

Assessment of Bacterial Hand Contamination and Associated Factors among Food Handlers Working in the Student Cafeterias of Jimma University Main Campus, Jimma, South West Ethiopia

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Abstract

Background: Food borne diseases continue to be a major global health problem and are the leading causes of morbidity and mortality in developing countries. Food handlers play a major role in the transmission of food borne pathogens via hands. This study aimed to assess the bacterial hand contamination and associated factors among food handlers working in the student cafeterias of Jimma University main campus.

Methods and materials: A cross-sectional study was conducted from May 2012 to April 2013 among food handlers working in the student cafeterias of Jimma University main campus. The data was collected by using structured questionnaire and observational checklist. Hand rinse samples was collected from participants and microbiologically examined for the presence of potential food borne bacterial contaminants using standard laboratory methods. The data was entered into a computer and analyzed using SPSS version-16.0 software.

Result: Among 230 food handlers, 114(49.6%) were tested positive for one or more potential food borne bacterial contaminants, and 73(31.7%) were tested positive for enteric pathogens. A total of 171 bacterial hand contaminants were isolated. *S. aureus* 54(23.5%), *Klebsiella* spp. 37(16.1%), *E. coli* 25(10.9%), *Enterobacter* spp. 21(9.1%), *Citrobacter* spp. 10(4.3%), *Serratia marcescens* 6(2.6%), *Pseudomonas aeruginosa* 8(3.5%), *Proteus* spp. 5(2.2%), *Providencia rettgeri* 3(1.3), and *salmonella* spp. 2(0.9%) were isolated with their corresponding prevalence rate. Bacterial hand contamination rate have significant association with service years (Chi-square=13.732, DF=4, P=0.008), age ($\chi^2=11.308$, P=0.010) and cleanness of outer garments ($\chi^2=7.653$, P=0.006).

Conclusion: The findings of this study emphasized the importance of food handlers' hands as a potential vector for potential food borne bacterial contaminants which could constitute a potential risk to food borne outbreaks. New employees and young and inexperienced food handlers should be well trained on personal hygienic practices pointing out on the importance of hand hygiene and appropriate hand washing techniques.

Keywords: Food handlers; Food borne bacterial contaminants; Isolation rate; Hand rinse

Introduction

Foodborne diseases can be defined as diseases commonly transmitted through food. Foodborne diseases comprise a broad group of illnesses caused by microbial pathogens, parasites, chemical contaminants and biotoxins [1]. The burden of disease can be defined as the incidence and prevalence of morbidity, disability, and mortality associated with acute and chronic manifestations of diseases [2].

The Centres for Disease Control and Prevention has identified more than 400 food-related illnesses. About two thirds of all outbreaks involve bacteria. The illnesses are caused either by the microorganisms themselves or by the toxins they release [3]. The consumption of foods contaminated by foodborne pathogenic microorganisms and toxins produced by them cause deaths, illnesses, hospitalization, and economic losses. Due to their widespread nature, foodborne diseases, in particular gastro-intestinal infections, represent a very large group of pathologies with a strong negative impact on public health [4,5].

Many food-borne disease incidents are reported every year in Africa. Numerous factors, contribute to this high number of incidents. However, it is extremely important to note that most cases of food-borne disease in the region are not reported, so the true extent of the problem is unknown. In most countries of the region, the surveillance infrastructure for food-borne diseases of both microbiological and chemical etiology is weak or non-existent. This absence of reliable data on the burden of food-borne disease impedes understanding about its public health importance and prevents the development of risk based

solutions to its management [6-8].

More aggravated situations and challenges prevail in Ethiopia where food safety issues are not well understood and have received little attention. In Ethiopia, according to the Ministry of Health annual report of 2011, dysentery and gastroenteritis were among the top ten diseases of outpatient visits although the report did not include all regions activity [9,10].

Food-borne diseases represent a persistent global health burden, and food handlers play a major role in their transmission [11]. Even though the sources of food contamination are diverse, food handlers serve as important source of food contamination either as carriers of pathogens or through poor hygienic practices [12]. The mishandling of food and the disregard of hygienic measures enable pathogens to come into contact with food and, in some cases, to survive and multiply in sufficient numbers to cause illness in consumers. Personal hygiene and

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environmental sanitation are among the key factors in the transmission of food borne diseases [13].

Several food-borne disease outbreaks are associated with poor personal hygiene of people handling foodstuffs. CDC reported that approximately 20% of food-related infections are due to food handlers [14]. Another study conducted in Malaysia also showed that approximately 10-20% of food-borne disease outbreaks are due to contamination by the food handlers [13]. Food workers may transmit pathogens to food coming from a contaminated surface of another food, or from hands contaminated with organisms from their gastrointestinal tract. This is also supported by report in which about 89% of outbreaks caused by food contamination by food workers, pathogens were transferred to food by workers' hands by Guzevich and Ross [15].

Food handlers are the most important sources for the transfer of microbial pathogens to food either from their hair, skin, hand, digestive systems, respiratory tracts, or from contaminated food prepared and served by them [16,17]. The hands are the last line of defence against exposure to pathogens which can occur either directly from the hand to the mouth, eye, nose, or other area of the skin, or indirectly by "handling" of food or water. The hands are particularly important since they are the last line of defence in the chain of transmission of gastrointestinal pathogens, either directly from hand-to-mouth, or indirectly by "handling" of food or water [18].

The hands of food handlers can be the vector to spread harmful microorganism through cross contamination, and during or after they experience gastrointestinal infection. An employee might contaminate his hands when using toilet, or bacteria might be spread from raw foods, from contaminated equipments, and environment [19]. Thus, these contaminated hands can transfer intestinal microbes to foods, equipment, and other workers in the food storage and preparation areas unless correct personal hygiene and adequate hand washing procedures are followed [20,21]. Some of the bacteria that can colonize the hands of food handlers are *Escherichia coli* and *Staphylococcus aureus* [22].

WHO emphasizes that "outbreaks of food-borne diseases can be reduced if both professional and domestic food-handlers understand the importance of correct hygienic food practices [12]. Food handlers should not smoke, sneeze, spit, cough, eat, handle money or engage in any act that could contaminate the food during the performance of their activities [23]. The role of the hands in disease transmission and the importance of hand hygiene in controlling infection in the food establishment are well established. Hand washing has been identified as the single most important means of preventing the spread of infection and if poorly or improperly implemented, can lead to foodborne illness outbreaks [23,24].

Food handlers in bigger eating establishments cater to a larger number of people, they are epidemiologically more important than domestic food handlers in spreading of food borne disease [11]. Nonetheless, bacterial hand contamination of food-handlers, may pose a real threat to those who are more susceptible to infection. Studying the hands microbial flora among the food handlers could have paramount importance to understand the hygienic practices of food handlers. The presence or absence of bacteria in the hands of food handlers can be used as a quantitative indicator of their behaviour regarding food-related and personal hygiene [25]. There are few related studies in Ethiopia and specifically to this study area. Therefore, this study aimed at assessing the bacterial hand contamination among food handlers working in the student cafeterias of JU main campus.

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have paramount importance to understand the hygienic practices of food handlers. The presence or absence of bacteria in the hands of food handlers can be used as a quantitative indicator of their behaviour regarding food-related and personal hygiene. However this issue is not well studied in Ethiopia. So this study aimed to assess the bacterial hand contamination among food handlers working in the student cafeterias of JU main campus. Thus findings of this study could create awareness about food handlers' bacterial hand contamination status. The findings of this study may also help the responsible bodies to create and implement intervention programs. It will have an important implication for future development of hygiene legislations. Furthermore it can also be used as a reference and spring bond for further studies and planning programmers.

Material and Method

Study area and period

The study was conducted at student cafeterias in Jimma University main campus, Jimma town, located at 355 km southwest Ethiopia from May 2012 to April 2013. Its geographical coordinates are: 07°39' Latitude and 36°50' Longitude, at an altitude of 1700-1750 m above sea level. Jimma University is organized into six colleges, out of which four of them are located in the Jimma University main campus. Around 500 food handlers are currently working in the student cafeterias of Jimma University main campus.

Study design

Descriptive cross-sectional study design was used

Source population

All food handlers working in the student cafeterias of Jimma University main campus

Study population

Selected food handlers working in the student cafeterias of Jimma University main campus

Inclusion criteria

Food handlers who are engaged in food preparation, serving, and Cleaning

Exclusion criteria

Food handlers who have skin irritation, eczema, and inflammation

Sample size determination

Sample size (n) was determined using a formula to estimate single population proportion. Taking 50% prevalence of bacterial hand contamination (p=0.5), 95% confidence interval (z=1.96) and 5% marginal error (d=0.05) the initial sample size was:

$$n = \frac{(z_{\alpha/2})^2 * P(1-P)}{d^2} = \frac{(1.96)^2 * (0.5)^2}{(0.05)^2} \approx 384$$

P: Bacterial hand contamination rate

z: z-statistics value that corresponds to 97.5 percentile cut-off point in the standard normal distribution

d: Margin of error

Since the total number of the source population was 500, correction formula was used to adjust the sample size to the population size and the sample size was calculated further as

$$\frac{n}{1 + \frac{n}{N}} = \frac{384}{1 + \frac{384}{500}} \approx 218$$

Finally by considering a 10% (≈22 subjects) non response rate, the final sample size was determined as:

$$n + 22 \approx 240$$

Sampling technique

Simple random sampling technique was employed. Study participants were selected by lottery method from the roster lists of food handlers which was obtained from students' cafeteria offices of Jimma University main campus.

Variables of the study

Dependent variables

- Bacterial hand contamination
- Types of bacterial hand contaminants

Independent variables

- Sociodemographic factors
- Hand washing habit
- Fingernail status
- Presence of jewelers on fingers
- Regular medical checkup
- Hygiene training
- Outer protective coat, and Hair cover
- Cleanness of outer garments

Data and specimen collection

Data related to socio-demographic characteristics, and personal hygiene practices of food handlers was collected by face to face interview method using structured questionnaire, and observational checklist. The tool was first prepared in English and then translated into the national language. Three sanitarians and two medical laboratory professionals were recruited for data collection and microbiological analysis. The data collectors were trained for two days by the principal investigator on data, and specimen collection procedures. After interviewing participants were asked to give hand rinse samples in sterile plastic bag (Stomacher@400 Classic; Seward, Worthing, UK) for microbiological analysis.

Before starting any meal preparation activity including hand washing (if any), participant's hands were sampled for microbial testing. Notification was not given in advance, and extra hand hygiene was not allowed during the hand rinse sample collection. A sterile polyethylene plastic bag technique was employed to collect the hand rinse samples. Participants were asked to dip their hands into sterile polyethylene plastic bag containing 100 milliliter of buffered peptone water (0.1% BPW) (Difco/Becton Dickinson, Franklin Lakes, and NJ). The bag was grasped tightly around the participant's wrist and the Peptone buffer was massaged through the wall of the bag by the investigator for one 1 minute, over all surfaces of the participant's hand, particularly around the nails and palm. The bag was immediately sealed and transported to Jimma University medical microbiology laboratory for examination [26,27].

Isolation and identification of potential food borne bacterial pathogens

All media used in this study were from Oxoid Ltd. and were prepared according to the manufacturer's instructions. The hand rinse samples were vortexed for one minute prior to microbiological examination. A loop full of each sample was separately spread-plated onto MacConkey (for detection of enteric bacteria), MSA (for detection of staphylococci), and XLD (for detection of Salmonella, and Shigella). Rappaport vassiliadis (RV) was used as a primary enrichment for the identification of Salmonella and Shigella. The bacterial colonies grown on the agar media were presumptively identified by colonial morphology and gram staining and a battery of biochemical tests like reaction on oxidase, catalase, simmon citrate, indole production, urease, motility, coagulase, methyl red-voges proskauer (MR-VP), LDC, KIA, gas and Hydrogen Sulfide (H₂S) production [28,29] (Figure 1).

Quality control

To manage the quality of the work SOP was strictly followed during processing of each sample. All the instruments used for sample processing were checked for proper functioning as far quality control strains of *S. aureus* (ATCC 6538) and *E. coli* (ATCC 25922) were used. Data consistency and completeness were made all the way during data collection, data entry and analysis. Culture Medias were prepared based on the manufactures instruction. Then the sterility of culture media was checked by incubating 5% of the batch at 35-37°C overnight and observed for bacterial growth. Those Media which shows growth was discarded.

Data processing and analysis

All components of data were entered and cleaned, coded and analyzed using SPSS version 16.0 (Copyright (c) SPSS Inc., 1997-2007, Polar Engineering and Consulting.) computer software. Data was organized, summarized, and presented in simple descriptive Statistical methods. Chi- square test was used for checking any possible association between various categorical variables, and p-value <0.05 considered as significant. The findings of the study were compared to other studies.

Ethical consideration

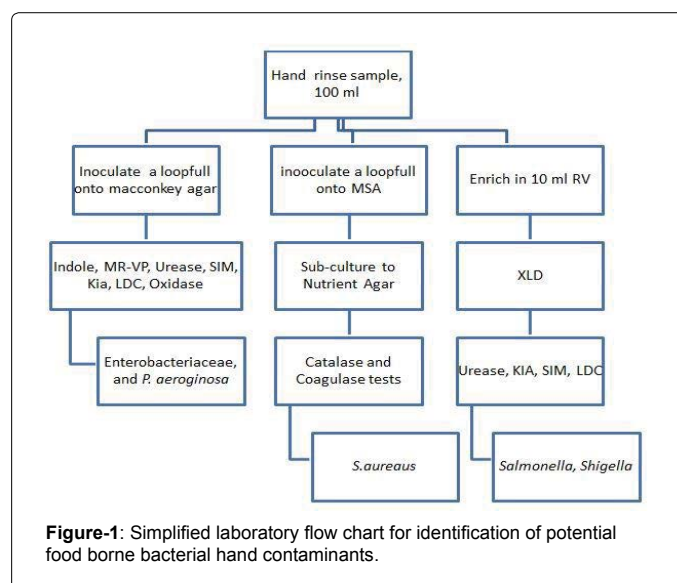


Figure-1: Simplified laboratory flow chart for identification of potential food borne bacterial hand contaminants.

The study was conducted after obtaining ethical clearance from Jimma University College of public health and Medical Sciences Ethical review Board. Permission letter was obtained from Jimma University Students' Service Dean Office to students' cafeteria office. Informed consent was obtained from participants after explanation of the purpose of the study and procedure of sample collection. In addition, participation in the study was made by willingness of study participants. All personal information about the study participants were kept confidential.

Dissemination of the findings

The finding of the study was disseminated to college of medical sciences and public health, Jimma University as a requirement for partial fulfillment of graduate study. The copy of the thesis results was provided to Student Cafeteria Offices of JU main campus. Furthermore a copy of the study will be submitted to health science library and Department of Medical Laboratory Sciences and Pathology. Finally, study results will be sent to the respective scientific journals requesting for publication.

Operational definition

Bacterial hand contamination: Presence of one or more potential food borne bacterial hand contaminants.

Food borne diseases: Intoxication, infection, or illness contracted by the consumption of contaminated food.

Food handler: A person who is engaged in the process of food preparing, serving, cleaning, and etc.

Potential food borne bacterial contaminants: Bacterial pathogens that can cause food contamination or spoilage.

Personal hygiene: Refers to those protection measures primarily with the responsibility of the individual, which promote and limit the spread of infectious disease, like hand washing using soap and water, keep body clean etc.

Risk factor: A factor whose presence is associated with an increased probability of bacterial hand contamination.

Results

Two hundred thirty food handlers were participated in this study making a response rate of 95.83%. From these 194(84.3%) of participants were females while 36(7.7%) were males. The mean and median age of the study subjects were 28.65(SD=8.09), and 26 respectively, whereas the minimum and maximum ages were 18 and 55 years respectively. About half of the food handlers 119(51.7%) were single, while 86(37%) of were married. The educational background is found as no formal education 28(12.2%), elementary school 115(50%), secondary school 72(31.3%), high school and above 15(6.5%). Regarding their job position 73(31.7%) were Cookers, 99(41.3%) were servers and 58(25.2%) were cleaners. Concerning service years, majority 185(63%) of food handlers have served for a period of less than five years in the student cafeterias of JU (Table 1).

Personal hygiene practices of food handlers

In the present study out of the total participants 164(71.3%) have worn outer protective Coat, 93(40.4%) have worn appropriate hair cover, 120(52.2%) have kept their outer garments clean. Out of the total participants 160(69.6%) have got informal food hygiene training, 131(57%) have got regular medical checkups, 185(80.4%) have trimmed fingernails, and 58(25.2%) have worn rings. Out of the total participants

hand washing habit using soap and water is reported by 177(77%) after toilet, 132(57.4%) after touching dirty materials, and 201(57%) before food handling (Table 2).

Types and prevalence of potential food borne bacterial hand contaminants

Bacteriological investigation of 230 hand rinse samples was performed out of which 114(49.6%) tested positive for one or more potential food borne bacterial hand contaminants, and 73(31.7%) were tested positive for Enteric pathogens. A total of 171 bacteria were isolated from which 109(63.7%) cases belong to the family of *Enterobacteriaceae*. In this study the following bacteria's were isolated with the corresponding prevalence rate: *Staphylococcus aureus* 54(23.5%), *Klebsiella* spp. 37(16.1%), *E. coli* 25(10.9%), and *Enterobacter* spp. 21(9.1%), *Citrobacter* spp. 10(4.3%), *Pseudomonas aeruginosa* 8(3.5%), *Serratia marcescens* 6(2.6%), *Proteus* spp. 5(2.2%), *Providencia rettgeri* 3(1.3%), and salmonella species 2(0.9%). While no shigella species was isolated (Table 3).

Variables	Categories	Frequency	Percent (%)
Sex	Male	36	15.7
	Female	194	84.3
Age	≤20 years	33	14.4
	21-30 years	124	53.9
	31-40 years	47	20.4
	≥41	26	11.3
Marital-status	Single	119	51.7
	Married	86	37.4
	Divorced	25	10.9
Ethnicity	Oromo	89	38.7
	Amhara	56	24.3
	Gurage	18	7.8
	Dawuro	32	13.9
	Kafa	16	7.0
	Others	19	8.3*
Religion	Orthodox	118	51.3
	Muslim	60	26.1
	Protestant	52	22.6
Education	No formal education	28	12.2
	Elementary	115	50.0
	Secondary	72	31.3
	High-school and above	15	6.5
Job-position	Cook	73	31.7
	Waiter	99	43.1
	Cleaner	58	25.2
Service years	<2	58	25.2
	2-4	87	37.8
	5-7	40	17.4
	8-10	25	10.9
	>10	19	8.7
Salary	420	160	69.6
	470	70	30.4

*implies to Wolayta, Sidama, Tigre and Yem

Table 1: Distribution of socio-demographic characteristics of food handlers working in the student cafeterias of JU main campus, May 2012-April 2013.

Variables	Categories	Frequency	Percent (%)
Appropriate protective Coat	outer Observed	164	71.3
	outer Not observed	66	28.7
Hair cover	Observed	93	40.4
	Not observed	137	59.6
Cleanness of outer garments	Kept	120	52.2
	Not kept	110	47.8
Hand washing habit after toilet	With soap and water	177	77.0
	With water only	53	23.0
Hand washing habit after touching dirty materials	With soap and water	132	57.4
	With water only	98	42.6
Hand washing habit before handling food	With soap and water	201	87.4
	With water only	29	12.6
Finger nail status	Trimmed	185	80.4
	Semi-trimmed	45	19.6
Regular Medical Checkup	Checked	131	57.0
	Not checked	99	43.0
Presence of rings	Observed	58	25.2
	Not observed	172	74.8
Hygiene training	Trained	160	69.6
	Not trained	70	30.4

Table 2: Personal hygiene practices of food handlers working in the student cafeterias of JU main campus, May 2012 to April 2013.

Factors associated with bacterial hand contamination

In the present study, no statistical association was found between bacterial hand contamination rate, and gender, educational background, job position, medical check-up, food hygiene training, hand washing habit, and fingernail status. However, bacterial hand contamination rate have significant association with service years, age, and cleanness of outer garments.

The isolation rate of potential food borne bacterial hand contaminants was much higher 25(75.8%) among food-handlers of ≤ 20 years age group, and lower 10(38.5%) among those ≥ 41 years age group. There is significant difference in isolation rate of potential food borne bacterial hand contaminants by age groups (Chi-square=11.308, DF=3, P=0.01).

Bacterial hand contamination rate have significant association with service years of participants ($\chi^2=13.732$, DF=4, P=0.008). The isolation rate of potential food borne bacterial hand contaminants was relatively higher 39(67.2%) among food handlers served for a period of less than two years, and lower 6(30%) among those served for a period of greater than 10 years.

The isolation rate of bacterial hand contaminants was lower 49(40.8%) among participants with clean outer garments, compared to 65(59.1%) with unclean outer garments. There is significant association between bacterial hand contamination rate and cleanness of outer garments ($\chi^2=7.653$, P=0.006) (Table 4).

Discussion

Food handlers are an important vehicle for microorganisms, and improper handling practices may cause food contamination and consequently food borne diseases, which pose a potential risk to public health [30]. This study is taken to assess bacterial hand contamination among food handlers working in the student cafeterias of Jimma University main campus.

In this study 49.6% participants' hands were contaminated with one

or more potentially food borne bacterial contaminants. *Staphylococcus aureus* 23.5%, *Klebsiella* species 16.1%, *E. coli* 0.9%, *Enterobacter* species 9.1%, *Citrobacter* species 4.3%, are among the most commonly isolated bacterial hand contaminants. The overall hand contamination rate of enteric bacterial contaminants was 31.7% among the participants. Similar types of bacterial contaminants were identified in Gondar [31], Nigeria [32], Egypt [33], Iran [34], Brazil [35] and Turkey [36].

Toxin-producing strains of *Staphylococcus aureus* are the leading cause of gastroenteritis following handling of food by persons who carry this bacterium in their noses and skin [37]. The present study *Staphylococcus aureus* were isolated from 23.5% food handlers' hands. This figure is comparable to 16.5%, 17.5%, and 31% prevalence reported in Gondar, Saudi Arabia, and Egypt respectively [29,33,38]. However, it is higher than 12.6%, and 7.1% incidence reported in Iran [34], and Nigeria [32] respectively. Nevertheless, the finding of the current study is lower than 42%, and 70% prevalence reported in Mexico [39], and Turkey [36] respectively. The discrepancy in socioeconomic status, type of food establishment, and lack of personal hygiene may explain this difference. The Isolation of *Staphylococcus aureus*, reflect improper hygiene practices such as pocking fingers into the nose.

Enteric pathogens that are believed to be capable of being transmitted by food workers include, but are not limited to, *E. coli*, *Salmonella* spp., *Shigella* spp. In addition, pathogens such as *Proteus*, and *Klebsiella*, which could originate from raw animal products, can contaminate hands from where they could be transferred to foods, equipment and other workers [15].

Enteric pathogens are among the transient hand flora that can be easily removed by hand washing. Isolation of these organisms includes a faeces-to-hand spread and indicating a poor hygiene practices of the food handlers [40]. Their presence indicates fecal contamination and poor hygiene practices food handlers are not taking enough care of hand hygiene [36]. In the present study' *Enterobacteriaceae* were identified from hands of 31.7% food handlers'. This result is nearly comparable to 38% isolation rate reported in Mexico [39], and higher than 6.9% reported in Egypt [33]. However it is lower than 44%, and 55.6% reported in South Africa [20], and Brazil [41] respectively. This could be resulted due to difference in source population, and type of food establishment. Isolation of *Enterobacteriaceae* from hands reflects contamination with fecal matter, and inadequate and poor hand washing habit which may pose potential risk of food borne outbreaks.

E. coli is naturally found in the human intestine and although

Bacterial isolates	Frequency (n=171)	Percent (%) (N=230)
<i>S. aureus</i>	54	23.5
<i>E. coli</i>	25	10.9
<i>Klebsiella</i> spp.	37	16.1
<i>Enterobacter</i> spp.	21	9.1
<i>Citrobacter</i> spp.	10	4.3
<i>Proteus</i> spp.	5	2.2
<i>Serratia marcescens</i>	6	2.6
<i>Providencia rettgeri</i>	3	1.3
<i>Pseudomonas aeruginosa</i>	8	3.5
<i>Salmonella</i> spp.	2	0.9

Table 3: Type and prevalence of potential food borne bacterial hand contaminants among food-handlers working in the student cafeterias of JU main campus, May 2012 to April 2013

Variables	Categories	Hand rinse culture result		Total N (%)	P-value
		Positive N (%)	Negative N (%)		
Gender	Female	98(50.5)	96 (49.5)	194(84.3)	$\chi^2=0.448$, P=0.503
	Male	16(44.4)	20 (55.6)	36 (15.7)	
Age Group	≤20	25(75.8)	8(24.2)	33 (14.4)	$\chi^2=11.308$, P=0.010
	21-30	56(45.2)	68(54.8)	124 (53.9)	
	31-40	23(48.9)	24(51.1)	47 (20.4)	
	≥41	10(38.5)	16(61.5)	26 (11.3)	
Educational background	No formal education	14(50.0)	14 (50.0)	28 (12.2.)	$\chi^2=2.176$, P=0.537
	Elementary school	62 (53.9)	53 (46.1)	115(50.0)	
	Secondary school	32 (44.4)	40 (55.6)	72 (31.3)	
	High school & above	6 (40.0)	9 (60.0)	15 (6.5)	
Job position	Cook	32(43.8)	41(56.2)	73 (31.7)	$\chi^2=2.907$, P=0.234
	Waiter	48(48.5)	51(51.5)	99 (43.1)	
	Cleaner	34(58.6)	24(41.4)	58 (25.2)	
Service years	<2	39(67.2)	19(32.8)	58 (25.2)	$\chi^2=13.73$, p=0.008
	2-4	43(49.4)	44(50.6)	87 (37.3)	
	5-7	18(45.0)	22(55.0)	40 (17.4)	
	8-10	8(32.0)	17(68.0)	25 (10.9)	
	>10	6(30.0)	14(70.0)	20 (8.7)	
Wears appropriate outer coat	Yes	77(47.0)	87(53.0)	164(71.3)	$\chi^2=1.562$, P=0.211
	No	37(56.1)	29(43.9)	66(28.7)	
Cleanness of outer garments	Kept	49(40.8)	71(59.2)	120(52.2)	$\chi^2=7.653$, P=0.006
	Not kept	65(59.1)	45(40.9)	110(47.8)	
Hand washing habit after toilet	With soap and water	83 (46.9)	94(53.1)	177 (77.0)	$\chi^2=2.195$, P=0.138
	With water only	31 (58.5)	22 (41.5)	53 (23.0)	
Hand washing habit after touching dirty materials	With soap and water	60 (45.9)	72 (54.5)	132 (57.4)	$\chi^2=2.094$, P=0.148

Table 4: Bacterial hand contamination rate and associated factors among food handlers working in the student cafeterias of JU main campus, May 2012 to April 2013.

most strains are harmless, some serotypes 0157:H7 can cause serious illness [42]. *E. coli* is normally absent from hands and the presence of *E. coli* gives a better indication of recent fecal contamination with enteric pathogens [20]. *E. coli* was detected on the hands of 10.9% of food handlers' in the current study, which is in line with 7.8%, and 6.8% carriage reported in Turkey, and Brazil respectively [35,36]. However, it is lower than 22% carriage reported in Iran [34]. Nevertheless, this figure is higher than 3.9%, 3.1%, 2.5%, and 1.8% isolation rate reported in Turkey [25], Gondar [29], Saudi Arabia [38], and Nigeria [32] respectively. The difference between our results and the previous studies may be attributed to sampling techniques.

In our study, no significant association was found for bacterial hand contamination by sex, educational background, medical check-up, training status, hand washing habit, and fingernail status of food handlers. However, there was significant association between bacterial hand contamination rate and service years (Chi-square=13.732, DF=4, P<0.05). This result indicated that food handlers more work experience have less risk of bacterial hand contamination. This could be explained as food handlers with more work experience have better personal hygienic practices than inexperienced food handlers.

There is a significant difference in bacterial hand contamination rate among different age groups ($\chi^2=11.308$, DFP=3, P=0.010). This can be explained as younger food handlers have poor hygienic practices. The bacterial hand contamination rate has significant association Cleanness of outer garments ($\chi^2=7.653$, DF=1, P=0.006). Undoubtedly, in-depth training about personal hygienic practices of new employees, inexperienced, and young food handlers could minimize the effect of service on bacterial hand contamination rates

Persons working in food services have to go through periodic medical examination. The interview result of our study showed that only 56.7% of food handlers had taken medical checkup. This figure is comparable to 63.2% reported in Mekele University [43]. However, it is much higher than 22.7% reported in Mekele [44], and the result reported in Bahirdar in which none of the participants come across regular medical examinations [45]. The difference with respect to medical checkup can be explained by better provision and enforcement in Jimma University.

It is known that improper handling is one of the main causes of food borne disease and that inappropriate hand hygiene is an important risk factor for food contamination [30]. Food handlers should always wash their hands when their level of cleanliness may affect food quality; for example: just before food handling, after any interruption, after touching contaminated material, after using the bathroom and whenever else needed. They should not smoke, sneeze, spit, cough, eat, handle money or engage in any act that could contaminate the food during the performance of their activities [23].

Hygienic assessment of the food handlers revealed that 77% of food handlers have a habit of hand washing with soap and water after toilet, while others used only water. This figure is nearly similar to 70.4%, and 89% reported in Mekele, and Gondar respectively [29,43]. However, it was lower than 90.6% reported in Bahirdar [46]. In the present study only 57% of food handlers have hand washing habit after touching dirty materials, and different body parts such as nose. This result shows food handlers negligence, and lack of awareness on sources of food contamination.

Food handlers should receive training before starting work in any food establishment, with a periodic refreshing training [47]. In this study 68.7% food handlers have got short course of training on food hygiene. This figure is much higher than 14%, and 12.3% reported in Bahirdar, and Mekele respectively [27,47]. This gap can be due to both studies enumerated only certified trainings. However, in the current study food handlers have got only short course of food safety training organized by the student cafeteria office. None of the food handlers were certified by formal training. Effective training of food handlers, may lead to an improvement in hygienic practices.

Food handlers should cover hair and wear appropriate protective covering, cut their fingernails short and during handling they should remove jewellery from their hands [23]. In the present study, 164(71.3%) food handlers were observed wearing outer working Coat, while only 40.4% had worn hair net. This result is in line with the report a cross-sectional study in mekele in which 72.6% of the food handlers were found wearing outer working garments, and 39% had worn hair net [44]. Nevertheless, it is higher than the figure reported in Ambo in which only 28% of food handlers' worn outer garment and hair covers [41]. This gap might be due to differences in socio-economic condition.

Moreover, in our study 80.4% of food handlers' fingernails were trimmed. This figure is by far comparable to 76.2%, and 88.4% reported in Mekele town [44,48], and Mekele University [43] respectively.

However, it is higher than 70% reported in Ambo [41]. Even though it had no association with the isolation rate of potential bacterial pathogens in this study, fingernails can serve as a vehicle for transport of microorganisms from their source to the foods or/and directly into the body. Beside this, 25.2% food handlers have worn finger ornaments. This figure is similar to 27.1% reported in Ambo [49,50], and lower than 35.7% reported in Mekele [44,51].

Limitations of the Study

As far as the study design is cross sectional, it simply provides information about relationship between the dependent and independent variables. Beside this Total Plate Count and Colliform count were not done because of resource and time constraint [52]. Serological identification of *Salmonella* species was not carried out. Antimicrobial susceptibility test for potential food borne bacterial contaminants was not done. Moreover, there is a scarcity of studies focused on isolation of bacteria from hands. This fact makes difficult the comparison of our results with that found by other researchers especially from developing countries.

Conclusion and Recommendation

In conclusion, our findings showed 114(49.6%) carriage of potential food borne bacterial hand contaminants and 73(31.7%) were tested positive for enteric bacterial hand contaminants. The following food borne bacterial hand contaminants were isolated with the corresponding prevalence rate: *S. aureus* 54(23.5%), *Klebsiella* spp. 37(16.1%), *E. coli* 25(10.9%), *Enterobacter* spp. 21(9.1%), *Citrobacter* spp. 10(4.3%), *Serratia marcescens* 6(2.6%), *Pseudomonas aeruginosa* 8(3.5%), *Proteus* spp. 5(2.2%), *Providencia rettgeri* 3(1.3), and salmonella spp.2(0.9%). These findings emphasized the importance of food handlers hand as potential vector of food borne bacterial pathogens that could constitute a potential risk of food borne disease outbreaks. Bacterial hand contamination rate have significant association with service years (Chi-square=13.732, DF=4, P=0.008), age ($\chi^2=11.308$, P=0.010) and cleanness of outer garments ($\chi^2=7.653$, P=0.006). Despite short course of informal food hygiene training none of the participants has been certified by formal training.

Based on the findings of the study the following recommendations are made:

As a responsible body to Jimma University:

Instruction regarding proper methods of hand washing should become a part of new employees, as well as young and inexperienced food handlers' orientation, education.

Food handlers should be well trained about personal hygienic practices pointing out on importance of hand hygiene and cleanness of outer garments

Close follow up, and regular supervision of personal hygienic practices of food handlers should be used as controlling strategies

Future studies should focus on enumeration of bacterial hand contaminants, and assessing sanitary facilities of the working environment.

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