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# Efficacy of simple hand-washing in reduction of microbial hand contamination of Iranian food handlers

Hasan Shojaei <sup>a,\*</sup>, Jafar Shooshtaripour <sup>b</sup>, Masoud Amiri <sup>c</sup><sup>a</sup> *Iranian Infectious Diseases and Tropical Medicine Research Center, Isfahan University of Medical Sciences, Isfahan, Iran*<sup>b</sup> *Hajar University Hospital, Shahrekord University of Medical Sciences, Shahrekord, Iran*<sup>c</sup> *Department of Health and Bioinformatics, Shahrekord University of Medical Sciences, Shahrekord, Iran*

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## Abstract

Foods are likely to be faecally contaminated during preparation or dissemination by the Iranian Muslim food handler that their religion enjoins the mechanical cleaning of themselves after defecation. The current study was designed to determine the actual rate of hand contamination of Iranian food handlers with pathogenic flora of faeces or nose and to evaluate the efficacy of simple hand-washing instruction in reduction of hand contamination.

A before–after study was conducted on 150 randomly selected food handlers in an Iranian city, Shahrekord. At the first stage, the hands of 72.7% of food handlers were found to be contaminated. A comparison of the before-and-after data, revealed a significant decline in hand contamination of the food handler from 72.7% to 32% ( $P < 0.0001$ ).

Our study showed that the poor hygienic practice by the food handler is such a serious problem facing the health sector that it merits a further consideration by Iranian authorities.

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**Keywords:** Food contamination; Food safety; Retail food establishment inspection; Food handling

## 1. Introduction

It is generally accepted that the hands of food handlers are an important vehicle of food cross-contamination and that improved personal hygiene and scrupulous hand-washing would lead to the basic control of faeces-to-hand-to-mouth spread of potentially pathogenic transient microorganisms (Allwood, Jenkins, Paulus, Johnson, & Hedberg, 2004; Daniels et al., 2002; Fry, Braden, Griffin, & Hughes, 2005; Sneed, Strohbehn, Gilmore, & Mendonca, 2004).

The difficulties of achieving this in countries in which hygiene is poor or unfavorable and social habitual barrier exist, are almost overwhelming (Marshall & Dickson,

1998). In an Iranian kind of society as we live, there has been a speculation that foods are more likely to be faecally contaminated during preparation or dissemination by the food handler since their religion enjoins the mechanical cleaning of themselves after defecation rather than using toilet papers.

In the current Iranian surveillance and investigation of food safety, the focus of food shop inspection is on environmental health and the food handler's personal hygiene inspection is limited to a systematic faecal examination of food-handlers with an interval time of six months to identify those infected with salmonellosis. In personal communication with the public health authorities in the region, they expressed dissatisfaction with the routine stool screening of food workers as they believed the approach is not sensitive enough and does not produce the evidence needed to design a practical plan of action in control of food contamination on spot.

\* Corresponding author. Tel.: +98 311 3359359; fax: +98 311 3357979/3373735.

E-mail address: [Shojaei@go.com](mailto:Shojaei@go.com) (H. Shojaei).

Taking into consideration the fact that in hospital settings the introduction of hand-washing has been accompanied by reduction of infection rate (Steele & Mallison, 1975), we speculated that a simple surveillance that includes the food handler screening for hand contamination followed by a simple instruction of hand-washing might play a similar role in food safety. Moreover, we intended to provide the health sector authorities with solid evidence on the efficacy of an alternative simple approach in replace of current ineffective and complicated surveillance system. Therefore, the current study was designed to illustrate the dimension of hand contamination of food handlers and evaluate the effectiveness of a simple hand-washing instruction in reduction of hand contamination rate.

## 2. Materials and methods

An interventional perspective before–after study was designed and conducted on 150 randomly selected food handlers working in small retail food outlets such as fruit and vegetable shops, meat shops, grocery stores, traditional bakery shops and fast-food shops in an Iranian small city, Shahrekord (Table 1). Most food handlers worked face to face with the public. The study did not include those who were engaged in large scale food plants as there were no such establishments in Shahrekord city. All food staff was male.

The study consisted of three stages. In the first stage, the food outlets were inspected and the food handlers were screened for hand contamination. They were instructed to wash and scrub all surfaces of each hand with a sterile scrub brush into a basin containing 500 ml of sterile water. The food handler was emphasized maintaining the same amount of activity on each hand and scrubbing under the fingernails as well as working over their surfaces. The samples were transferred immediately to the research laboratory using a cold box. A 10 ml volume of well-stirred samples was then centrifuged for 10 min at 2000 rpm. After the centrifugation, 8 ml of the supernatant was removed cautiously and the remaining was then resuspended in 2 ml of the supernatant and plated on blood, nutrient, Eosin Methylene Blue and MacConkey agar. We recorded the total bacterial contamination of hands as the number of colony forming units (cfu) recovered from both hands on nutrient agar after 48 h of incubation. We incubated plates at 37°C under aerobic conditions. No anaerobic cultures were done. The hand contamination was considered as isolating one or more potentially pathogenic microbial colonies but not normal flora from the hands of food handlers. The identification of isolated microbial flora and the colony counts were carried out based on conventional microbiological methods. We identified *Staphylococcus aureus*, *Escherichia coli* or other pathogenic bacteria not usually found in skin flora by using standard microbiological procedures. Briefly, *Staphylococcus aureus* was identified by colony morphology, hemolytic patterns on blood agar, Gram-staining characteristics, mannitol fermentation and slide

and tube coagulase test. The various genera of enteric bacilli were differentiated and identified by colony morphology, Gram-staining characteristics, oxidase, and biochemical reactions on MacConkey agar and the IMViC series of biochemical tests. The level of contamination was ranked into light, moderate and heavy based on a bacterial colony count of  $10^3$  or less,  $10^3$ – $10^6$  and  $\geq 10^6$  cfu/ml, respectively (Cardoso, Pereira, Zequim, & Guilhermetti, 1999).

The second stage, i.e., the interventional stage, included a health education program for the food handlers participated in the first stage of the study. Particular emphasis was placed on sanitation and personal hygiene. Briefly, the shops were revisited by the team of research and the food workers as well as the shop owners were informed of the results of the first stage and the significance of the worrying high rate of hand contamination. They were educated face to face on the importance of personal sanitation and simple hand-washing with plain soap and water after defecation in reduction of hand contamination. No samples were taken at this stage.

The final stage conducted with an interval time of one month after the previous stage. This stage included the same procedure as the first stage to appraise the hand-washing compliance by the same food staff participated in the first and second stage of the study with the prescribed measures of sanitation and personal hygiene. The food handlers at the final stage were visited unexpectedly and without prior notice.

### 2.1. Analysis

We calculated a sample size of 119 by simple random cluster sampling technique considering  $P=0.5$  as the estimated proportion of hand contamination in the food handler population,  $d=0.09$  as the desired level of precision, and a confidence level of 95%. We extended the sample size to 150 to take into account possible technical difficulties in our study. We calculated the percentage reduction in hand contamination for each small retail food outlet. We used  $\chi^2$  or Fisher's exact tests for checking any possible significant independence between various categorical variables. Microsoft excel was used to perform the analysis and considered  $P < 0.05$  as significant.

## 3. Results and discussion

Poor personal hygiene by food handlers frequently contributes to outbreaks of food borne illnesses caused by *Staphylococcus aureus* and gram negative bacilli such as *Salmonella* spp., *Shigella* spp., *Campylobacter jejuni*; enterotoxigenic *E. coli* as well as viral agents, i.e., hepatitis A, and Norovirus (Atreya, 2004; Hundy & Cameron, 2002; Lee & Middleton, 2003; Le Loir, Baron, & Gautier, 2003; Olsen et al., 2001; Sala et al., 2005; Wachtel, Whitehand, & Mandrell, 2002).

Table 1  
Frequency of potentially pathogenic bacteria isolated from the hands of Iranian food handlers

Retail food outlets	Frequency of food handlers	<i>Bacillus</i> spp.		<i>E. coli</i>		<i>Enterobacter</i> spp.		<i>Klebsiella</i> spp.		<i>Staphylococcus aureus</i>		<i>Serratia</i> spp.		<i>Vibrio</i> spp.		<i>Aeromonas</i> spp.		<i>Citrobacter</i> spp.		<i>Proteus</i> spp.		<i>Yersinia</i> spp.		<i>Salmonella</i> spp.		<i>Pseudomonas</i> spp.	
		B <sup>a</sup>	A <sup>b</sup>	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Grocery and dairy store	92	29	9	20	4	13	5	14	2	10	6	7	0	4	0	3	0	3	0	2	0	1	0	0	1	2	0
Butchery shop	19	4	2	6	1	3	2	0	0	5	2	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0
Vegetable and fruit shop	10	4	1	3	0	1	1	2	2	3	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Fast-food shop	8	3	2	1	0	3	0	1	0	1	2	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Ice-cream shop	7	0	0	0	0	1	1	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Poultry and fish shop	6	0	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Confectionery shop	5	2	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Restaurant	3	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Total	150	43	16	33	5	22	11	20	4	19	12	10	1	5	0	8	0	4	1	4	0	1	0	1	1	3	0
Percentage	100	28.6	10.6	22	3.3	14.6	7.3	13.3	2.6	12.6	8	6.6	0.6	3.3	0	5.3	0	2.6	0.6	2.6	0	0.6	0	0.6	0.6	2	0

<sup>a</sup> Before the intervention.

<sup>b</sup> After the intervention.

Although thorough cooking of food just before consumption eliminates the risk of many illnesses, protection against some foodborne diseases such as staphylococcal food poisoning is not provided, because the staphylococcal enterotoxins are heat stable (Balaban & Rasooly, 2000). In addition, the products, which are usually eaten cold or uncooked or without further cooking such as cold sweets, cream cakes and foods of plant origin – fruit and salad vegetables may be contaminated by food handlers (Daniels et al., 2002; Gotz et al., 2002; Hundy & Cameron, 2002; Jablasone, Warriner, & Griffiths, 2005; Kassa, 2001; Kishimoto et al., 2004; Sivapalasingam, Friedman, Cohen, & Tauxe, 2004).

Our results showed that at the first stage and before intervention, the hands of 109 people out of 150 food handlers (72.7%) were contaminated with one or more potentially pathogenic bacteria. The microbial contamination level of the hands was found to be heavy in 88 (80.7%), moderate in 14 (12.8%) and light in 7 (6.5%) cases (Fig. 1). The frequency of hands contamination among Iranian food handlers after the intervention was dropped significantly from 109 (72.8%) to 48 (32%); ( $P < 0.0001$ ) (Table 1). The impact of intervention was found to be 56%. A dramatic reduction in hand contamination achieved by the current study after a simple intervention which included a face-to-face health education on strict hand-washing after toilet showed that much emphasis should be put on meticulous hand-washing by health inspectors. However, staff may be reluctant to comply with. If employers are trained to monitor this hand wash program, the removal of transient pathogenic microorganisms from hands and fingertips is assured. In our experience hand-washing may seem trivial to the food staff, but failing to do it can have tragic consequences. Employees should be given positive reinforcement and in-service training to wash their fingertips and hands correctly and adequately so that they know why these procedures are necessary and the hand-washing procedure becomes habitual. In addition, the health sector should offer consumers information that will allow them to help themselves in the battle against the food handler poor hygiene.

The most common potentially pathogenic bacteria isolated from hands of Iranian food handlers at the first stage were *Bacillus* spp. (28.6%), *Escherichia coli* (22%), *Enterobacter* spp. (14.6%), *Klebsiella* spp. (13.3%) and *Staphylococcus aureus* (12.6%) (Table 1). In a rather similar study on

hygienic status of Thai food handlers *Staphylococcus* spp., *Bacillus* spp., *Aeromonas hydrophila*, *Klebsiella pneumoniae*, *Acinetobacter*, *Enterobacter cloacae*, *Escherichia coli*, *Pseudomonas* spp., *Proteus mirabilis*, *Serratia* spp. and *Citrobacter freundii* were isolated from the hands and nails of food handlers (Dumavibhat, Tiengpitak, Srinkapibulaya, Nilakul, & Tuntimavanich, 1989).

The frequency of the most potentially pathogenic bacteria isolated from hands of Iranian food handlers, i.e., *Bacillus* spp., *Escherichia coli*, *Enterobacter* spp., *Klebsiella* spp. and *Staphylococcus aureus* dropped significantly from 28.6%, 22%, 14.6%, 13.3% and 12.6% at the first stage and before intervention to 10.6%, 3.3%, 7.3%, 2.6%, and 8%, respectively, after the intervention (Table 1).

Our results also showed that 64.1% (111 out of 173 total cases) of microorganisms isolated from the hands of food workers were Gram negative bacilli. Isolation of these organisms includes a faeces-to-hand spread and indicating a poor hygiene is practiced by the food handlers. A significant reduction in hand contamination with the Gram negative bacilli, i.e., from 64.1% to 13.2% in the current study demonstrated that these organisms are readily removed by hand-washing.

Isolation of *Bacillus* spp. from the hands of food workers (28.6%) shows that these organisms may come from sources such as soil and again indicates the food handler's poor hygiene. It has been well documented by Champagne, Laing, Roy, Mafu, and Griffiths (1994) that pathogenic psychrotrophs including *Bacillus cereus* have great influence on the quality of raw milk, pasteurized and UHT milks, butter, ice cream, cheese, and powders.

The current results also showed that a significant number of food handlers (12.6%) might be nasal carriers of *Staphylococcus aureus* and frequently contaminate their hands. Le Loir et al. (2003) in a review of *Staphylococcus aureus* and food poisoning have stated that this organism is a leading cause of gastroenteritis resulting from the consumption of contaminated food. Information from many episodes of staphylococcal gastroenteritis outbreaks indicates that strains of *Staphylococcus aureus* isolated from specimens of vomitus and faeces were identical with those from the implicated food and from the hands and often the nose of a food handler (Do Carmo et al., 2004; Hatakka, Bjorkroth, Asplund, Maki-Petays, & Korkeala, 2000; Pereira, do Carmo, dos Santos, & Bergdoll, 1994; Tondo, Guimaraes, Henriques, & Ayub, 2000).

We found no significant correlation between hands contamination and contributing factors such as current general health, history of infectious diseases, and presence of hand wound in food handlers. However, there was a significant correlation between hand contamination and food establishment specifications ( $P < 0.01$ ). In other words, out of a total of 45 food handlers working in a food establishment that failed to comply with environmental health laws and rules or violated of the general requirements that establishments must meet to maintain the proper environment for food service, 40 (88.9%) had contaminated hands.

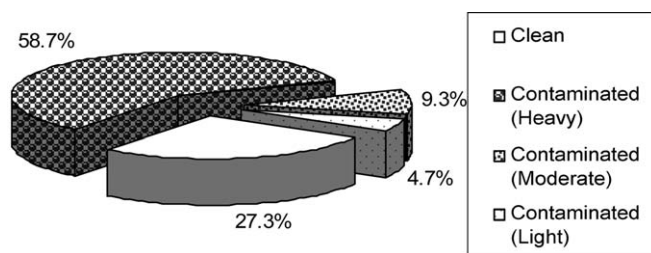


Fig. 1. The rate of hand contamination (%) of Iranian food handlers by level of contamination.

### 3.1. Limitations

One potential limitation of our study includes the fact that we assessed bacterial contamination in a rather small Iranian city. There were not enough and well distributed numbers of food outlets in the city. Consequently, there was no chance of comparison of hand contamination by profession. Another limitation was lack of sufficient funding to include viral and parasitic pathogenic isolation from the hands of food handlers.

### 4. Conclusions

Our study showed that the poor hygienic practice is a serious problem facing the Iranian health sector. The results of our study confirm that hand-washing with plain soap and water is an effective, acceptable and tolerable approach in reduction of hand contamination. The results showed that the Iranian consumer has relatively much to be concerned with regarding the food they consume. The result has also emphasis on the fact that control is best focused on worker hygiene and avoidance of human waste. However, in spite of showing food handlers that their hands are contaminated with quite a large number of pathogenic bacteria, and that food safety can be improved by hand-washing, staff may be reluctant to comply with. In another words, without a persistent surveillance system to monitor hand-washing compliance it does not seem the kind of research studies as we did could have a lasting positive effect.

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