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RESEARCH ARTICLE OPEN ACCESS

Hand Contamination among Food Handlers: A Study on the Assessment of Food Handlers in Canteen of Various Hospitals in Solapur City, Maharashtra

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Abstract

Food handlers often act as an important vehicle for the transmission of microorganisms responsible for causing foodborne illness, which pose as a major public health problem of global concern. Poor hygiene while preparation of food is a major source of illness caused by pathogenic microbes. This study was done for a period of 2 months after approval from the Institutional Ethical Committee. The study population included food handlers working in canteens of various hospitals in Solapur. Swabs from hands, nose and fingernail specimens were collected and inoculated on bacteriological culture media and identification was done using standard protocols. Data was collected using a structured questionnaire to evaluate the socio-demographic status and self-hygiene practices followed by the food handlers. Data were analyzed using an appropriate statistical test. All the people involved in food handling including the cook, server and cleaner were included after a written informed consent. The sample size was 45 food handlers. From the 45 food handlers which were included in the study there were 20 cooks (44.44%), 14 servers (31.11%) and 11 cleaners (24.45%) Out of these 45 food handlers 22 (49%) were males and 23 (51%) were females. Knowledge about basic health education was seen in 73.33% of the subjects, while only 18% were sensitized to hand washing, 22.22% had annual health examination, 35.5% wore finger ornaments. Of 45 food handlers 69% had trimmed fingernails, 73.3% washed their hands regularly. However, no association was found between these factors and hand contamination. This may be because none of the food handlers used soap or hand sanitizer to clean their hands. They used plain water to wash their hands. Food handlers act as an important source in transmission of foodborne illnesses therefore it is necessary to sensitize and create awareness amongst them about the importance of hand hygiene.

Keywords. Hand hygiene, food handlers, annual health examination, food borne illness

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INTRODUCTION

Food handlers act as an important source for dissemination of food borne illness and pose as a threat to the public health. Over the years due to high morbidity and mortality due to diarrheal diseases food borne illness have become public health problem of global concern[1]. According to WHO the statistics as on 30th April 2020 it is estimated that almost 1 in every 10 people fall sick due to intake of contaminated food items and 420,000 die every year due to food borne illness. Diarrheal diseases attribute to about 600 million people getting sick and about 420,000 deaths annually, which results in the loss of 33 million healthy daily life years (DALYs)[2].

In India the extent of the problem remains unclear due to fewer studies which include parameters like hand hygiene and awareness on food borne illness among food handlers. Often due to scarcity of resources outbreaks of food borne illness either go unreported or uninvestigated until the magnitude of problem is big in terms of health or monetary damage. It is important that steps should be taken to prevent future outbreaks by strengthening policies on food safety which are yet to be established[3].

WHO defined food handlers as those persons who in the course of their normal routine work, handle food or food items or those who may come into contact with handling of eating and drinking utensils not meant for their personal use[4]. Food contamination can occur by varied sources however food handlers often act as carriers of such infections due to lack of awareness about hand hygiene practices[5]. Poor hygiene while preparation of food could be potential source of infection due to pathogenic bacteria[6,7]. Food handlers can contaminate the food by spreading bacteria on the surfaces that food will come in contact example- work tops, food packaging before it is used, food handlers can also contaminate other surfaces such as door handles that enable transmission of bacteria to other food handler's hand who are involved in food preparation and serving[8]. Food handlers often transmit infection as they may carry these microbes as their skin flora, or may be present in their nasal secretions or stool[9]. As per CDC food handlers attribute to about 20% of food borne illness. For better tracking and investigation of food borne illnesses and outbreaks CDC has put forward surveillance systems like Pulsenet, Foodnet and the system for enteric disease response, investigation and coordination (SEDRIC)[10].

Hand hygiene is most important step to limit food borne illness. As often due to lack of hand hygiene hands of food handlers aid in food contamination. As hands are used right from cleaning food items to preparation and storage, thus unclean hands harbor pathogenic microbes which results in food borne illness. It is important to sensitize individuals handling food items about hand hygiene i.e. how to wash hands, when to wash hands and the duration of hand washing. Therefore until and unless such corrective measures are not followed properly it will be difficult to contain such episodes of food borne illness[12,13].

Food borne illness can be infectious or toxic in nature, caused by consumption of food. Food borne illness has been associated with 40 different kinds of bacteria, viruses, parasites and moulds[14]. Contaminated food may not look, taste or smell any different from food that is safe to eat. Most common symptoms of food borne illness include diarrhea and vomiting[15].

Staphylococcus aureus is a common colonizer in hands. Organisms like *Staphylococcus aureus* and *Escherichia coli* which are commonly associated with food borne illness can survive for days on the surfaces and unclean hands often result in episodes of diarrheal disease[16]. These microbes have been associated with food borne illnesses and have been associated with increase in mortality and morbidity among patients along with hospital stay and increase financial burden on the patients[17].

Food handlers in bigger eating establishment like hospital canteens, cater to large number of people including doctors, paramedical staff and patients attendants, these food handlers therefore are more important epidemiologically as compared to domestic food handlers in spreading food borne illnesses[1]. The cleanliness and personal hygiene of workers or food handler that handle food directly or indirectly must be managed to minimize the risk of contamination[18]. The availability of restroom and hand washing basins are important in preventing contamination of food produced by food handlers[19].

Food handlers are the individuals who are involved in food handling involving food preparation as well as serving of food[20]. WHO emphasizes that "outbreak of food borne diseases" can be decreased by adhering to self -hygiene practices among food handlers[21]. Various studies have shown that number of outbreaks of bacterial and viral infections and role of food handlers in causing food borne illness among individuals due to their poor sanitary practices and negligence in practices like regular hand washing[22,23]. Fecal-oral transmission is common mode of infection transmission that results in food borne illness. Food, water, nails, hands all can act as a vector for transmission of such infections[24]. In absence of proper hand hygiene nail bed may act as an important source of harboring pathogenic bacteria[25]. Individuals involved in preparation of food should avoid smoking, coughing, eating or handling money while food preparation as these practices may result in cross contamination[26]. Hand washing is the most important step to prevent spread of food borne illness[26,27].

Therefore present study has been undertaken with the aim to evaluate bacterial micro flora among food handlers with assessment of bacterial contamination on hands and anterior nares of food handlers which act as an important vehicle in transmission of infection to the food consumers, in our case food is consumed by doctors, paramedical staff, interns, students and attendants of patients admitted to the hospital. Therefore this study will help in tracking carriers and infected food handlers and help in increasing awareness among food handlers on importance of hand washing in prevention of spread of infection to others.

Aim and Objective

1. To evaluate hand hygiene among food handlers working in canteens across various hospitals in Solapur city, Maharashtra.
2. To evaluate the need of sensitization about hand hygiene among food handlers working in canteens of various hospitals in Solapur city, Maharashtra.

MATERIAL AND METHOD

The study was conducted among food handlers working in canteens of major hospitals in Solapur city, Maharashtra. The study was performed for a period of 2 months. All the people involved in food handling including the cook, server and cleaner were included after a written informed consent. The sample size is 45 food handlers.

Type of study- Cross sectional study

Source population- Those individuals concerned with food handling who work in canteen across major hospitals in Solapur were included.

Selection criteria

Inclusion criteria

All individuals who handle food including those involved in preparation, storage and cleaning not meant for their personal use[4] working in canteens of various hospitals in Solapur, Maharashtra. Food handlers should not be suffering from skin inflammation, eczema or irritation.

Exclusion criteria

Food handlers with any skin disease/ inflammation/eczema or irritation were excluded. Sample size- All food handlers working in canteens including cook, server and cleaner in major hospitals in Solapur were included in the study.

The total number of subjects were 45 food handlers.

Before the study was conducted permission from the institutional ethics committee was taken. Permission from other hospitals to conduct study on their food handlers was also taken. Written consent was taken from all the participants included in the study.

A structured questionnaire was used to record hygiene practices, level of education and socio demographic status of the food handlers. All the data collected from the individuals was confidential and not disclosed.

Questionnaire for Assessment of Hand Hygiene

Name: Age: Sex: Work in canteen:

1. Have suffered from diarrhea or vomiting over the last 7 days? Yes □ No □
2. Do you now, or have you ever suffered from:
a) Eczema, dermatitis or any other skin condition affecting hands, arms or face? Yes □ No □
b) Boils, styes or septic fingers? Yes □ No □
c) Discharge or infection of the eyes, ears, gums or mouth? Yes □ No □
3. Do you suffer from recurring diarrhea, vomiting

or a bowel disorder? Yes □ No □
4. Do you know the correct method to wash hands? Yes □ No □
5. Do you wash their hands regularly? Yes □ No □
6. Do you have short nails? Yes □ No □
7. Do you use hair protection? Yes □ No □
8. Do you touch food with your hands without washing? Yes □ No □
9. Do you wear finger ornaments? Yes □ No □
10. Do you have wounds or infectionson their hands Yes □ No □
11. Do you go for Annual health examinations? Yes □ No □
12. Do you use soap while washing hands? Yes □ No □

The association between various risk factors and contamination was found using Chi square test and Fischer exact test.

Procedure

Sterile swabs were used to collect samples from hand, nose and bed of fingernails. Before taking samples the swabs we moistened using sterile saline. This swab was then used to collect sample of each patient. The sample was immediately transferred to a sterile test tube and transported to Microbiology laboratory. The samples were inoculated on blood agar and Mac Conkey agar and nutrient agar and plates were transferred to the incubator for incubation for 18-24 hours. The plates were examined for growth after appropriate incubation. Bacteriological identification was done as per standard protocol[32]. Smears of growth were made and stained with using gram stain. On the basis of culture characteristics, smear microscopy, biochemical tests were performed. In case of gram positive cocci catalase, oxidase, coagulase- slide and tube, mannitol fermentation and bile esculin was used. While in case of Gram negative bacteria indole, Methyl red, Voges- Proskauer, Citrate tests were used for classification. Appropriate ATCC controls were used for identification of organisms. *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923.

The data was collected and analyses using Microsoft Excel 2010. The association between various risk factors and contamination was found using Chi square test and Fischer exact test.

After collection of sample the food handlers were taught the right method of washing their hands. They were educated about the benefits of hand washing and about the harms of not washing their hands properly. They were also educated about the kind of diseases that would spread if hand washing was not practiced.

RESULT

In the present study, samples were collected from 45 food handlers which included 20 cooks (44.44%), 14 servers (31.11%) and 11 cleaners (24.45%). As shown in Table-1.

The age group of the food handlers ranged from 18 to 75 years with mean age of 39.8 years. As shown in Table-2.

Among 45 food handlers 12 (27%) were illiterate and 33(73%) were literate. As shown in Table-3.

Out of 45 food handlers only 10 (22.22%) had annual health examination and only 8 (18%) were already sensitized for hand hygiene. As shown in Table-4 and Table-5.

All the food handlers were using only water and no soap to wash their hands while doing their chores.

Out of 45 food handlers 31 (69%) had short nails, 2(4.44%) of the food handlers were using hair protection, 16(35.5%) food handlers were wearing finger ornaments and 2(4.44%) of the food handlers had recent history of diarrhea and vomiting for which they were already treated. None of them had any wound or skin infection. As shown in Table-6 and Fig-1.

From a total of 45 food handlers, 65 bacterial isolates were obtained. Out of which 41(63.07%) were obtained from hands of food handlers while 24(37%) were obtained from anterior nares of the food handlers.

Table 1. Distribution of food handlers included in the study

No.	Work in canteen	Number	Percentage
1.	Cook	20	44.44%
2.	Server	14	31.11%
3.	Cleaner	11	24.45%
4.	TOTAL	45	100%

Out of the total 45 food handlers 22 (49%) were males and 23 (51%) were females.

Majority of bacterial isolates obtained from the hand and anterior nares were gram positive bacteria.

In the hands of the food handlers most common organism isolated were *Bacillus species* 18 (44%) followed by *Staphylococcus aureus* 10 (25%), *Citrobacter species* 6 (14.63%), *CONS (Cogulase negative Staphylococcus)* 3 (7.31%), *Proteus species* 2 (5%), *E. coli* 1 (2.43%) and *Enterococcus species* 1 (2.43%) Fig-2.

Table 2. Distribution of food handlers on the basis of age group

No.	Age group	Number
1	18-20	3
2	21-30	8
3	31-40	13
4	41-50	15
5	51-60	5
6	61-70	0
7	>75	1

Table 4. Annual health examination data among food handlers

No.	Annual Health Examination	Number	Percentage
1	Yes	10	22.22%
2	No	35	77.78%

Bacterial isolates from anterior nares of the food handlers showed majority of bacterial isolates of *Staphylococcus aureus* 12(50%) followed by *Bacillus species* 6(25%), *Diphtheroids* 5 (21%) and *CONS* 1 (4%). As shown in Fig-3.

Overall bacterial isolates obtained from hands and anterior nares of food handlers were *Staphylococcus aureus* 34% followed by *Bacillus species* 24.6%, *Diphtheroids* 20%, *Citrobacter species* 9%, *CONS* 6%, *Proteus species* 3.3% *E. coli* 1.5%, *Enterobacter species* 1.5%. As shown in Fig-4.

The association between hand

Table 3. Distribution of food handlers on the basis of literacy level

No.	Education	Number
1	No formal education	12
2	Primary	10
3	Secondary	19
4	Graduate	4

Table 5. Food handlers sensitized for hand hygiene

No.	Sensitized to hand hygiene	Number	Percentage
1	Yes	8	18%
2	No	37	82%

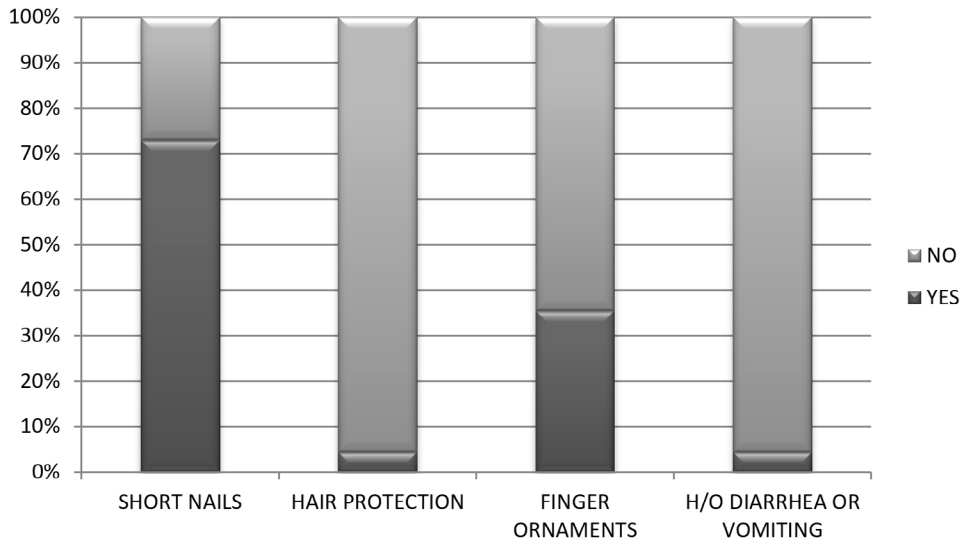

Fig. 1. Different parameters of self-hygiene practices among food handlers

contamination and various risk factors were found using Chi square test and Fisher Exact test. The results were as follows (as shown in Table-7).

DISCUSSION

Food handlers can act as an important source for spreading food borne illness. Proper implementation of self-hygiene practices, importance of hand washing, general health

Table 6. Self hygiene practices among food handlers

No.	Miscellaneous findings	Yes	No	Total
1	Short nails	31	14	45
2	Hair protection	2	43	45
3	Finger ornaments	16	29	45
4	h/o diarrhea or vomiting	2	43	45

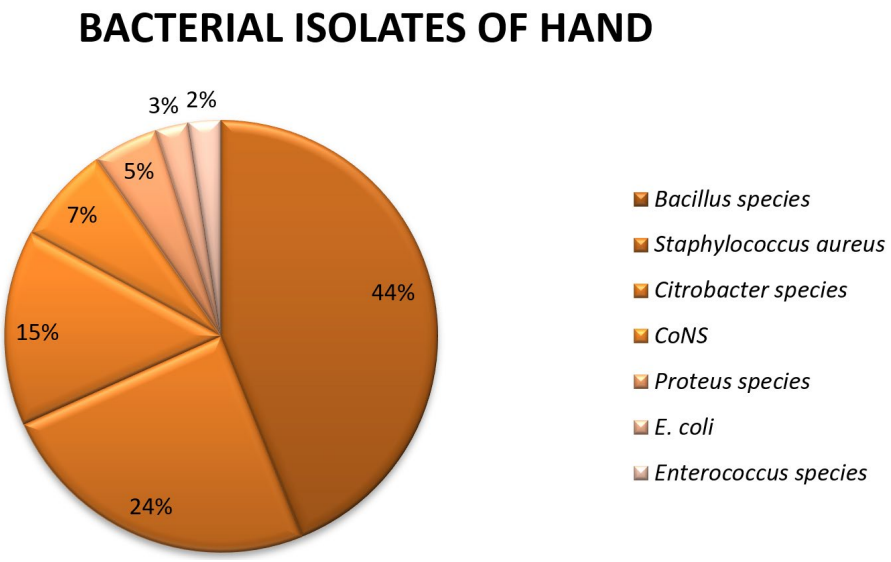

Fig. 2. Distribution of bacterial isolates from hands of food handlers

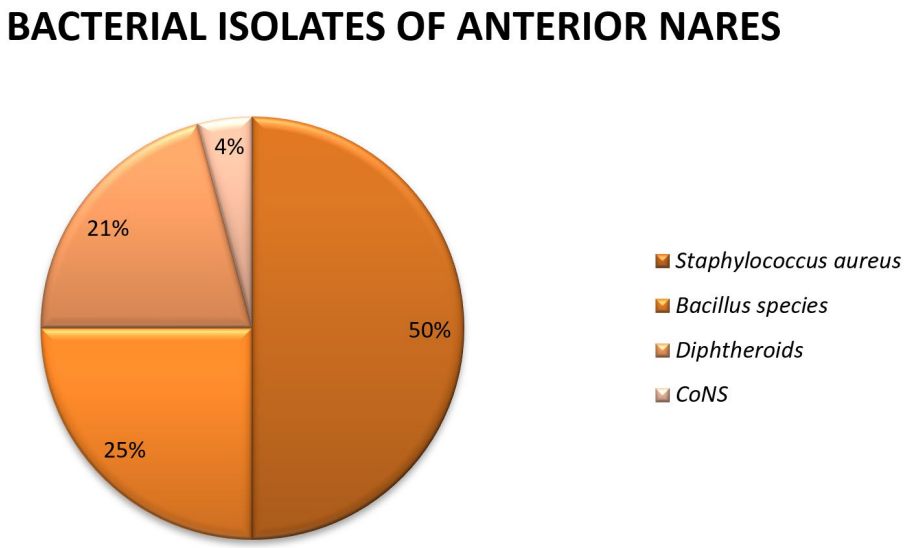

Fig. 3. Distribution of bacterial isolates from anterior nares of food handlers

Table 7. The association between hand contamination and various risk factors found using Chi square test and Fisher Exact test

Risk Factors	Hand Contamination		p- Value
	Present	Absent	
GENDER			
Male	13	9	0.463
Female	16	7	
EDUCATION			
<=4th grade	11	6	0.616
>=4th grade	16	12	
INFORMAL HAND HYGIENE TRAINING			
Yes	6	2	0.69
No	22	15	
REGULAR HAND WASHING			
Yes	21	12	0.746
No	7	5	
TRIMMED FINGER NAILS			
Yes	20	13	0.49
No	9	3	
FINGER ORNAMENTS			
Yes	11	5	0.502
No	17	12	
USE OF HAIR TIE			
Yes	1	1	1
No	16	12	
JOB POSITION			
Cook	12	8	0.92
Server	9	5	
Cleaner	8	3	
ANNUAL HEALTH EXAMNATION			
Yes	7	3	1
No	23	12	

education, annual medical check-up and formal education are important factors that may drastically reduce the prevalence of food borne illness cases world-wide especially in developing countries like ours[33]. In the present study we have studied 45 food handlers from major hospitals in Solapur city, Maharashtra. Of which cook were 20 (44.44%), servers 14 (31.11%) and cleaners were 11 (24.44%).

Among the food handlers 22 (49%) were males while 23 (51%) females. The age group of food handlers ranged from 18-75 years, none of the food handler was minor. Study done by Assefa et al[29] showed females were more commonly involved in food handling as compared to males while the study done by Hasan et al[14] and Allam et al[19] showed results in contrast to our study. In the present study majority of the food handlers had at least primary school education. The age group among food handlers was widely between 18-75 years but none of the age groups showed a cluster of cases within bacterial contamination of hand and anterior nares of food handlers. In the present study annual health check-up among food handlers was done for 10 (22.22%) individuals which is low. Study done by Nasrolahei et al[30] showed results similar to our study. Study done by Assefa et al[29] showed all food handlers in their study had regular annual check-up.

However, in the present study, no statistical association ($p>0.05$) was seen between hand contamination rate, age group, either sexes,

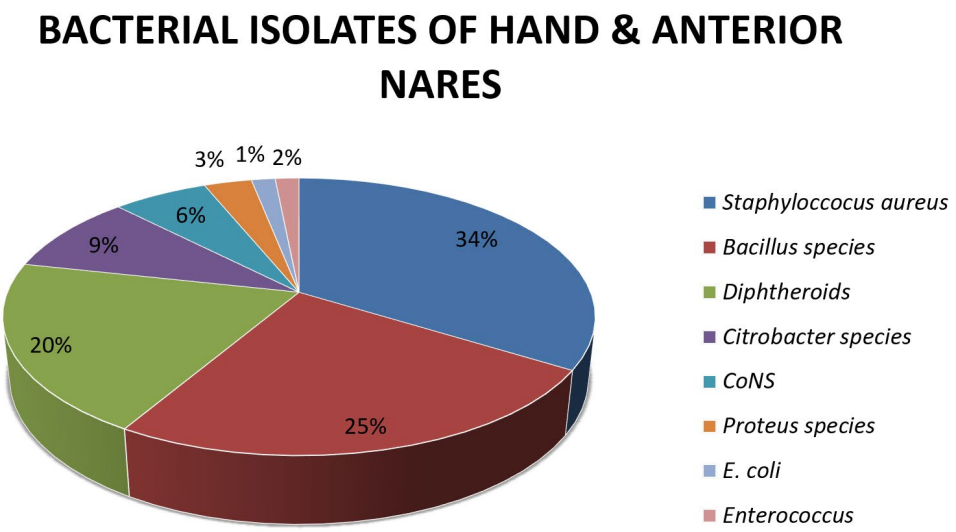

Fig. 4. Cumulative data on bacterial isolates obtained from hand and anterior nares of food handlers

education status, economical condition, annual medical check-up, use of hair-accessories, use of finger ornaments and fingernail status is seen. It also does not show association between informal hand hygiene training or regular hand washing with hand contamination. This may be because even though 73.3% washed their hands regularly and also 73.3% had trimmed nails none of them used soap or any kind of sanitizer to clean their hands. Hand washing with warm water and liquid soap is recommended for 40 – 60 seconds to reduce hand contamination[34]. This shows high level of negligence about hand washing among the food handlers and this led to the isolation of various bacterial isolates. Study done by Allam et al[19] shows results similar to our study, as food handlers lack standards of hand hygiene, however our study differs from their study as majority of food handlers in our study had their nails trimmed.

In the present study overall most common organism isolated from hands and anterior nares of food handlers was *Staphylococcus aureus* 33.84% followed by *Bacillus species* 24.61%, *Diphtheroids* 20%, *Citrobacter species* 9.23% , *CONS* 6.2%, *Proteus species* 3.07% , *E.coli* 1.53%, *Enterococcus species* 1.53%. Study done by Assefa et al[29] and Nasrolahei[30] showed *Staphylococcus aureus* as the predominant organism isolated from food handlers. However the percentage of *Staphylococcus aureus* in the present study is less than that in the study done by Mohtaram Nasrolahei[30] probably because of the type of food establishment, difference in literacy and hand hygiene practices.

Allam et al[19] assessed the hand contamination of food handlers working in Menofia University and Shebin Al-Kom educational hospital in 2016. They assessed 72 food handlers by using a pre structured questionnaire, collecting data about the socio-demographic characteristics, personal hygiene practices and risk factors of contamination. A sterile polyethylene bag containing 100 ml of peptone was used to collect hand rinse samples. This method is different from the one done by Mohanad Hasan Mohamed Honua[14] in Sudan in 2018 where the sterile swab method was used. However it is similar to the methodology used by Shojaei et al[28] in Iran in 2005 and Assefa et al[29]

In the study done by Allam et al[19] 70.8% of food handlers were male. This is because food handling in Egypt is mainly a men occupation. Majority of isolates were of *E. coli* 41.7% and of *Staphylococcus aureus* 29.2%. The study showed being illiterate, ignoring hand washing after toilet and not trimming finger nails regularly are

important sources that contribute to food borne illness.

Nasrolahei et al[30] assessed 220 food handlers in Sari city, Iran in 2016. In this study structured questionnaire was given asking about important parameters which included age, sex, literacy level, health education status, income and hand hygiene practices. In this study also males were more than females. The study showed highest prevalence of *Staphylococcus aureus* 46%, followed by *E. coli* 29.2% which is in contrast to the study done by Allam et al[19] The results are consistent with the study done by Assefa et al[29] which also showed highest prevalence of *Staphylococcus aureus* 23.5% followed by *E. coli* 10.9%. The study also isolated *S. aureus* 65% from the anterior nostrils of the food handlers. Highest prevalence of *Staphylococcus aureus* in the study done by Nasrolehei et al[30] is because it is the true pathogenic bacteria included in the resident micro-flora of the skin and 40-50% of the healthy people carry *Staphylococcus aureus* in their anterior nares of the nose[31]. In this study highest rate of bacterial infestation was found among people with low income level. Hence it is estimated that better the living conditions lower the prevalence rates. In this study no significant difference in the rate of bacterial contamination was observed in between two genders.

The study done by Tsegaye Assefa and et al[29] in 2015 however found no association between bacterial hand contamination and gender, educational background, medical check-ups, training in hand washing, finger nail status, hand washing habits of food handlers. However it was found that a significant difference in the age groups with the younger age groups having higher bacterial contamination. It also showed significant association of bacterial contamination and cleanness of outer garments. There was also significant association between bacterial contamination and service experience. It showed that food handlers with more work experience had less risk of bacterial contamination. Source of gastroenteritis associated by *Staphylococcus aureus* toxins can be from nose or skin flora of carrier food handlers[37]. Lack of hand hygiene practices by food handlers can easily lead to contamination of food thus resulting in food borne illness among people consuming such food items[36,37].

Presence of organisms like *Bacillus species* in the hands of food handlers may be due to contact with contaminated raw products like vegetables, unwashed fruits, poultry[38].

Isolation of *Diphtheroids, CONS* and other enteric pathogens like *Citrobacter, E. coli* can be easily removed by washing hands with soap and water as these are transient flora acquired during course of their work. Isolation of such organisms in the present study shows potential of feco–oral transmission of pathogens indicating that compliance of hand hygiene practices is lacking among food handlers[39].

Hence it is most important that there should be regular check-up and lectures to sensitize food handlers on importance of hand washing to prevent spread of food borne illness among healthy individuals. Infected employees should be immediately relieved from their duties for proper treatment and should be excluded completely from handling of food items in any way. Till the time, they are appropriately treated. There is a need for proper screening procedure which will be helpful to diagnose food handlers who are carrier or infected and treat them and thus lead to decrease in morbidity among people having food from these outlets.

WHO recommends hand washing for 20-30 seconds if hand is not visibly soiled and 40-60 seconds if visibly soiled. It also recommends the use of alcohol based sanitizer and antibacterial soap respectively. The food handlers need to be educated about this to improve their personal hygiene.

CONCLUSION

Food handlers may act as important source for food borne illness. It is important to sensitize persons involved in food handling about hand hygiene, self-hygiene practices, as due to lack of this knowledge these people tend to contaminate food and thus results in food borne illness, which poses as public health problem of global concern. It is essential that higher authorities should arrange awareness programs for these people about hand hygiene, and importance of hygiene in food handling. The

authorities should make a provision of annual medical check-up and immunization of these food handlers to prevent outbreaks of food borne illness. Lack of proper food handling practices has been attributed as a leading cause of majority of food borne diseases.

Recommendation

- All food handlers should be taught the right technique of hand hygiene.
- Routine checkups should be conducted on all food handlers at least annually. Appropriate treatment should be administered to those who are found to be infected.
- Infected food handlers should not be allowed to perform any work that includes touching the food directly or indirectly example washing utensils, etc.
- Provide proper wash basins and alcohol containing soaps do that the food handlers can wash their hands.
- Food handlers should be encouraged to use alcohol based sanitizer or antibacterial soap to wash their hands.

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None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

All author's listed have made a substantial direct and intellectual contribution to the work and approved it for publication.

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DATA AVAILABILITY

All the data set generated or analyzed during this study are included in the manuscript.

ETHICS STATEMENT

The study was approved by the institutional ethics committee (IEC) Dr. Vaishampayan Memorial Government Medical College ,Solapur, Maharashtra-413524 . Permission from other hospitals to conduct study on their food handlers was also taken. Written consent was taken from all the participants included in the study.

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