Assessment of bacterial hand contamination and associated factors among food handlers working in catering establishments in Hossana town, Hadiya zone, south Ethiopia, 2023

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Research Article

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Abstract

Background: Hands are the major source of contamination, and can never be completely free of microorganisms, especially bacteria. Food can become contaminated by dirty hands if there is a lack of proper hygiene among the food handlers when handling food. Human hands are in regular contact with the surrounding environment, and a variety of pathogens can reach the mucous membranes in the mouth, nose, eyes, and genitals of humans through the hands and consequently contribute to foodborne illness outbreaks.

Objective: This study assessed bacterial hand contamination and associated factors among food handlers working in food establishments in Hossana Town, southern Ethiopia.

Method: A community-based cross-sectional study was conducted among food handlers at food establishments in Hosanna town, Hadiya zone, southern Ethiopia, from March 2023 to May 2023. A stratified random sampling technique was employed to allocate study participants to their catering establishment, and then a random sampling technique was applied to recruit participants. After signed consent was obtained, a structured questionnaire was used to collect data on sociodemographic and potential risk factors. The data were entered into EpiData version 3.1 and analyzed using the SPSS version 20 statistical package, and descriptive statistics were used to describe the variables. The chi-square test was used to identify factors associated with the outcome variable.

Results: The overall prevalence of bacterial positivity was 18/156 (11.5%), and among the identified bacterial isolates, 10/156 (6.4%) were Staphylococcus aureus, followed by Escherichia coli (5/156 (3.2%)), and Salmonella typhi. 3/156 (1.9%). The isolated pathogens were associated with those who were not trained in food preparation and handling, those who had no clean nails observed, poor hand washing after sneezing, poor hand washing after touching waste, and those who had no habit of hand washing after latrine usage (defecation) (p < 0.001).

This finding implies the need to strengthen the personal hygiene and redressal training of food handlers on personal hygiene guidelines to improve practices during food processing.

1. INTRODUCTION

1.1 Background of the study

Hands are the major source of contamination and can never be totally free of microorganisms, especially bacteria [Fagernes & Lingaas, 2011; Jacob, 1989; Käferstein & Abdussalam, 1999; Lin et al., 2003; Voigt, 1990]. Food can become contaminated via dirty hands if there is a lack of proper hygiene among food handlers. Human hands are in regular contact with the surrounding environment, and a variety of pathogens can reach mucous membranes in the mouth, nose, eyes, and genitals of human beings through hands and consequently contribute to foodborne illness outbreaks [Käferstein & Abdussalam, 1999; Lin et al., 2003].
Foodborne illnesses are a global public health concern and are often caused by the consumption of contaminated food. Food handlers play a critical role in food safety, as they are responsible for the preparation, handling, and serving of food. If food handlers have poor personal hygiene practices, they can introduce harmful bacteria and other pathogens into food, leading to foodborne illness outbreaks [Ifeadike et al., 2012; Josie et al., 2006; Saeeda & Hamid, 2010].

In Ethiopia, several studies have been conducted to assess the prevalence of bacterial contamination among food handlers in different regions and settings. Studies conducted in Addis Ababa, Gondar, Mekelle, Bahir Dar, Hawassa, and Jimma have reported varying prevalence rates of bacterial contamination among food handlers [Aklilu et al., 2015; Andargie et al., 2008; Araya et al., 2014; Bayeh et al., 2010; Desta et al., 2014; Mohammedaman et al., 2016; Mulat et al., 2013; Tsegaye et al., 2015]. However, limited research has been conducted in the Hadiya Zone, southern Ethiopia, particularly in Hossana town, to assess bacterial hand contamination among food handlers working in food establishments. This study aimed to fill this research gap by assessing the prevalence of bacterial hand contamination and associated factors among food handlers in catering establishments in Hossana Town, southern Ethiopia.

1.2 Statement of the problem

Like in many other African countries, food-borne illnesses are prevalent in Ethiopia, and the loss of human life and suffering is enormous. Epidemiologic data related to food-borne diseases are inadequate in Ethiopia. However, these conditions are very common in the country because of many reasons, including poverty, lack of awareness, poor water supply, poor personal hygiene and poor environmental sanitation. According to the 2016-2017 “Health and Health Related Indicators” published by the Planning and Programming Department of the Federal Ministry of Health of Ethiopia, helminthic infections were the second leading cause of outpatient visits, dysentery and different parasitic infections were also among the ten leading causes of outpatient visits, dysentery was among the leading causes of hospital admissions and deaths, typhoid fever, acute diarrheal diseases, bloody diarrhea and anthrax were reported as some of the major causes of outbreaks (FMOH, 2016/2017).

It is known that food handlers are a common source of foodborne diseases. The practice of good personal hygiene is essential for anyone who handles food, especially in food and drink establishments where many customers could be affected. A sick food handler with symptoms of diarrhea, eye and ear discharge, skin infection, open cuts and wounds, or coughing should not continue working. They must be treated and be completely recovered before returning to work (WHO, 1992).

Despite the increasing number of food sources in food establishments, no study has been conducted on bacterial hand contamination and associated risk factors in Hossana Town, Haddiya Zone.

1.3. OBJECTIVES
1.3.1. General Objective

The aim of this study was to assess bacterial hand contamination and associated factors among food handlers in the catering establishments of Hossana town, Haddiya zone, southern Ethiopia, in 2023.

1.3.2. Specific Objectives

1. To assess the bacterial hand contamination of food handlers at food establishments in Hossana town, Haddiya zone, southern Ethiopia

2. To identify factors associated with bacterial hand contamination of food handlers in the food establishments of Hossana town, Haddiya zone, southern Ethiopia

1.4 Significance of the study

Since no previous research has been conducted in Hossana town, this study aimed to identify bacterial hand contamination of food handlers in food establishments. The findings will help the concerned body and the owner emphasize and allocate resources to improve the overall repair and sanitary conditions of premises and to empower and equip food handlers with safe food handling practices in catering establishments.

2. Literature review

Food-related infections constitute an important public health problem in both developed and developing countries (Jacob, M. 1989). This problem is severe in developing countries due to difficulties in securing optimal hygienic food handling practices. In developing countries, up to an estimated 70% of cases of diarrheal disease are associated with the consumption of contaminated food (WHO, 2000). The World Health Organization estimates that 16 million new cases and 600,000 deaths from typhoid fever occur each year worldwide (WHO, 2003). Several studies have demonstrated that food handlers asymptotically harbor S. typhi (Senthilkumar, B., & Prabakaran, G. 2005). One of the historically notorious examples is the American cook “Typhoid Mary” (Mary Malon), which was responsible for 7 epidemics of typhoid fever affecting more than 200 people (Parikh, U. N., & Murti, P. 1987).

Accordingly, food handlers with poor personal hygiene and inadequate knowledge working in food serving establishments could be potential sources of infections of many enteropathogenic bacteria and parasites (Andargie, G. et al., 2008, and Voigt, J. 1990). Likewise, food handlers who harbor enteropathogenic bacteria may contaminate foods with their feces via their fingers, which in turn leads to food processing and ultimately to consumer infection (Käferstein, F., & Abdussalam, M. 1999). Compared to other parts of the hand, the area beneath fingernails harbors many microorganisms
and is difficult to clean (Lin, C. M. et al., 2003). More aggravated situations and challenges prevail in Ethiopia, where food safety issues are not well understood and have received little attention.

Moreover, cases of foodborne illnesses are rarely investigated in detail and underreported even if they are diagnosed in the form of an outbreak or an individual illness. In addition, research in the area of identifying the causative agent and food incriminated is also in its infancy because of a lack of well-developed laboratory systems, consumables and reagents for isolation identification and a lack of coordinated epidemiological surveillance systems. Therefore, the aim of this study was to assess the prevalence of bacterial hand contamination and associated factors among food handlers in Hossana Town.

2.1. Conceptual Framework

3. Methods and Materials

3.1. Study Area and Period

The study was conducted in Hossana town, southern Ethiopia. It is located 232 km from Addis Ababa, the capital of Ethiopia, and 170 km from Hawassa, the capital of SNNPR. The study will be conducted from March 2023 to May 2023.

3.2. Study Design

A community-based cross-sectional study design was applied.

3.3. Source population and study population

All food handlers from a selected catering establishment in Hossana Town, which has a license, will be study subjects, and all food handlers who are engaged in food preparation, serving, and cleaning and who have never used any antimicrobial agents in the last 2 weeks and during the study period will be studied.

3.4 Study participants

The study participants were purposively selected from the catering establishment from Kitchen and from waiters.

3.5. Inclusion and exclusion criteria

Inclusion criteria

All study participants who had worked for at least 6 months in the establishment and all food handlers who reported having never used any antimicrobial agents in the last 2 weeks or during the study period and who were working in food catering establishments such as hotels, cafeterias, restaurants, tea/snack houses, and fruit and juice houses were included in the study. Licensed food establishments were
included to obtain the actual information for this study, and these establishments are also expected to provide food services for large people.

**Exclusion criteria**

Severely ill participants and those who were on medication were excluded from this study. Food handlers in drinking service establishments and nonlicensed street food vendors or hawkers were excluded. Food handlers working in drinking service establishments were excluded because the risk of contracting disease caused by bacterial contamination is greater in food catering establishments than in establishments that provide only drinking services. In addition, food handlers who experienced skin irritation, eczema, or inflammation were excluded from the study, and people who were not willing to participate in the study were excluded. Participants with a history of antibiotic use 2 weeks prior to the study were excluded.

### 3.6. Sample size determination

The sample size will be calculated using a single population proportion formula

\[ n = \frac{z^2 p (1 - p)}{d^2} \]

- **n**: unadjusted sample size
- **z**: z value obtained from the standard normal distribution value (1.96 corresponding to the 95% confidence level)
- **p**: Prestudy estimate proportion, 50% because there is no published study indicating the prevalence in a similar setting.
- **d**: margin of error (0.05)

Therefore,

\[ n = \frac{(1.96)^2 (0.5(1-0.5))}{0.05^2} = 384 \]

Since the total number of the source population is less than 10,000, we used the correction formula

\[ nf = \frac{n}{1 + \frac{n}{N}} = n f = \frac{384}{1 + \frac{384}{226}} = 142 \]
nf with contingency = 142+(10%*142) = 156

3.7. Sampling techniques

According to the Hossana Town Trade and Investment Bureau (2016), there were 121 tea houses, 78 cafés and restaurants, and 27 hotels. To select representative participants, the final sample size was proportionally allocated to each stratum, and food handlers were selected using a simple random sampling technique. As a result, one food handler selected randomly from each catering establishment. Accordingly, 83, 54 and 19 participants from selected tea houses, cafés and restaurants and hotels, respectively, were included in the study.

3.8. Sampling Procedures

From each strata, the catering establishment was selected randomly, and the data collectors prepared a frame based on the strata.

3.9. Data collection tools and procedures

A pretested structured questionnaire was used to collect data relating to sociodemographic characteristics, personal hygiene practices of food handlers, lifestyle and behavioral factors, and work-related factors. The questionnaire was developed from validated tools (Araya et al., 2014; Fagernes and Lingaas, 2011; and Josie, 2006), prepared in English and translated into Amharic, and an observational checklist was used to obtain supplemental data. Five sanitarians and four medical laboratory professionals were selected for data collection. Before starting any meal preparation activities, including hand washing (if any), the participants’ hands were sampled for microbial testing. Notification was not given in advance, and extra hand hygiene was not allowed during data collection.

3.10. Laboratory data

3.10.1 Sample collection, transport and inoculation

Sterile cotton swabs (Puritan Low-Lint Cylindrical Tip) were prepared and dipped into sterile test tubes containing saline to collect samples from the fingernails and palm of the hand. Using these moistened cotton swabs, fingernail contents were collected from both hands of each subject by rubbing all over the surface under the nails. These samples were kept with normal saline in a test tube and transported to the Hosanna College of Health Science Laboratory by cold chain at approximately 4°C. The swabs were simultaneously inoculated on MacConkey agar for the growth of gram-negative bacteria and on mannitol salt agar for the growth of staphylococcal bacteria. Then, the remaining sample was subjected to Gram staining to obtain information about the reaction. All samples were cultured on the same day of collection.

3.10.2. Bacterial identification

All of the samples were inoculated onto MacConkey agar (Oxoid, Hampshire, UK) and mannitol salt agar (Oxoid, Hampshire, UK). After 24 h of incubation at 37°C, colony characterization of the isolates and
Gram staining were performed, and the species of the bacteria were identified following standard procedures using biochemical tests such as catalase, coagulase, indole, motility, triple sugar iron agar, citrate, and urea (Vandepitte and Verhaegen, 2003).

### 3.11. Study Variables

**Dependent variable**

Bacterial hand contamination.

**Independent variables**

- **Sociodemographic characteristics**
  - Age
  - Sex
  - Educational status
  - Marital status
  - Monthly income
- **Issues Related to Establishment**
  - Type of establishment
  - Ownership status of the building
- **Lifestyle and behavioral factors**
  - Smoking
  - Drinking alcohol
  - Habit of touching hair and/or nostrils
  - Habit of touching a mobile device
- **Work-related factors**
  - Work experience
  - Average working hours per day
  - Training status
- **Environmental factors**
  - Latrine facility
  - Water supply
  - Waste management
  - Housing Conditions
  - Cleanness of outer garments
  - Inspection status of the establishments
  - Personal hygiene
3.12. Operational definition of selected variables

**Bacterial hand contamination**

the presence of one or more potential foodborne bacterial hand contaminants

**Foodborne diseases** - intoxication, infection, or illness contracted by the consumption of contaminated food

**The food handler** is a person who is engaged in the process of food preparation, serving, cleaning, etc.

**Potential foodborne 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, such as hand washing using soap and water and keeping the body clean.

3.13. Data quality management

To maintain the quality of the work, the SOP was strictly followed during the 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) were used. Data consistency and completeness will be ensured throughout the data collection, data entry and analysis. Culture media were prepared based on the manufacturer’s instructions. The sterility of the culture media was checked by incubating 3% of the batch at 35–37°C overnight. The media that showed any growth were discarded.

3.14. Data Processing and Analysis

The data were entered into Epidata version 3.1 and analyzed by using SPSS version 20 (Copyright (c) SPSS Inc., 1997–2007, Polar Engineering and Consulting.) computer software. The data will be organized, summarized, and presented via simple descriptive statistical methods. The chi-square test was used to assess any possible associations between various categorical variables, and a p value < 0.05 was considered to indicate statistical significance.

3.15. Ethical Consideration

Ethical approval to conduct the study was obtained from the Hossana College of Health Sciences Research and Ethics Publication Committee (RPC), and permission to conduct the study was obtained from the Hossana Town Municipal Council. Further permission was obtained from the owners of the catering establishments, and written consent was obtained from each study participant. The confidentiality of the data was maintained by making the data collectors aware not to record any identification information found on the card. For those who are carriers of permanent intrinsic pathogens, appropriate referral linkages will be suggested.
3.16. Dissemination Plan

The findings of the study will be disseminated to different stakeholders, such as the Hossana Town Trade and Investment Bureau, Municipality, and other relevant offices.

4. Results

4.1. Characteristics of the study participants

A total of 156 individuals participated in this study, for a response rate of 100%. Among them, 53.8% were female, and 48.8% were aged between 20 and 24 years (mean age 22.92 ± 4.67 years and median 22 years). The majority (69.2%) of the participants were single, and 65.4% had completed primary school, followed by secondary school (23.1%). More than half of the participants (56.4%) were from café and restaurants, and 34% were from tea and breakfast. The majority (64.1%) of the study participants were engaged in waiter preparation, and 34% were working in food preparation in kitchens. The majority of food handlers (77.6%) had 1–2 years of work experience. Of the total participants, 15.5% were certified for training in food handling and preparation, and 62.7% had previously undergone a medical check-up, including a stool examination (Table 1).
### Table 1
Sociodemographic characteristics of the study participants

<table>
<thead>
<tr>
<th>Sociodemo variables Category</th>
<th>Frequency (n = 156)</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marital status single</td>
<td>108</td>
<td>69.2</td>
</tr>
<tr>
<td>Married</td>
<td>48</td>
<td>30.8</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>8</td>
<td>5.1</td>
</tr>
<tr>
<td>Primary (grade 1–6)</td>
<td>102</td>
<td>65.4</td>
</tr>
<tr>
<td>Secondary (9–10)</td>
<td>36</td>
<td>23.1</td>
</tr>
<tr>
<td>Diploma &amp; above</td>
<td>10</td>
<td>6.4</td>
</tr>
<tr>
<td>Preparing food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>34.0</td>
<td></td>
</tr>
<tr>
<td>Type of work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>waitering</td>
<td>100</td>
<td>64.1</td>
</tr>
<tr>
<td>Washing</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>Type of catering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td>15</td>
<td>9.6</td>
</tr>
<tr>
<td>Café and Restaurant</td>
<td>88</td>
<td>56.4</td>
</tr>
<tr>
<td>Tea and break fast</td>
<td>53</td>
<td>34.0</td>
</tr>
<tr>
<td>sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>72</td>
<td>46.2</td>
</tr>
<tr>
<td>Female</td>
<td>84</td>
<td>53.8</td>
</tr>
<tr>
<td>&lt; 20 years</td>
<td>64</td>
<td>41.0</td>
</tr>
<tr>
<td>Age groups 20–24</td>
<td>72</td>
<td>48.8</td>
</tr>
<tr>
<td>&gt;25</td>
<td>17</td>
<td>10.2</td>
</tr>
<tr>
<td>Total</td>
<td>156</td>
<td>100</td>
</tr>
</tbody>
</table>

#### 2.1.1 Prevalence of bacteria isolated from the hand swabs of food handlers

The overall prevalence of bacterial positivity was 18/156 (11.5%), and among the identified bacterial isolates, 10/156 (6.4%) were *Staphylococcus aureus*, followed by *Escherichia coli* 5/156 (3.2%) and *Salmonella typhi* 3/156 (1.9%), as shown in Table 2.
Among all the bacterial isolates, 11/72 (3.5%) were male, and 14/108 (13.9%) were single. Among all positive participants, 7/64 (10.9%) were less than 20 years old, and 15/102 (14.7%) had completed primary education, as summarized in Table 3.

### 2.1.2 Distribution of isolated bacteria among different variables

With regard to hand-washing practices, 80.2% of food handlers reported that they had a habit of hand-washing after using the toilet. Additionally, most of the food handlers reported that they had a habit of hand washing after touching different parts of their body (hair, nose, and ears) between handling food items (Table 4).

Pathogen prevalence and associated risk factors As shown in Table 4, 18 (11.5%) of the hand swab specimens tested positive for bacterial isolates. *S. aureus* (n = 10; 6.4%) had a greater frequency than did *E. coli* (n = 5; 3.2%) and *S. typhi* (n = 3 (1.9%), while no pathogen was isolated from the swabs of 148 (88.5%) participants. Different factors were assessed for a possible association with pathogen infections among the study participants (Tables 2 and 4). The greatest proportion of infections was detected in the < 20 years age group, but this difference was not statistically significant, as shown in Table 3.

All of the isolated pathogens were from individuals who were not trained in food preparation and handling. As illustrated in Table 4, the isolation rate of potential foodborne bacteria in swab samples was relatively greater among food handlers who had served for more than 8 hours (n = 15; 15.7%, P = 0.095) and was significantly greater among those who had no clean nails (n = 13; 35.5%), as shown in Table 4.

Regarding the habit of hand washing after defecation, 80.2% had a habit of hand washing after defecation. Among them, 1.6% were positive and 98.4% were negative for pathogens. Among the respondents who had no habit of hand washing after defecation (19.8% of the study population), 51.6% were positive and 48.4% were negative for pathogens. Therefore, the highest bacterial infection rate was observed in participants who had no habit of hand washing after latrine usage (defecation), and this difference was statistically significant (p < 0.001) (Table 4).
### Table 3
The distribution of bacterial positivity by sociodemographic variables using chi-square tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>Bacterial positivity</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>77</td>
</tr>
<tr>
<td>Marital status</td>
<td>Single</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>44</td>
</tr>
<tr>
<td>Age group</td>
<td>&lt;20 Years</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>20–24 Years</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>&gt; 25 years</td>
<td>14</td>
</tr>
<tr>
<td>Educational level</td>
<td>Illiterate</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Diploma &amp; above</td>
<td>10</td>
</tr>
<tr>
<td>Type of catering</td>
<td>Hotel</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Café and Restaurant</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Tea &amp; breakfast</td>
<td>46</td>
</tr>
<tr>
<td>Type of task</td>
<td>Food preparation</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Waiter</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Washing dish</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>148</td>
<td>18(11.5%)</td>
</tr>
<tr>
<td>Variables</td>
<td>Category</td>
<td>Bacterial positivity</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>136</td>
</tr>
<tr>
<td>Alcohol drinking</td>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>126</td>
</tr>
<tr>
<td>Respondent trend of touching hair or nose</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>during food preparation</td>
<td>No</td>
<td>132</td>
</tr>
<tr>
<td>Respondent trend of touching mobile phone</td>
<td>Yes</td>
<td>33</td>
</tr>
<tr>
<td>during food preparation</td>
<td>No</td>
<td>105</td>
</tr>
<tr>
<td>Work load</td>
<td>&lt; 8 hrs</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>8–12 hrs</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>&gt; 12 hrs</td>
<td>17</td>
</tr>
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<td>Training</td>
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<tr>
<td></td>
<td>No</td>
<td>111</td>
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<tr>
<td>Awareness on food born disease</td>
<td>Yes</td>
<td>87</td>
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<tr>
<td></td>
<td>No</td>
<td>51</td>
</tr>
<tr>
<td>Hand washing after toilet</td>
<td>Yes</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>15</td>
</tr>
<tr>
<td>Hand washing before starting food</td>
<td>Yes</td>
<td>127</td>
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<tr>
<td>preparation</td>
<td>No</td>
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</tr>
<tr>
<td>Hand washing after sneezing</td>
<td>Yes</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>14</td>
</tr>
<tr>
<td>Variables</td>
<td>Category</td>
<td>Bacterial positivity</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>Hand washing after touching waste</td>
<td>Yes</td>
<td>129</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>9</td>
</tr>
<tr>
<td>touching food by your bare hand during waitery</td>
<td>Yes</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>69</td>
</tr>
<tr>
<td>Hand washing area clean</td>
<td>Yes</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>24</td>
</tr>
<tr>
<td>Clean nail</td>
<td>Yes</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>148</td>
</tr>
</tbody>
</table>

5. Discussion

Food handlers are important vehicles for microorganisms, and improper handling practices may cause food contamination and consequently food-borne diseases, which pose a potential risk to public health (Tsegaye, A. et al., 2015). Published information about foodborne pathogens among food handlers is scarce in Ethiopia. Therefore, this study was undertaken to assess the prevalence and associated factors of bacterial isolates among food handlers in catering establishments in Hossana town in southern Ethiopia. Hand swab cultures of 18 (11.5%) food handlers were positive for pathogenic bacterial species. This finding is similar to those of previous studies performed in Ethiopia from Arba Minch, Ethiopia, where the reported isolation rate was 10% (Aklilu, A. et al., 2015). However, these percentages are greater than those reported for Gondar (3.1%; Mohammedaman, M., & Getaneh, A. 2016) and Addis Ababa (3.5%; Andargie, G. et al., 2008), and these percentages are lower than those reported for Abuja, Nigeria (62.6%) (Ifeadike, C. O et al., 20012) and Omdurman, Sudan (30.1%) (Saeeda, A. H., & Hamid, H. H. H. 2010). The discrepancies may be due to differences in the technique of pathogen isolation, the type of study participant, and the sample size. This rate of detection in the present study indicates that the hygiene conditions of the food handlers were challenging due to the isolation of enteric pathogens such as Salmonella and *E. coli* from hand swab cultures. Good hygiene practices, both personal and food handling, are the basis for preventing the transmission of pathogens from food-handling personnel to consumers (Mohammedaman, M., & Getaneh, A. 2016). Hand swab cultures revealed that Salmonella typhi was isolated from 1.9%, *E. coli* from 3.2% and *S. aureus* from 6.4% of the food handlers in the present study. This figure is comparable to that reported among food handlers at Gondar University.
cafeteria (2.7%) by Mulat, D. et al. (2013), at Gondar town by Andargie et al. (2008) (3.1%), and at Arba Minch University by Mohammedaman, M., & Getaneh, A. (2016), (3%). The present study demonstrated a greater rate of isolation than did reports from Hawassa, Ethiopia (0.4%), Sudan (1.3%), and Jordan (1.4%) (Saeeda, A. H., & Hamid, H. H. 2010, Mulat, D. et al., 2013, and Desta, M., 2014). This may be due to differences in technique, the type of study participants, and the sample size.

**Conclusion**

- A total of 156 individuals participated in this study, for a response rate of 100%.
- The overall prevalence of bacterial positivity was 18/156 (11.5%), and among the identified bacterial isolates, 10/156 (6.4%) were *Staphylococcus aureus*, followed by *Escherichia coli* 5/156 (3.2%) and *Salmonella typhi* 3/156 (1.9%).
- The isolated pathogens were associated with those who were not trained in food preparation and handling, who had no clean nails observed (n = 13; 35.5%), who had poor hand washing after sneezing, who had poor hand washing after touching waste and who had no habit of hand washing after latrine usage (defecation) (p < 0.001).

**Recommendations**

- The survey revealed the need to strengthen personal hygiene and refreshment training for food handlers according to personal hygiene guidelines to improve food processing practices.
- Promote optimal hand washing at critical times and hand washing facilities located near the latrine
- Hosanna town health unit office should inspect and intervene in the health and health-related problems of food and drink establishment
- Urban health extension workers should increase their effort to increase their awareness of personal hygiene during food preparation and handling through information, education and communication with food and drink establishment workers.
- Promising efforts must be made by the municipality, the Zonal Health Department, and kebele administrative and urban health extension workers by strengthening and organizing more effective and strengthening supervision, control and providing awareness creation activities to the community and food and drink establishment.

**Abbreviations**

- ATCC-American Type Culture Collection
- RPC- Research and Ethics Publication Committee
- SNNPR- Southern Nation Nationality Peoples’ Region
- WHO- World Health Organization
**Declarations**

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I, Ashena Woime, takes responsibility for the integrity of this research paper titled "Assessment of bacterial hand contamination and associated factors among food handlers working in catering establishments in Hosanna Town, Hadiya Zone, South Ethiopia, 2023." I designed the study, collected and analyzed the data, interpreted the results, and wrote the manuscript. I confirm that this manuscript represents an honest work of mine and have approved the final version.

I attest that I have made substantial contributions to the conception and design of the work and the acquisition, analysis, and interpretation of the data. I have drafted and critically revised the work for important intellectual content. I have approved the final version to be published and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. To the best of my knowledge, my statement fairly represents my contributions to this project.

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**Data Availability Statement**

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request due to their containing confidential information about human subjects. The data is available in Excel format. Aggregated data will be shared after obtaining permission from Hossana College of Research Ethics Review Committee which approved this study.

The datasets analyzed during the current study include hand swab samples collected from 156 food handlers working in catering establishments in Hosanna town to assess bacterial contamination. Samples were analyzed in the Microbiology Laboratory of the Hadiya Zone Health Science College using standard microbiological techniques and identified bacterial contaminants. Demographic and other associated factor data were also collected via interviewer-administered questionnaires.
While the raw bacterial culture results contain confidential human subject information and identifiers, deidentified data excluding personal details can be made available to other researchers upon reasonable request. This includes microbiological analysis results categorized by associated factor variables. All data are stored on a password-protected computer in the office of the corresponding author.

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Figures

Figure 1

Conceptual framework adapted from the literature

Supplementary Files
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- Annexes.docx