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Efficacy of Different Alcohol-based Hand Disinfectants in Reduction of Hand Contamination among Food Handlers in Alexandria, Egypt

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: To assess hand contamination among food handlers working at the cafeterias of Pharos University and to compare the efficacy of different alcohol-based hand rubs (ABHRs) in reducing hand contamination among them during routine work.
Study Design: Pre/post test quasi experimental study.
Place and Duration of Study: The study was carried out in the period from April to August 2018 and included fifty volunteered food handlers at the cafeterias of Pharos University, Alexandria, Egypt.
Methodology: Dominant hand direct finger-print samples were collected from the fifty participants during a pre-intervention visit to estimate the prevalence of hand contamination. In four following visits, another 400 finger-print samples were collected before and after applying four different hand disinfectants: three liquid ABHRs and a hand-rubbing gel. Samples were microbiologically examined for identification of contaminants. The different formulae were evaluated regarding their efficacy in reducing the count of hand contaminants.
Results: Thirty out of fifty (60%) of the finger-print samples were positive for one or more microbial contaminants. Coagulase-negative staphylococci (CNS) were the most prevalent isolates; detected

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in 66% of samples. The isolation rate of potential food borne contaminants was significantly higher among food handlers who served for less than five years (80%), compared to only 16.7% among those who served for more than ten years (P=0.001). The isolation rate of contaminants was significantly lower among participants who washed their hands after visiting the toilet (45.8%), compared to 73.1% among those who didn't (p=0.05). A significant percentage reduction in the microbial count was recorded for all formulae used; with the gel hand rub being the least reducing formula.

Conclusion: Hand contamination with food borne pathogens is highly prevalent among food handlers. Liquid formulae of hand disinfectants containing propanol, applied for 15 seconds, are more efficient than those containing ethanol and than the gel formulae.

Keywords: Food borne diseases; food handlers; alcohol based hand rubs; hand hygiene.

1. INTRODUCTION

Food-borne illnesses impose a substantial economic and quality of life burden on society by way of acute morbidity and chronic sequelae. Faecal-oral transmission is the major route of infection with enteric pathogens if good personal hygiene is not practised [1]. Hand contamination of food-handlers in big eating establishments may pose a real threat in spreading food borne diseases [2].

The World Health Organization (WHO) reported that approximately 2 million fatal cases of food poisoning occur every year globally especially in developing countries. This scenario could be attributed to the poor state of food safety and general hygiene [3]. In those countries, up to 70% of cases of diarrheal diseases are associated with the consumption of contaminated food; with approximately 10 to 20% of cases attributed to contamination by food handlers [4].

The problem of food safety is not a preserve of developing countries only but also significant cases of food poisoning were recorded in developed countries, regardless of their advancement in food chain monitoring systems [5]. The Centre for Disease Control and Prevention (CDC) reported that in the USA, 48 million cases of food poisoning are estimated to happen yearly (1 in every 6 American citizens). This in turn results in 128,000 hospital admissions and 3,000 deaths [6].

In spite of this high incidence reported yearly worldwide, yet most cases of food-borne diseases are not reported and so the true extent of the problem is unknown [7].

Food handlers are people who work for a food business and handle food, regardless of whether they prepare or serve it. They could transmit microorganisms to the food from their skin, nasal secretions or bowel [8].

The mishandling of food and the neglection of hygienic practices enable pathogens to contaminate food, to survive and multiply in sufficient numbers and to cause illness in consumers. Personal hygiene, knowledge and practice of food hygiene besides environmental sanitation are the major key factors in the control of food borne diseases [9]. It has been estimated that hand hygiene could save a million lives annually [10].

Several reports demonstrated similarities between the pathogens isolated from patients and food handlers; clearly emphasising that food handlers were the vehicles of transmission for the food-borne pathogens [4,7,11,12].

Despite the plethora of national and international programmes and recommendations about the significance of hand washing; compliance to this procedure continues to be insufficient [13]. Some studies reported that only 0 to 61% of restaurant workers and 6 to 73% of workers in institutional settings, properly follow recommended hand washing procedures [14,15].

The reasons that hinder compliance to proper hand hygiene practices are: Lack of supervisory or peer support, limited time for hand-washing, hand irritation, allergy to chemicals, insufficient supplies in addition to limited knowledge, experience and education [16].

Hand hygiene is defined as any method that removes or destroys microorganisms on hands. It applies to either hand washing, antiseptic hand wash or antiseptic hand rub. The aim of hand hygiene practices is to eliminate quickly, as far as possible, the transient (contaminating) flora and also to have persistent antimicrobial activity on the resident flora [10]. Earlier guidelines recommended washing hands using water and soap or a soap solution in preference to

waterless antiseptic solutions [17] while more recently the opposite has been recommended [18].

Alcohol-Based Hand Rubs (ABHRs) are the most popular hand sanitisers. Alcohols act by denaturation and coagulation of proteins. Cells are thus lysed and the cellular metabolism is disrupted. They are most effective at concentrations of 60–80%, while at concentrations higher than 80% alcohols are less potent because proteins are not easily denatured in absence of water [19].

The combination of hand washing followed by the use of ABHRs produces even greater reduction of bacteria on hands [20]. Guidelines provided by CDC and WHO recommend that visible dirt is supposed to be washed first with soap or antiseptic and water since hand rubs do not clean soiled hands [21]. Also the Food and Drug Administration (FDA) recommends that the use of hand sanitisers with at least 60% alcohol should follow hand washing with soap and water as they do not reduce fatty and proteinaceous materials in the skin and on which pathogens can survive [22].

Various preparations of hand sanitisers are commercially available including gel, foam and liquid solutions. Active ingredients of hand sanitisers include ethanol, isopropanol, n-propanol or providone-iodine. In 2009, WHO recommended the use of two different ABHRs; based on either ethanol 80% vol/vol (WHO I) or isopropanol 75% vol/vol (WHO II) [23]. WHO suggested 20-30 seconds as appropriate contact time for ABHR hand hygiene compared to 45-60 seconds for hand washing with soap and water [24]. Regards product rub-in times (dry-times), WHO guidelines stated that any product should take 20–30 seconds to rub until dry whereas the CDC guidelines stated that if the product is dry before 10 to 15 seconds, then an insufficient amount was used [25].

ABHRs are recommended worldwide because of their broad spectrum antimicrobial effect, better compliance rate, ease of application and because of their being tolerable to many people skins [26]. On the other hand, ABHRs still have their limitations as they are effective against some but not all microorganisms and because their daily cost can sum up to 4.5 times higher than that of soap and water. In addition, ABHRs can be flammable and may be abused for their alcohol content [27].

2. METHODOLOGY

A pre/post test quasi experimental study was conducted in the period from April to August 2018, at the student cafeterias of Pharos University in Alexandria, Egypt.

2.1 Inclusion and Exclusion Criteria

Fifty food handlers who were engaged in food preparation, serving and in cleaning in the kitchen and were expected to be available throughout the study period were enrolled in the study. Those who had alcohol allergy, skin irritation, eczema, recent inflammation or trauma to the fingers or hands were excluded.

This study was conducted after obtaining formal administrative approval from Pharos University. Nevertheless, participation in the study was not obligatory, oral consents of the study participants were taken and all personal information were kept confidential. This study received ethical approval from the High Institute of Public Health (HIPH) Ethics Committee.

2.2 Materials and Methods

A pre-structured questionnaire, including data about socio-demographic characteristics and personal hygiene practices of food handlers, was filled in for each participant during a face to face interview carried out in the first pre-intervention visit. During the same visit direct (5-fingertip imprint) samples were collected within the working hours from all participants on Columbia blood agar plates. At the microbiology laboratory of the Medical Laboratory Technology Department, Pharos University, the plates were incubated aerobically for 24 hours at 37°C and were examined for presence or absence of microbial growth to estimate the prevalence of microbial contamination.

Aiming to evaluate the efficacy of four hand disinfectants, fingertip imprint samples of the dominant hand for each food handler, (before application and after application), were collected in four different visits; summing up to 400 cultures throughout the study : 50 food handlers X 2 samples each visit X 4 visits). Notification was not given in advance and sampling wad done before starting any meal preparation activity including hand washing.

Disinfectants included 3 liquid hand disinfectants; commercially available in the Egyptian market;

Brand A (ethanol 96%), Brand B (ethanol 80%, iso-propanol 45%, n-propanol 30% and mecetronium etilsulfate 0.2%) and hand disinfectant C (a locally prepared hand disinfectant formulation; according to the WHO recommendations (ethanol 80% [v/v] +1.45% glycerol+0.125% H_2O_2) [28]. Brand D, was a hand disinfectant gel (ethanol 65% and iso-propanol 60%).

Verbal orientation together with the demonstration of hand sanitisation technique was performed and extra hand hygiene was not allowed during sample collection. Participants performed the proper hand hygiene procedures under close observation for 15 seconds and hands were allowed to air-dry for at least 30 seconds before sampling.

At the laboratory, after overnight incubation of culture plates, the total microbial count was recorded as the number of colonies forming units (CFU) / hand. Isolates from the pre-disinfection samples were tested for colony morphology, Gram stained, examined microscopically and were tested biochemically according to the standard microbiological methods [29].

For identification of Gram-positive cocci (GPC); isolates that appeared as medium sized, circular, white or golden yellow with smooth convex surface and entire edge, were β-hemolytic or non-hemolytic and were positive for catalase, slide and tube coagulase tests and for Voges Proskauer (VP) test were considered as *Staphylococcus aureus (S. aureus)*. Catalase positive, coagulase-negative and bacitracin-resistant GPC were considered as *Coagulase-negative staphylococci (CNS)*. As regards Gram-negative bacilli (GNB) (lactose and non-lactose fermenters), they were tested for oxidase production and for a set of biochemical reactions using API 20 E (Biomerieux). Diphtheroids appeared as Gram positive bacilli with no spores and Candida appeared as Gram positive budding yeast cells.

2.3 Statistical Analysis

Data analysis was done using IBM SPSS software package version 20.0. Bacterial counts in CFU, before and after application of one of the ABHRs, were compared using Wilcoxon signed ranks test. Percentage reduction was calculated for all formulae, tested by Kruskal Wallis and compared using Mann Whitney test. Statistical significance was considered at $p \leq 0.05$ [30].

$$\text{CFU Log reduction (L)} = \text{Log}_{10} A - \text{Log}_{10} B$$

A= CFU before application of hand disinfectant
B= CFU after application of hand disinfectant
Percent reduction= $(1-10^{-L}) X100$

3. RESULTS AND DISCUSSION

3.1 Results

Regarding the socio-demographic characteristics of the investigated food handlers; it was observed that most of them (70%) were males and that more than half of them; (54%) were in the age group of 21-30 years old.

Considering their educational background; 62% of the studied food handlers had basic or up to secondary education only. Most of them were rural dwellers (78%) and the majority of them (52%) were single. Regards the job; (30%) cooked the food, (48%) were waiters and the rest (22%) were cleaners in the kitchen.

In the present study, no significant statistical association was found between the hand contamination rate and gender, age, educational background or job position (Table 1).

The majority (60%) of studied food handlers had only less than five years experience in food service while the minority (12%) had more than 10 years experience in this field. Hand contamination rates had a significant association with service years of participants. The isolation rate of hand contaminants was evidently higher among food handlers who served for less than five years (80%), compared to only (16.7%) among those served for more than 10 years (P=0.001) (Table 1).

During close observation of the personal hygiene practices of the participants; it was noticed that most of them adopted incorrect practices and habits. Only 26% used aprons, 40% (mostly females) used hair covers and 22% only wore gloves during food handling. On the other hand, the majority (76%) paid attention to finger nails trimming (Table 1). No significant statistical association between these practices and hand contamination rate was recorded.

According to the data provided by participants; it was noted that those who washed their hands (with soap and water) after visiting the toilet or after touching dirty materials and before food handling, represented 48% and 78%;

respectively (Table 1). Only washing hands (with soap and water) after visiting the toilet significantly affected the contamination rate of the hands of the studied food handlers. The hand contamination rate was relatively lower among participants who washed their hands (with soap and water) after visiting the toilet (45.8%) compared to (73.1%) among those who didn't (p=0.05) (Table 1).

Out of the 50 participants; 42% had regular medical checkups and only 16% have got previous informal food hygiene training. No significant association between these factors and hand contamination was recorded (Table 1).

Thirty out of 50 (60%) of the finger imprint samples taken at the first pre-intervention visit were positive for one or more bacterial/fungal contaminants while the other 40% yielded no contaminants.

A total of 264 bacterial and fungal agents were isolated from fingertips of the food handlers before performing hand hygiene (Table 2). Mixed pattern of colonisation by ≥ 2 isolates was detected in more than half of the samples (61%), while 39% yielded a single isolate. CNS were the most prevalent isolates; detected in 66% of food-handlers' fingertips, while *S. aureus* and GNB were isolated from 22% and 6% of samples, respectively. Besides, diphtheroids and Candida were detected in 20% and 18% of samples, respectively (Table 3).

CFU count before application of hand hygiene was considered as a baseline; with a recorded average mean of 132.8 (±155.9) CFU/hand. A significant percentage reduction in CFU count for all hand hygiene formulae , applied for only 15 seconds, was recorded; with the gel hand rub (D) being the least reducing method ($p < 0.05$, using Mann Whitney test) (Fig. 1).

3.2 Discussion

Food-borne diseases via consumption of contaminated food and beverages are considered as a persistent nationwide challenge and public health burden. Food handlers are an important vehicle for transmission of micro-organisms; as improper handling practices may result in food contamination and consequently food borne diseases [31]. Hand hygiene is the most basic yet critical criterion for ensuring safe food handling [32].

Several studies reported that the contaminated hands of food handlers were the vehicle with the highest possibility for cross contamination during the routine work and that made the greatest contribution to food-borne disease outbreaks [33-35].

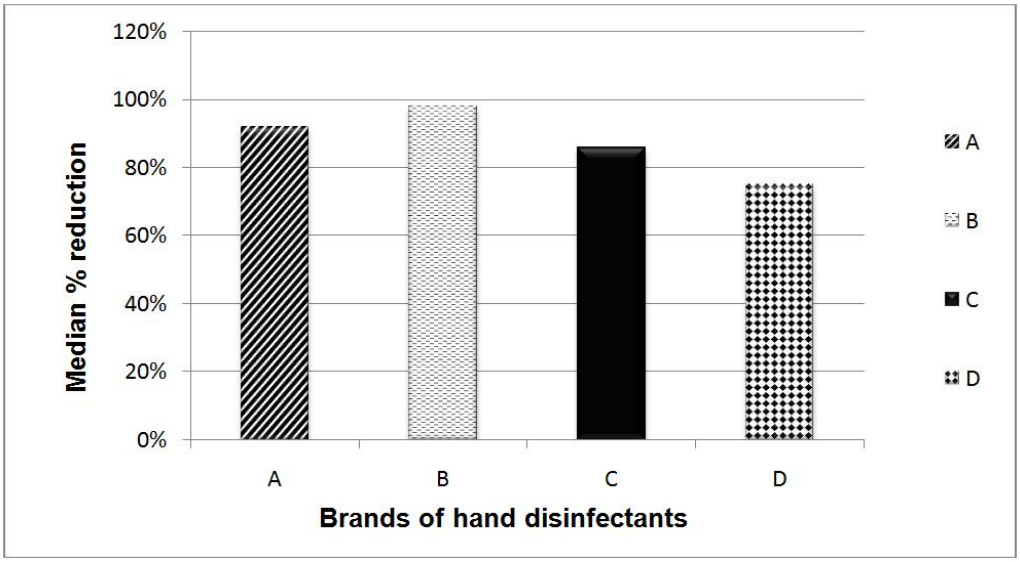

Fig. 1. Comparison of percentage reduction of microbial counts on hands of food handlers after application of different hand disinfectants

Z: Z for Wilcoxon signed ranks test; Statistically significant at P ≤ 0.05

Chi square for Kruskal Wallis test, (χ^2 p: 22.024, <0.001)

Table 1. Hand contamination and associated risk factors among food handlers

Risk factor	Categories	Hand contamination				Total (50)		χ^2	*P*-value
		Present (30)		Absent (20)		No	%		
		NO	%	No	%				
Gender	• Male	21	60.0	14	40.0	35	70	0.000	1.000
	• Female	9	60.0	6	40.0	15	30		
Age	• ≤ 20	6	85.7	1	14.3	7	14	2.547	0.295
	• 21-30	14	51.9	13	48.1	27	54		
	• 31-40	10	62.5	6	37.5	16	32		
Education	• Illiterate	5	71.4	2	28.6	7	14	4.480	0.098
	• Basic/secondary education	21	67.7	10	32.3	31	62		
	• High school and above	4	33.3	8	66.7	12	24		
Residence	• Urban	6	54.5	5	45.5	11	22	0.175	0.736
	• Rural	24	61.5	15	38.5	39	78		
Marital Status	• Single	15	57.7	11	42.3	26	52	0.246	1.000
	• Married	11	61.1	7	38.9	18	36		
	• Widow/Divorced	4	66.7	2	33.3	6	12		
Job position	• Cooker	6	40.0	9	60.0	15	30	3.361	0.188
	• Waiter	17	70.8	7	29.2	24	48		
	• Cleaner	7	63.6	4	36.4	11	22		
Service years	• <5	24	80.0	6	20.0	30	60	12.850*	0.001*
	• 6-10	5	35.7	9	64.3	14	28		
	• >10	1	16.7	5	83.3	6	12		
Use of apron	• Observed	7	53.8	6	46.2	13	26	0.277	0.599
	• Not observed	23	62.2	14	37.8	37	74		
Hair cover	• Observed	10	50.0	10	50.0	20	40	1.389	0.239
	• Not observed	20	66.7	10	33.3	30	60		
Wearing gloves	• Observed	5	45.5	6	54.5	11	22	1.243	0.311
	• Not observed	25	64.1	14	35.9	39	78		

Risk factor	Categories	Hand contamination				Total (50)		χ^2	*P*-value
		Present (30)		Absent (20)		No	%		
		NO	%	No	%				
Finger nail status	• Trimmed	24	63.2	14	36.8	38	76	0.658	0.506
	• Not trimmed	6	50.0	6	50.0	12	24		
Hand wash habit after touching dirty objects and before handling food	• With soap and water	22	56.4	17	43.6	39	78	0.952	0.489
	• With water only	8	72.7	3	27.3	11	22		
Hand wash habit after visiting the toilet	• With soap and water	11	45.8	13	54.2	24	48	3.860*	0.049*
	• With water only	19	73.1	7	26.9	26	52		
Regular medical check up	• Checked	12	57.1	9	42.9	2	42	0.123	0.726
	• Not checked	18	62.1	11	37.9	29	58		
Informal hygiene training	• Done	4	50.0	4	50.0	8	16	0.397	0.697
	• Not done	26	61.9	16	38.1	4	84		

χ^2: Chi square test, P: P value for comparing between the different categories;: Statistically significant at P ≤ 0.05*

Table 2. Isolated organisms from fingertips of the food handlers (before performing hand hygiene)

Bacterial isolates	Frequency of isolation	
	No.	% (out of 264)
C.N.S*	132	50.0%
S. aureus	44	16.7%
GNB*	12	4.5%
Diphtheroids	40	15.2%
Candida	36	13.6%
Total	264 Isolates	100.0%

**C.N.S: Coagulase negative staphylococci; GNB: Gram negative bacilli*

Table 3. Frequency of microbial colonisation on the hands of food handlers

Bacterial isolate	Bacterial colonisation / 200 hands*	
	No.	%
CNS	132	66
S. aureus	44	22
GNB	12	6
Diphtheroids	40	20
Candida	36	18

**200 fingertip imprint samples (taken from the 50 food handlers in 4 different visits) before using a different formula of hand disinfectants each time*
N.B Total % sums up to > 100 % due to presence of mixed colonisation

The microbiological hygiene assessment reflects the real practices of safe food handling and so the current study was carried out to assess the hand contamination rate among food handlers working at the cafeterias of Pharos University.

In the current work, the majority (70%) of the studied food handlers were males. This condition was similar to another Egyptian study by Allam et al. [31]. This is because food handling in Egypt is mainly an occupation performed by men.

In this study, contamination rate was the same (60%) among both sexes and this was in line with the finding of Nasrolahei et al. who reported that gender didn't significantly affect contamination level among food handlers [33]. Unlikely, other studies reported higher contamination rates among female food handlers and this was attributed to factors such as artificial nails, frequent hand shaking with lack of hand hygiene facilities and frequent contact with mobile phones [7,36].

The highest contamination rate in the current study (85.7%) was recorded among those ≤20 years old. This was similarly reported by Assefa et al. and can be explained as younger individuals usually have poor hygienic practices [7].

In the present work, longer experience in the field of food handling significantly reduced the contamination rate of hands of food handlers. This goes with the previous reports of Assefa et al. [7] and Lee et al. [37] and can be attributed to better personal hygienic practices among food handlers with more work experience than among inexperienced ones.

In the current work, contamination rate was highest (71.4%) among the enrolled illiterate food handlers. This was also previously reported by other researchers and owes to the direct relation between the level of education and the behavior and hygienic practices of individuals [7,31,37].

Food handlers come from diverse cultural backgrounds, with different concepts of the principles of contamination and sanitation. Considering the hygienic practices of the currently investigated food handlers, lower contamination rates were recorded among those who wore protective aprons, hair covers and gloves. Similarly, in other studies, such hygienic practices remarkably reduced hand contamination among food handlers [7,31].

Wearing gloves in particular; in the present work and in previous reports, had no significant effect on reduction of hand contamination [37,38]. Usually food handlers use cheap gloves through which organisms can pass; besides wearing gloves may also give food handlers a false sense of security. Fuller et al. deduced from his observational study that using gloves significantly decreased hand hygiene practices among food handlers [38].

In the present research, washing hands with water and soap after visiting the toilet significantly reduced the contamination rate to 45.8% compared to 73.1% among those who mentioned they washed hands using only water (probably instead of admitting they didn't wash their hands at all). This agrees with previous reports by Assefa et al. [7], Allam et al. [31], and Nasrolahei et al. [37]. Neglection of hand hygiene practices can be explained by that most of the participants came from low

socioeconomic levels, with low income and limited education.

In the current work and in agreement with previous reports, neither regular medical checkup of food handlers nor their previous informal hygiene training significantly reduced hand contamination [7,31,38,39]. Better hygienic performance was even reported by Lee et al. among those who got no training than among those who did [37]. This highlights the fact that checkups or training alone without follow up to ensure constant implementation of hygienic practices is just a waste of time and doesn't improve the actual level of hand hygiene among food handlers. Manager commitment is required and programs should be designed to encourage compliance through rewards and penalties.

Hand contamination was recorded in 60% of the food handlers enrolled in the present study. This rate is comparable to others previously reported in similar studies worldwide [2,7,33,40]. This emphasises how dangerous is the sector of food handlers as a vehicle for transmission of food borne diseases and the urge for regular monitoring of their health status and constant observation of their commitment to hygienic practices.

CNS are present on almost every hand as they are the main type of resident skin flora. In the present piece of work, CNS were the most prevalent isolates; detected in 66% of food-handlers' fingertips. This finding is in line with previous reports in Egypt as those of Allam et al. [31] and Abaza et al. [41] and in Nigeria (Okareh and Erhahon) [42].

The current work revealed that *S. aureus* was isolated from 22% of the participants' fingertips. This figure is comparable to previous reports in Egypt, Gondar, K.S.A and Ethiopia [43-45,7]. However, some studies reported lower rates of infestations in Egypt and Nigeria [40,41]. On the other hand much higher rates were recorded in Nigeria, Alexandria and Sudan [42,46,47]. The significance of isolation of *S. aureus* resides in its being the true pathogenic bacterium in the resident skin flora and up to 40-50% of healthy individuals harbor it in their anterior nostrils of the nose. Food handlers who carry *S. aureus* can contaminate their hands or even the food directly if they have the bad habit of nose picking and if they sneeze or cough during food handling. Regular screening for nasal carriage of *S. aureus* in this sector is therefore mandatory.

GNB in the present study was detected in only 6% of samples and they were mostly E. coli strains. This finding is in line with previous reports in Egypt [43,46] and other African countries [7,42]. GNB were isolated at remarkably higher rates from hands of food handlers in other studies in Egypt [31] and worldwide [40,48].

Detection of important food borne pathogens like *S. aureus* and faecal contaminants like E. coli in the finger print samples of food handlers highlights the major role this sector can play in transmission of food borne diseases with all its drawbacks on public health. Scheduled checkups so as to immediately exclude infected food handlers until they are efficiently treated must be done regularly.

As many as 80% of individuals still retain some pathogenic organisms on their hands after hand washing with soap and water [49]. This may be because repeated use of soap removes the skin's own fatty acids, which may result in cracked skin that provides an entry portal for pathogens. Not every food handler has the time or facility to frequent access to water and soap; that is why the more convenient alcohol- based hand sanitisers are increasing in popularity besides their effective action in the reduction of pathogenic microorganisms [39].Therefore in the current study, the efficacy of hand washing with soap and water alone was not assessed in comparison to application of ABHRs.

It was previously documented that shortening the application time of ABHRs from 30 seconds to 15 seconds didn't significantly affect the antimicrobial efficacy of ABHR products applied on the hands; nevertheless, it significantly increased the frequency of hand antisepsis practices. This is because time pressure and workload in food service facilities are recognised barriers to compliance [50]. Accordingly in the present work, the tested hand disinfectants were applied for only 15 seconds by the participants.

FDA recommended sanitisers with a concentration of 60% to 95% alcohol (ethanol or isopropanol) for greatest germicidal efficacy [36]. Several researchers reported that the best bactericidal effect of alcohol is obtained at a composition of 70% which would guarantee destruction of nearly all possible microorganisms present on the hands of food handlers [39].

The antimicrobial efficacy of alcohol rubs besides being directly related to the concentration is also

ranked according to the efficacy of the alcohol formulations used. Zandiyeh and Roshanaei reported that propanol (75%) formula is the best effective alcohol; which leads to an immediate decrease of resident hand flora [51]. The current work, in agreement with other previous similar ones, highlighted that isopropanol was more effective than ethanol in reduction of microbial load on participants' hands [41,52]. Brand B (containing isopropanol besides ethanol) showed the highest percentage reduction (98%), while the percentages recorded for brand A and hand disinfectant C (containing only ethanol) were 92% and 86%, respectively.

The gel formula (brand D) applied in the current study showed the poorest performance and the lowest reduction potential (75%) regards reducing the microbial count on hands of food handlers, besides its prolonged drying time. This finding is in concordance with those of Abaza et al. [41] and Ochwoto et al. [19], who reported that ethanol gel formulations were less efficacious than ethanol solution formulae.

4. CONCLUSION

a. Hand contamination with food borne pathogens is common among food handlers and this highlights their role as a vector of transmission of food-borne diseases.
b. Users of hand disinfectants should not blindly trust manufacturers' claims of reducing bacteria by 99.9% and must beware of the existence of substandard ABHRs available in the market.
c. Application of ABHRs for only 15 seconds is sufficient to reduce hand contamination.
d. Liquid formulae of ABHRs containing propanol are more efficient than those containing ethanol and than the gel formulae.
e. Hand wash with soap and water is advised for those working in food services before application of disinfectants to enhance the procedure of sanitisation.
f. Health education and training programmes in hand hygiene and sanitation should be routinely applied in the field of food services and should be followed up by close observation to ensure proper application is carried out.

CONSENT

This study was conducted after obtaining formal administrative approval from Pharos University. Nevertheless, participation in the study was not obligatory, informed consents of the study participants were taken and all personal information were kept confidential.

ETHICAL APPROVAL

This study received ethical approval from the High Institute of Public Health (HIPH) Ethics Committee.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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