = 0.690	9(75)	3(25)	P = 0.959

Table 5 Antimicrobial resistance pattern of 41 *S. aureus* isolated from 200 nasal swab cultures of food handlers at the University of Gondar students cafeterias from January 1 to June 30, 2011

Antimicrobial agents	Total-resistance n(%)	CMHS n = 18 n(%)	Tewodros n = 15 n(%)	Maraki n = 8 n(%)
Vancomycin	0	0	0	0
Methicilin	4(9.8%)	2(11)	1(6.7)	1(12.5)
Ciprofloxacin	4(9.8%)	1(5.6)	2(13)	1(12.5)
Penicillin	21 (51.2%)	9(50)	10(66.7)	2(25)
Ampicilin	19(46.3%)	8(44.4)	9(50)	2(25)
Amoxicillin	16(39%)	8(44.4)	6(40)	2(25)
Erythromycin	6(14.6%)	3(16.7)	2(13)	1(12.5)
Tetracycline	13(31.7%)	6(33.3)	5(33.3)	2(25)
Cotrimoxazole	11(26.8%)	5(27.7)	5(33.3)	1(12.5)

Intestinal parasites

Direct microscopic and concentration techniques were used for identifying intestinal parasites from 200 stool specimens. The consistency of stool was 168(84%) formed, 18(9%) semi formed, 12(6%) diarrhea and 2(1%) dysentery. Only the formed stool was done by sedimentation concentration techniques. Fifty (25%) stool specimens were positive for different intestinal parasites. *Giardia lamblia* was the most prevalent parasites 22(11%), followed by *Ascaris lumbricoides* 13(6.5%) and *Entamoeba histolytica/dispar* 12(6%). In our study trophozoites of *G. lamblia*, *E. histolytica* and larvae of *S. stercoralis* were found in diarrhea stool. As noted in the (Table 6), *G. lamblia* and *E. histolytica*, cyst forms of the parasites are higher than the trophozoite form.

Discussion

In this study, nasal swab culture and stool microscopic examination of 200 food handlers had been investigated for the presence of bacteria and intestinal parasites. The rate of isolation of *S. aureus* from the nasal cultures in our study 41 (20.5%) was found to be similar to those reported by several researchers as 26.6%, 23.1% and 21.6% [26-29]. However, our finding was found to be higher than the rate 69(0.77%) obtained from a study conducted in Turkey [30] and much lower than the findings reported in Brazil and Botswana as 30%, and 44.6%; respectively [31,32]. Nasal carriage rates reported by several workers vary and the variation has been attributed to the ecological differences of the study population.

It is very important to note that although *S. aureus* causes severe infections it may also be as a member of the normal flora of the nasal cavity [33]. If by chance, a food handlers carries, an enterotoxin producer *S. aureus* he/she may contaminate the food and causes staphylococcal food poisoning outbreak in the students population. However, in our nasal carriage strains isolated from food handlers, we were not able to identify the presence

or the absence enterotoxin producer strains because of lack of reagent enterotoxin kit, Phage typing and PCR techniques.

Our study demonstrated that 4(9.8%) strains of *S. aureus* were resistant to methicillin. It is important to note that the emergence and dissemination of MRSA (Methicillin Resistant Staphylococcus aureus) is an increasing global health problem that complicates the therapeutic management of staphylococcal infections. However, the rate of resistance in our study was much lower than that reported as 3(20%) the study done in Gondar from nasal swab isolate of health professionals (unpublished). The possible explanation for the higher rate of MRSA in the previous study may be due to cross transmission with hospital strains. In this study isolates of *S. aureus* resistant to ampicilin was 19(46.3%) in line with reported as 45% in Brazil [27]. However, the resistance of *S. aureus* to penicillin in our study was lower than from the reported 70% in Brazil

Table 6 Prevalence of intestinal parasites and their frequency isolated from 200 food handlers at University of Gondar students cafeterias from January 1 to June 30, 2011

Parasite species	Number	%
Protozoa		
<i>Giardia lamblia</i>		
Trophozoite form	4	2
Cyst form	18	9
<i>Entamoeba histolytica/dispar</i>		
Trophozoite form	3	1.5
Cyst form	9	4.5
Helminthes		
<i>Ascaris lumbricoides</i>	13	6.5
<i>Strongloid stercoralis</i>	1	0.5
<i>Schistosoma mansoni</i>	1	0.5
Taenia species	1	0.5
Total	50	25

[31]. In our study all isolates were sensitive to vancomycin in line with a finding by Acco *et al.* [31]. However, a study conducted in Botswana showed that 9(27.3%) of the isolates were resistant to vancomycin [32].

In this study, the overall prevalence of intestinal parasite among food handlers were 50(25%) consistent with the study done in Gondar town (29%) and in Sudan 23.1% [29,34]. However, this prevalence was much lower compared to previous study done at Bahir Dar town [34], reported as 158(41.1%) and in Jimma which was 59(58.4%) [35]. The possible explanation may be more than half of the food handlers in this study had taken medical examination and might be treated for intestinal parasites or this study did not use sensitive techniques like Kato-thick smear for most of intestinal helminthes especially for *Schistosoma mansoni*, water emergency technique for *Strongyloides stercoralis* and the adhesive scotch tape for *E. vermicularis*.

A. lumbricoides, *S. mansoni*, *Taenia species* and *S. stercoralis* were reported in this study, note that this parasites are not food borne pathogens. However, the presence of such pathogens may indicate low personal hygiene in food handlers and as the same time these pathogens must be treated.

It was noted that 12 (6%) and 2(1%) of food handlers working in the kitchens were suffering from diarrhea and dysentery; respectively. Active trophozoites forms of *E. histolytica*, *G. lamblia* and larva of *S. stercoralis* were associated with diarrheic food handlers. Infections with the protozoan parasites like *E. histolytica* and *G. lamblia* are common causes of diarrhoea worldwide [35]. *G. lamblia* and *E. histolytica* infected food handlers can directly transmit to consumers if ingested via contaminated food and water because *G. lamblia* cysts and *E. histolytica* cyst do not need environmental maturation. Thus, food handlers should be in a good health and those suffering from diarrhea and dysentery must be excluded from work until they have been completely free of symptoms and must get rest.

In this study, majority of food handlers working in the cafeterias were young adults 135 (67.5%) but which was older than study done in Bahir Dar 371(96.6%) [37]. More than half of (53.5%) the food handlers had medical check-up in the past. However, none of the food handlers had medical check-up in the past in Bahir Dar study [34].

Conclusion

Multiple antimicrobial resistant strains of *S. aureus* were isolated and protozoan cysts were detected from food handlers working at University of Gondar students' cafeterias. These findings indicate that the food handlers may be potential source of food borne disease for the students' population being served in three cafeterias.

Abbreviations

BAP: Blood agar plate; FEC: Formol ether concentration; MRSA: Methicillin resistant *Staphylococcus aureus*; MSA: Manitol salt agar; PCR: Polymerase chain reaction; SOPs: Standard operating procedures; WHO: World Health Organization.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

MD was the primary researcher, conceived the study, designed, participated in data collection, conducted data analysis, drafted and finalized the manuscript for publication. MT and FM assisted in data collection and reviewed the initial and final drafts of the manuscript. MD, MT, FM and ZT interpreted the results, and reviewed the initial and final drafts of the manuscript. All authors read and approved the final manuscript.

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