Original Article

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Microbial Contamination and Poor Hygienic Practices among Food Handlers in a Slum of Kolkata: A Matter of Concern

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Abstract

Purpose: Unsafe methods of food processing and food handling with relative lack of proper storage facilities possess higher risk of food-borne diseases. Current IDSP data suggested that nearly half of reported out breaks were food-borne. Proper hygienic practices are essential to preclude the microbial contamination from food establishments through sanitation barrier.

Objectives: To find out the prevalence and predictors of poor hygienic practices and microbial contamination of hands among food handlers.

Materials and Methods: A cross-sectional study was conducted among 137 randomly selected food handlers in Chetla, Kolkata from June to September 2019. Participants were interviewed using a predesigned, pretested schedule. Hygienic practices were observed using a predesigned pretested checklist. Micro biological assessments of hand swabs were also conducted. Data were analysed using SPSS version 16.0 and logistic regression was used.

Results: Microbial contamination was observed in nearly two-third (69.3%) of the participants' hand. High colony count (≥20 CFU/cm²) was noticed in 40% cases. Staphylococcus aureus was the commonest (36.5%) identified bacteria in their hand. Most of them (56.9%) had poor hygienic practices. Majority had an unsatisfactory level of knowledge (78.8%) and attitude (68.6%). Positive growth was significantly associated with Poor hygienic practice (P-value <0.01), unsatisfactory level of knowledge (P-value <0.01) and attitude (P-value <0.05).

Conclusion: High prevalence of bacteriological growth indicated failure in safe food handling practices. Further training is needed to improve their knowledge, attitude and practices regarding safe food handling. Effective and inclusive food safety policy and legislation is the need of the hour.

Keywords: Food Safety; Food Handling; Food-Borne Diseases; Drug Resistance-Microbial; Hand Hygiene.

Introduction

Access to ample quantities of safe and salubrious food is pivotal to enduring life and promoting good health. Unsafe food carrying pathogenic bacteria, viruses or parasites accounts more than 200 diseases ranging from diarrhoea to cancers. The World Health Organization (WHO) reports that 600 million fall ill after eating contaminated food and 4,20,000 die every year, culminating in the loss of 33 million healthy life years (DALYs),

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more so in developing capitals.[1] The trend of street food vending is mushrooming in India. These provide a source of economical, easily available and often salutary food in urban area. Integrated Diseases Surveillance Programme (IDSP) showed food borne outbreaks constitute nearly half of all reported outbreaks in 2015-17.[2]

Unsatisfactory personal hygiene most importantly in effective hand washing has been identified as a significant risk factor of food poisoning.[3] Hand hygiene is the most basic yet critical measure for ensuring safe food handling by food handlers.[4–8] Therefore, it is speculated that hand hygiene could play as an indicator of food handlers' adherence to safe food practices during food preparation. Food safety, nutrition and food security exist in a labyrinthine association. Unsafe food forges a vicious cycle of disease and malnutrition, particularly affecting extremes of ages and the infirm. Food borne diseases thwart socioeconomic advancement by straining health care systems, and harming national economies, tourism and trade.[1] To prevent the contamination from food settlements we have to find out the epidemiological co-relates of poor food hygiene. Testimony on the food safety and hygiene practices of food handlers is sparse in the eastern part of the country. In present study, microbiological evidence on hand hygiene was assessed among street food handlers in an urban community in Kolkata and its determinants had been found out.

Materials and Methods

Work place based observational study with cross-sectional design was conducted from June to September 2019 at urban field practice area of the institute in Chetla, Kolkata. The food handlers of various food establishments as well as street food vendors residing in the study area and working for at least six months were included in the study. Food handlers unwilling to participate were excluded from the study.

Sampling: Using standard formula for sample size calculation, Sample size (N) = Z 2 PQ/L2 Where, P = prevalence, Q = 1-P, Z = standard normal deviate and L = absolute precision, Z (at confidence level 95%) = 1.96. Prevalence (65%) of microbiologically confirmed hand swab among food handlers was taken from Malaysia study.[9] Taking 8.5% absolute precision minimum sample size 124, with 10% non-response rate final sample size = 137 food handlers. The list of food handlers were obtained from the Occupational Health register of Urban Health Unit. By random number table, 137 food handlers were selected by simple random sampling from the list.

Study Tool: A pre-designed, pre-tested, structured schedule developed by the researchers including items on socio-demographic, respondents' knowledge, attitude and observed practices on food safety and hygiene containing both open and close ended questions was used. The schedule consisted of 59 items on demographic information (14 items), food safety knowledge (16 items), attitude (9 items), and observed checklist for practices (20 items). Food safety knowledge was assessed based on three constructs (i) personal hygiene (7 items); (ii) cross-contamination prevention and sanitation (6 items) and (iii) food borne diseases (3 items). The respondents were required to choose either "correct" (score = 2), "don't know" (score = 1) or "incorrect" (score = 0) for each item on food safety knowledge.

For items under the attitude section, 5 point Likert scale was used with the lowest point (1 point) was given to "strongly disagree" to the highest (5 points) for "strongly agree". The participants were given a score of 1 for "Good practice" and 0 for "bad practice" in observed checklist.

Data Collection

This study was approved by Institutional Ethics Committee of AIIH & PH (Certificate no. PSM/IEC/2018/4 (dated 11th October, 2018). Confidentiality was maintained through out the process. Informed written consent was obtained from all participants' prior data collection. Multiple visits were conducted in the work place of those food handlers. At first participants were interviewed with a predesigned pretested schedule. Second visit was done to collect hand swab from the participants'. Each sterile swab was dipped into a sterile test tube containing peptone water to moisten the swab tip and swabbed over the palm and fingertips of the food handler's dominant hand, collected from 12:00 p.m. - 1:00 p.m. when the food handlers were preparing food, and then transported in vaccine carrier maintaining SOP (as per WHO guideline) to the microbiology lab of the institute within 1 hour of collection.

Microbial Analysis: He swabbed samples were put into nutrient agar culture media for growth under controlled environment. Test used for identification of *Staphylococcus* species were Catalase and slide coagulase test using pooled human plasma. *Bacillus* cereus was identified by dry colonies, Gram staining, positive lecithinase activity in Egg Yolk agar and inability to break down mannitol.

Antibiotic susceptibility testing (AST) was conducted following the *Clinical & Laboratory*

Standards Institute (CLSI) guidelines. For these purpose Mueller Hinton Agar plate and Kirby Bauer disk diffusion method were used. Antibiotics used for *Staphylococcus aureus* were methicillin, ciprofloxacin, erythromycin and tetracycline. For Gram negative bacilli susceptibility testing ciprofloxacin, erythromycin and tetracycline were used.

Data Description and Analysis

Data was analysed using Microsoft Excel 2007 and Statistical Package for the Social Sciences version 16 (SPSS for Windows, version 16.0, SPSS Inc., Chicago, USA) software. Descriptive statistics was performed to assess the background characteristics. Maximum and minimum attainable score for knowledge were 28 and 0 respectively, for attitude (based on 5 - point Likert scale) and self-reported practice score it was 45, 9 and 20, 0 respectively. Univariate and multivariate logistic regression analysis conducted to find significant association of hand swab result with its predictors, if any.[10]

Operational Definition

The scores were dichotomized into knowledge as *satisfactory* - ≥21 out of 28 (3rd quartile)/ *unsatisfactory* - (<21 out of 28), attitude as *satisfactory* - (≥33 out of 45 (3rd quartile)/ *unsatisfactory* - <33 out of 45), taking 75th percentile of attained score as the cut off and for practice as *satisfactory* - (≥11 out of 20)/ *unsatisfactory* - (<11 out of 20), taking 50th percentile of attained score as the cut off.

Microbiological Hand Swab Test

Positive if any of the non-commensal bacteria found to be present on the culture media plate after inoculation of sampled swabstick into the petri dish containing growth media for defined period following standard operating procedures.

Results

Background Characteristics: Mean age of study population was 38.2 years (± 12.4). Majority (71.5%) of study participants were male. Majority (94.1%) of study population belonged to Hindu. Out of total 137 participants, 85.4% of subjects were married. Mean years of schooling was 6.7 (± 0.32) years. 15.3% of study population had no formal education. Approximately two third of the study participants' per capita monthly family income were below INR 2000. Food processor consisted 35.8% and street food vend or comprised of 19% and rest (45.2%) of the participants belonged to mixed job category. Participants involved in these work for more than a decade comprised of 43.8%. (Table 1)

Knowledge, Attitude and Observed Practice

Table 1: Distributions of Background Characteristics of the Study Participants (N= 137)

Variable	Characteristics	Number (%)	Descriptive Statistics
Gender	Female	39 (28.5)	-
	Male	98 (71.5)	
Age (in years)	<40	87 (63.5)	Age in years
	≥40	50 (36.5)	Range = 17 to 67
			Mean (SD)= 38.19 (12.37)
			Median (IQR)= 38 (29, 48)
Educational level	Above primary	45 (33.0)	Years of schooling
	Primary and below	92 (77.0)	Range = 0 to 15
			Mean (SD) = 6.70 (3.84)
			Median (IQR)= 8 (4,10)
Religion	Hindu	129 (94.2)	_
	Muslim	8 (5.8)	
Marital status	Married	117 (85.4)	_
	Never married	15 (10.9)	
	Widow/widower	5 (3.6)	
Modified BG Prasad Social class (2019)	I	0 (0)	Per Capita Income (INR)
	II	15 (10.9)	Range = 714 to 6000
	III	37 (27.0)	Mean (SD)= 2097.8 (1008.3)
	IV	69 (50.4)	Median (IQR)= 2000.0(1333.3
	V	16 (11.7)	2500.0)
Job type	Food processor	49 (35.8)	_
	Street food vendor	26 (19.0)	
	Mixed	62 (45.2)	
Job years	>10 years	77(56.2)	_
	≤10 years	60 (43.8)	

The prevalence of unsatisfactory knowledge was 78.8% among the participants. of the three constructs on food safety knowledge tested, the respondents scored highest in the construct of personal hygiene (mean score = 54.8±24.1%) but performed poorly in the construct of cross-contamination prevention and sanitation (mean score = 37.5 ± 21.7%) and food borne diseases (mean score = 33.7 ± 27.3%). With regards to food safety attitude the participants showed unsatisfactory results in 68.6% of the respondents. The observed practices assessed demonstrated that unsatisfactory observed practice was seen among 56.9% of participants. (Fig. 1)

Fig. 1: Distribution of Knowledge, attitude, practice of participants (N=137)

Microbiological Findings

On bacteriological culture, most of the respondent's hand swab sample (69.3%) showed growth of at least one pathogenic bacterium. *Staphylococcus aureus* detected on most (36.5%) of the food handlers' hand followed by *Coagulase Negative Staphylococcus* (26.2%), *Bacillus cereus* (19.7%), Anaerobic spore bearer (19%), Small Gram Positive Cocci (9.5%) and 18.2% of the sample tested positive for other pathogenic bacteria. (Fig. 2) These bacteria consisted of *Acinetobacter baumannii, Bacillus species other than Bacillus cereus, Citrobacter koseri, Enterobacter cloacae, Enterobacter aerogenes, Streptococcus bovis, Acinetobacter lwoffii, Moraxella catarrhalis, and Staphylococcus saprophyticus.*

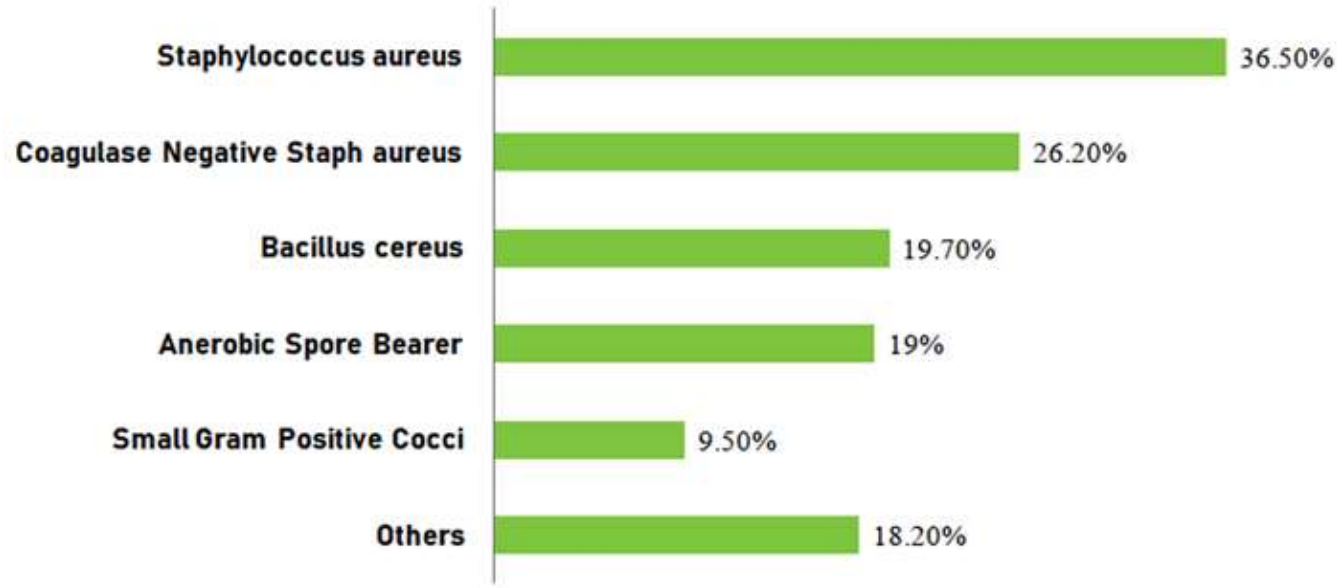

Fig. 2: Distribution of study participants according to microbiological assessment of hand swab

Bacteriological Profile

Hand hygiene assessment of the food handlers participating in this study revealed that 39.4% (n = 54) of them had an aerobic bacterial count exceeding the threshold of ≥20 CFU/cm2 based on Sneed *et al.*[11] and Tan *et al.*[12] Most alarmingly all the bacteria developed resistance to one or more of the antibiotic in Antimicrobial susceptibility testing (AST) mostly seen in Coagulase Negative Staphylococcus aureus (77.7%), followed by Staphylococcus aureus (56%) and Bacillus cereus (55.5%). (Table 2) Among 50 hand swab sample positive for Staphylococcus aureus 11 (22.0%) tested methicillin resistant (MRSA) in AST.

Table 2: Distribution of Study Participants According to Bacteriological Profile (N=137)

Microbial indicator	Number (%)	Min. C.F.U* count/cm²	Max. C.F.U count/cm²	Resistance to C/S test (%)
CONS†	36 (26.2)	2	110	28 (77.7)
S. aureus	50 (36.5)	6	300	28 (56.0)
B. cereus	27 (19.7)	1	30	15 (55.5)
ASB‡	26 (19.0)	1	10	5 (19.2)
Small GPC§	13 (9.5)	3	100	7 (53.8)
Others	25 (18.2)	2	200	2 (8)
Total	95 (69.3)	-	-	No (%)

*Colony Forming Unit, † Coagulase Negative Staphylococcus, ‡ Anaerobic Spore Bearer, § Gram Positive Cocci

Association with Related Factors

Univariate logistic regression analysis showed statistically significant association of positive hand swab test for pathogens within satisfactory knowledge about food borne disease (OR=1.69; P-value <0.01), knowledge about personal hygiene (OR = 1.31; P-value<0.05), knowledge about cross-contamination prevention and sanitation (OR= 1.73; P-value<0.05), attitude (OR= 6.61; P-value <0.05) and observed practice (OR = 14.80; P-value <0.01) with whereas it showed statistically insignificant association with unsatisfactory self-reported practice (OR = 2.69; P-value >0.05). (Table 3).

Multivariate logistic regression analysis retained strong association of unsatisfactory attitude (AOR = 6.47, P-value<0.05) and unsatisfactory observed practice (AOR= 14.61, P–value<0.05) with positive hand swab test for bacteria. This model explained 11-15% variance of dependent variable i.e. microbiological status (Nagel Karke R2= 0.15, Cox and Snell R2= 0.11) with goodness of fit (Hosmer-Leme show = 0.217).

Table 3: Association of positive growth with Co-variates in a Logistic Regression Model (N= 137)

Independent variable	Hand swab Growth positive (%)	OR (CI) for Growth positive hand swab; P-value	AOR (CI) for Growth positive hand swab; P-value
Sex			
Male	70.5	1.17 (0.52 – 2.67)	–
Female	61.3	1 (P-value = 0.07)	–
Age (years)			
<40	66.3	1.48 (0.70 – 3.10)	–
≥40	53.4	1 (P-value = 0.03)	–
Monthly PCI (in INR)			
>2000	56.2	2.14 (0.96 – 4.57)	–
≤2000	43.2	1	–
Job Type			
Food processor	71.4	1.37 (0.61 – 3.08)	–
Street food vendor	21.1	1.83 (0.64 – 5.24)	–
Mixed	64.5	1 (P-value = 0.40)	–
Job duration (in years)			
>10	57.9	3.65 (0.94 – 8.37)	–
≤10	32.5	1	–
Knowledge about food-borne disease			
Unsatisfactory	86.1	1.69 (1.02 – 4.73)	–
Satisfactory	36.9	1 (P-value <0.01)	–
Knowledge about personal hygiene			
Unsatisfactory	64.3	1.31*	–
Satisfactory	25.7	1 (P-value <0.05)	–
Knowledge about cross-contamination prevention and sanitation			
Unsatisfactory	73.8	1.73 (1.10 – 5.39)	–
Satisfactory	26.2	1 (P-value <0.05)	–
Attitude			
Unsatisfactory	80.9	6.61 (2.18 – 20.04)*	6.47(1.90 – 21.96)
Satisfactory	19.1	1 (P-value <0.05)	–
Observed Practice			
Unsatisfactory	76.9	14.80 (5.81–37.64)*	14.61 (5.52 – 38.70)*
Satisfactory	9.3	1 (P-value <0.01)	–

Discussion

In the knowledge domain, significant association of positive hand swab growth was seen with each of the constructs i.e. personal hygiene, cross contamination prevention and food borne diseases. This showed that current study findings were consistent with several studies.[14–17] In current study the proportion (21.2%) of participants having satisfactory knowledge was low compared to findings by Bas *et al.*(43.4%), Marais *et al.* (46%), and Gomes *et al.*(56.5%) and Araujo *et al.* (62.5%) for food handlers.[13,17–19] Angelillo *et al.* suggested that food handlers who had good knowledge of proper food handling practices could aid to curb food poisoning because of their immediate contact with food, particularly ready-to-eat foods.[20] In this study the majority of food handler's food safety attitude was unsatisfactory and similar attitude was seen by Lee H K *et al.*[9] suggesting lack of concerns about keeping ready-to-eat food safe for consumption. This study found out higher prevalence of unsatisfactory food safety practices in contrast to the study findings by Kubde *et al.*[21] Another study conducted by Malhotra *et al.* Among food handlers working in North India found prevalence of entero-parasite infestation to be 41.1% and hand washing practices were observed to be poor with low use of soap.[22]

A microbial assessment to examine the hand hygiene of the food handlers was conducted to obtain a better insight into the evidence of current food safety practices. It reflects the actual practices of safe food handling and at the same time could

be used to validate the self-reported practices. The findings from this study were not encouraging as very large number of food handlers were found to have microbial counts exceeding the standards (Table 3). More alarmingly, Staphylococcus aureus was detected on the hands of about one third (36.5%) of the food handlers while other studies by Okareh *et al.*, Yap M *et al.*, Loeto D *et al.* showed similar findings of 38.3 % and 30 % and 30.9% in hands-swab samples among the food handlers.[23–25] A study by Assefa *et al.* found prevalence of Staphylococcus aureus 23.5%[26] Almost one quarter (26.2%) showed Coagulase negative staphylococcus in their working hand which was almost similar to the study finding (28.4%) by Udo EE *et al*.[27] This study found Bacillus cereusin 19.7 % of hand swabs while another study by Yap M *et al.* showed the similar only in 5% of food handler hands, where as another study by Woh PY *et al.* found similar prevalence (25%).[25,27] Staphylococcus aureus ranged between 6 and 300 CFU/cm^2 on dominant hand finger tips. These microbes are frequent inhabitants of the skin and mucous membranes and 20% to 60% of normal healthy adults may be carriers of Staphylococcus aureus.[29] Its presence in fingertips during food preparation may be attributed to it being introduced into the food during cutting, chopping or mixing after cooking by contamination from other body parts of vendors. In a study done in the Johannesburg area, South Africa, by Mosupye *et al.* reported similar observations.[30] Another important co-finding of the current study showed that there is critically greater spectrum of antimicrobial resistance of the isolated bacteria indicating a double fringeds word for this industry. In the current study Staphylococcus aureus was shown to be resistant to one or more of the antibiotics in AST in nearly half (56%) of the isolates which is lower than study findings of 73.5% by Loeto *et al.*[25] The prevalence of MRSA among the isolates positive for Staphylococcus aureus in this study was 22.0% which is almost similar to the findings (22.4%) by Loeto *et al*.[25]

Conclusion

The meagre performance in the hand hygiene assessment illustrated a deficient definite practice in food handling. The current finding suggested a call for scrutinizing the effectiveness of safe food handling practices. It was professed from this study that a good knowledge is not emblematic of satisfactory food safety practice. Current nation wide safe food handling initiative under FSSAI should improve dissemination of food safety knowledge, but most importantly intervene to make safe food handling practices among street food handlers. Evidence should be build up to unearth the predictors that impede the conversion of knowledge into food safety behavior so that an effective food safety policy can be instituted.

By exercising microbiological evaluation, this study yielded evidence for magnitude of translation of knowledge into real hygiene and safety practices. It may provide an imperative justification for planning and determination of further approaches to be taken to improve food safety in the country. Forth comingre search should implicate partnership with the government and a larger population of food handlers so that the authority can establish a more comprehensive approach to ensure food safety.

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