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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 specially 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.

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. 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. The 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 $n = \frac{Z^2 \cdot p \cdot q}{d^2}$

hand washing habit using soap and water is reported by 177(77%) after using 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

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

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 with cleanliness 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

most strains are harmless, some serotypes 0157:H7 can cause severe 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 checkup, 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.

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