



Evaluation of Bacterial Contamination of Hand Washing Tools in Restaurants in Lebanon

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Authors' contributions

This work was carried out in collaboration between both authors. Author CBG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author EBY supervised and reviewed the work of Author CBG. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aims to determine the extent of bacterial contamination of various hand hygiene tools as well as to isolate and identify the diversity of bacteria, mold and yeast present in these commercial products. The possible contamination of these utensils due to the environment encountering them is also being investigated.

Study Design: First a literature search was conducted with the aim of finding the hand hygiene tools that are frequently contaminated and the most frequent bacteria that contaminate it. Then restaurants were visited for an observational study and for the collection of samples for microbiological testing.

Place and Duration of Study: Study enrollment was voluntary and limited to the restaurants located in the Maten region-Lebanon, between September 2012 and January 2013.

Methodology: Seven different restaurants participated in this study, from which we collected the following samples if they were found: Water samples (from the kitchen and the toilet), soap samples (from bulk and dispenser), paper towel samples (from the kitchen and the toilet) and hand

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disinfectant samples. Collected samples were tested for total coliforms, total bacterial count, fecal coliforms, yeast, and mold.

Results: None of the restaurants were able to meet all hygiene requirements and 7 over 7 restaurants were not able to meet more than 45% of the Food Code requirements for hand washing station. Almost all the restaurants had at least 2 contaminated samples and no restaurants had hand disinfectant. This study found that even if hand washing is carried out properly, hands could become contaminated at first by the pre-contaminated hand hygiene tools.

Conclusion: The assessment of the hand hygiene tools' safety may be considered as complementary to the Food Code's recommendations given that the safety of these products is as important as the hand hygiene itself. A scheduled microbiological test for all hand hygiene tools should also be planned at least once a year.

Keywords: Hand hygiene; Lebanese restaurants; food safety; paper towels; sanitizers; soap.

ABBREVIATIONS

LIBNOR: *The Lebanese Standards Institution. LIBNOR is a public institution attached to the Ministry of Industry. It was established in 23-7-1962 by a law giving it solely the right to prepare, publish and amend national standards, as well as to grant the Lebanese Conformity Mark NL. LIBNOR is a member of the International Organization for Standardization (ISO), the Arab Industrial Development and Mining Organization (AIDMO), the Association Réseau Normalisation et Francophonie (RNF) and the Standards and Metrology Institute for the Islamic Countries (SMIIC), an Affiliate Member of the European Committee for Standardization (CEN), as well as the Codex Alimentarius Contact Point in Lebanon.*

WHO: *World Health Organization*

FDA: *Food & Drug Administration*

1. INTRODUCTION

Since the purchase and consumption of meals from restaurants are increasing, a great importance for proper and adequate hand hygiene is therefore required at food preparation facilities [1]. Thus high standards of personnel hygiene should be maintained at all times [2].

2% of asymptomatic food workers carry on their hands fecal pathogens such as Salmonella, Shigella, E. Coli, S. aureus and Norovirus, which in turn may lead indirectly to food infection [3,4,5].

Due to that, hands are believed to be the main infection transmission route, and the most important hygiene mean in the food industry [4] [6].

According to the WHO [7], most food infection is caused by the cross-contamination of foods mainly via the hands of the food handler's. Moreover the FDA Food Code [8] recommends hand washing as the primary means of hand hygiene.

Even though hand hygiene is one of the primary barriers to the spread of disease in food production [9], unfortunately, it is not always carried out effectively. Thus, food workers should be dedicated to proper hand hygiene process at all its levels [10]: From hand washing, to hand drying, to finish by the use of antiseptics and glove wear; in order to avoid contamination of foods during preparation [11].

In 89% of outbreaks caused by food contaminated by food workers, pathogens were transferred to food by workers' hands [12].

Moreover, according to the FDA [13] observations, improper hand washing occurs in 73% of restaurants and failure to prevent bare-hand contact with ready to eat foods in 57% of restaurants.

Thus, hand hygiene practices should aim to eliminate rapidly, as far as possible, the transient contaminating flora and to have persistent antimicrobial activity on the resident flora [14].

Hand washing with soap was found to reduce diarrheal risk by 30% [15], while hand drying after hand washing can reduce transfer of bacteria to food by 99% and is considered as important as the hand washing itself [16,17]. Hence a proper hand drying must be free of contamination that might be transferred from contaminated unused paper towels, cloth towels, and air dryers.

Unfortunately, barriers to effective hand hygiene encounters numerous problems leading to outbreaks from which we can identify the pre-contamination of hand hygiene tools [14,16], and the contamination of the environment around the hand washing station.

Hand hygiene tools should thus be clean and free of pathogens in order to have an effective hand wash. However, Water, unused paper towels, and soap in refillable dispensers were found in the literature [14,16] to be contaminated and sinks and the environment around the hand hygiene station were found to have a negative influence on the safety of the hand wash.

According to Jumaa [14], liquid soaps for instance may become contaminated with bacteria during use.

Although paper towels can be one of the most effective tools for hand drying in reducing the number of bacteria on hands [18]; yet, McCusky Gendron Louis et al. [16], fear that the unused paper towels can be a threat rather than a safe method for hand drying. Their study found that more than 17 species of bacteria can live on paper towels, from which *Bacillus* was identified as one of the paper towels' most risky bacteria.

Damp towels left in the dispenser may also pose an infection risk; therefore, it is essential to maintain a clean environment around paper towels in order to avoid non-hazardous hand drying. This includes the choice of dispenser allowing ease of delivery, correct use of the dispenser, jamming of the dispenser, site of dispenser in relation to sinks and splash zones. Not to mention that the dispenser itself may be the source of microorganisms when contaminated [14].

Furthermore, the potable water in Lebanon is well known to be contaminated with harmful bacteria, which might thus lead to the contamination of washed hands and cause food borne illnesses [20].

Hence, the aim of this study is to determine the extent of bacterial contamination of hand hygiene tools; isolate & identify the diversity of bacteria, and mold & yeast present in these commercial products; and to investigate the possible contamination of these utensils due to the environment encountering them.

2. MATERIALS AND METHODS

A literature search was conducted during September 2012 until January 2013, with the aim of finding the hand hygiene tools that are frequently contaminated and the most frequent bacteria that contaminate it.

2.1 Sampling

The sample size chosen in our study was similar to the number of samples used in the published literature which was enough to represent the existent situation in the Lebanese restaurants.

Study enrollment was voluntary and limited to the restaurants located in the Maten region. All participants were presented a letter of information for consent to participate in the research. The letter outlined the study design, the risks, the benefits, the compensation, and the informed-consent process.

Seven different restaurants participated in this study, from which we collected the following samples if they were found, after one single visit:

- 2 water samples: "W1" from the tap on the kitchen sink and "W2" from the toilet sink,
- 2 paper towel samples: "P1" from the kitchen sink and "P2" from the toilet sink,
- 2 liquid soap samples: "S1" from bulk and "S2" from the dispenser of the kitchen sink,
- 1 hand disinfectant sample: "D" from the kitchen.

Samples were collected from the kitchen and the kitchen staff toilet of the restaurants during the rush hours: Around 2 pm and 7 pm. Samples were collected in a sterile container and transported on ice cubs in a mini cooler to maintain a temperature below 5 Celsius degree and to avoid bacterial proliferation during the transport to the laboratory.

2.2 Tests

The sampling & the tests were according to the regulations of the laboratory of the Eye & Ear Hospital.

Before all experiments, hands were washed with soap, dried using paper towels, sanitized, and then covered with sterile gloves. The hand wash protocol was respected.

The microbiological tests were conducted according to the procedure of the laboratory of the Eye & Ear hospital, which is an accredited

hospital, by the ministry of Health with a grade "1".

The same time interval was adopted between sampling and testing when studying all the samples, which were kept in controlled refrigerator specific for samples collection.

Collected samples were tested using the Membrane filtration method for total coliforms, total bacterial count, fecal coliforms, yeast, and mold.

2.2.1 Procedure of total bacterial count in soap, paper towel & disinfectant

- *Soap & disinfectant*: Melt 2 PCA tubes (Liofilshom, exp. 20-02-2014) in a water bath. After melting, take the tubes and cool them to be slightly warm. Place 1 ml of the test sample in the petri Dish. Add 15 ml of the medium and mix by gentle rotation. Incubate (in Memmert) PCA plates at 36 Celsius degree to be checked after 48 hours.

- *Paper towel*: Incubate (in Memmert) the paper towel with Thioglycolate (Biomérieux, exp. 18-06-2014) at 37 Celsius degree for 24 hours. After 24 hours, repeat the same steps used for the soap and disinfectant.

2.2.2 Procedure of fecal coliforms in soap, paper towel & disinfectant

- *Soap & disinfectant*: Inoculate with the sample (soap or disinfectant) one Tergitol TTC agar (Liofilshom, exp. 4-05-2014). Incubate (in Memmert) at 44 Celsius degree and check after 24 hours and 48 hours, if positive.

- *Paper towel*: Incubate (in Memmert) the paper towel with Thioglycolate (Biomérieux, exp. 18-06-2014) at 37 Celsius degree for 24 hours. After 24 hours, repeat the same steps used for the soap and disinfectant.

2.2.3 Procedure of mold & yeast in soap, paper towel & disinfectant

- *Soap & disinfectant*: Inoculate with the sample (soap or disinfectant) one plate of Sabour and Chloranphenil (Pronadisa, exp. 07-03-2014) and leave at room temperature for 48 hours.

- *Paper towel*: Incubate (in Memmert) the paper towel with Thioglycolate (Biomérieux,

exp. 18-06-2014) at 37 Celsius degree for 24 hours. After 24 hours, repeat the same steps used for the soap and disinfectant.

2.2.4 Procedure of total bacterial count in water

Melt 2 PCA tubes (Liofilshom, exp. 20-02-2014) in a water bath. After melting, take the tubes and cool them to be slightly warm. Place 1 ml of the test sample in the petri Dish. Add 15 ml of the medium and mix by gentle rotation.

Incubate (in Memmert) PCA plates at 36 Celsius degree to be checked after 48 hours.

2.2.5 Procedure of total coliforms in 100 ml of water

Flame the forceps and remove the cellulose nitrate membrane filter from the sterile package, place the membrane filter into the funnel assembly.

Put 100 ml of the sample into the funnel; allow the sample to draw completely through the funnel.

Remove the membrane funnel and place it into one Tergitol TTC agar (Liofilshom, exp. 4-05-2014, marked 37 Celsius degree) to be incubated (in Memmert) at 37 Celsius degree and checked after 24 hours and 48 hours, if positive.

2.2.6 Procedure of fecal coliforms in 250 ml of water

Flame the forceps and remove the cellulose nitrate membrane filter from the sterile package, place the membrane filter into the funnel assembly.

Put 250 ml of the sample into the funnel; allow the sample to draw completely through the funnel.

Remove the membrane funnel and place it into one Tergitol TTC agar (Liofilshom, exp. 4-05-2014, marked 44 Celsius degree) to be incubated (in Memmert) at 44 Celsius degree and checked after 24 hours and 48 hours, if positive.

2.3 Inclusion and Exclusion Criteria

The restaurants included in this study were the fine dining and table service restaurants without satellite kitchen located in Maten area in

Lebanon. However, fast food restaurants and table service restaurants with satellite kitchen were not included in this study since both types of restaurants deals with finish and semi finish products.

2.4 Barriers and Limitations

Unfortunately, multiple barriers limit this study since no or few other studies have discussed this issue, and at some point, only the data provided by the restaurants and our personal culture will define the result of this Work. Furthermore, due to the limited resources devoted to this study, we were only able to work with 7 restaurants in one specific region of Lebanon. Yet the meaningful results of the carefully chosen restaurants which are well respected, having good reputation and which approved voluntarily to participate in this study, can thus be considered as a snap shot of the situation and shed some attention to similar conditions happening in other regions of Lebanon.

2.5 Conformity Assessment References

A LIBNOR (Lebanese Standards Institution) standard for drinking water was used as reference to assess the conformity of the water quality used for hand washing; whereas Food Code standards [8], was used as reference to assess the conformity of the observed hand washing stations.

2.6 Statistical Analysis

Microsoft excel 2010 was used to draw the statistics results as charts. Pie charts and bar charts were used to set the frequency and the conformity level of each restaurant.

Results of the culture were confidential and were only discussed with the company who provided the samples.

3. RESULTS AND DISCUSSION

Two types of analysis were conducted during this study, the first was an observational study and the second was microbiological testing of the samples.

3.1 Compliance with Norms & Standards

When comparing the restaurants compliance with the norms and standards, the following were the results:

7 over 7 restaurants respected the filtering of water, while 3 over 7 restaurants didn't respect the strict use of paper towels, and 4 over 7 restaurants didn't have a separate hand washing sink, whereas 2 over 7 restaurants used cleaning detergent for hand wash.

Thus, 0 over 7 restaurants were able to meet all hygiene requirements and 7 over 7 restaurants were not able to meet more than 45% of the Food Code [8] requirements.

Details of these findings are shown in Table 1.

Table 1. Compliance level of restaurants per criteria with the food code 2009 standards

Criteria	Compliance level per criteria
Water filtered	100 %
No Open bins	71 %
No recycled paper towel	71 %
Sink far from the toilet seat	71 %
No use of cloth towel in the kitchen	57 %
Specific hand washing station	43 %
No touch tap	0 %
No touch soap dispenser	0 %
T° of W1> 30°C	0 %
T° of W2> 30°C	0 %
Availability of sign and posters	0 %

The most obvious violations were registered in the lack of applying important requirements such as the absence of educational signs and poster, the no-touch system of the tap water, the no-touch system of soap dispenser and the water temperature, both in the kitchen and in the WC, since none of the seven restaurants was able to comply with these requirements.

It is important to note that these restaurants have accepted voluntary to participate in this study and were completely prepared for the sampling day. Moreover, the managers who accompanied us during the sampling were proud of the sanitation status of their kitchen.

Thus, we believe that these high non-conformity levels are the result of a lack of knowledge or under estimation of the contamination risk; they are putting their clients on and not due to bad intention.

3.2 Microbiological Testing

According to the result of Fig. 1, almost all the restaurants had at least 2 contaminated samples

except for restaurant E who did not have any contaminated samples. However, no restaurants had hand disinfectant and restaurants A, B and E did not provide us with paper towel samples since they use cloth towels in the kitchen.

were fecally contaminated. Six water samples from the kitchen and six from the toilet were contaminated with total coliforms, from which one sample was fecally contaminated. Three paper towel samples from the toilet were contaminated; however, none of the paper towel samples from the kitchen was contaminated.

According to the Fig. 2, none of the samples was contaminated with yeast and mold. One soap sample from bulk and one from the dispenser

The origins of these contaminations are still undefined and might thus be numerous.

Table 2. Result of bacterial count per sample

	Sample	Fecal coliform (CFU=Coliform forming unit)	Yeast & mold	Total bacterial count	Total coliform (CFU/100 ml)
Rest. A	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P2	20 CFU /g	<1 CFU/g	20 CFU /g	
	W1	<1 CFU/250 ml		25 CFU	2000
	W2	<1 CFU/250 ml		10 CFU	1000
Rest. B	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P2	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	W1	<1 CFU/250 ml		12 CFU	1000
	W2	<1 CFU/250 ml		20 CFU	1500
Rest. C	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P1	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	P2	50 CFU /g	<1 CFU/g	50 CFU /g	
	W1	<1 CFU/250 ml		5 CFU	400
	W2	<1 CFU/250 ml		10 CFU	1000
Rest. D	S1	20 CFU /ml	<1 CFU/mL	10 CFU	
	S2	50 CFU /ml	<1 CFU/mL	50 CFU	
	P1	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	P2	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	W1	<1 CFU/250 ml		25 CFU	2000
	W2	<1 CFU/250 ml		20 CFU	1600
Rest. E	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P2	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	W1	<1 CFU/250 ml		<1 CFU	<1
	W2	<1 CFU/250 ml		<1 CFU	<1
Rest. F	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P1	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	P2	15 CFU /g	<1 CFU/g	<1 CFU/g	
	W1	<1 CFU/250 ml		10 CFU	500
	W2	<1 CFU/250 ml		20 CFU	1500
Rest. G	S1	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	S2	<1 CFU/mL	<1 CFU/mL	<1 CFU	
	P1	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	P2	<1 CFU/g	<1 CFU/g	<1 CFU/g	
	W1	<1 CFU/250 ml		15 CFU	1000
	W2	100 CFU /250 ml		30 CFU	1500

* S = Soap sample from bulk; S2= Soap sample from the dispenser of the kitchen
 P1= Paper towel sample from the kitchen P2= Paper towel sample from the WC of the kitchen staff
 W1= Water sample from the kitchen; W2 =Water sample from the WC of the kitchen staff

3.2.1 Soap

Since soap samples were equally contaminated, we tested soap samples from bulk and from dispenser to see if there is a relationship between the contamination status and the soap storage unit. And because both contaminated soap samples came from the same restaurant, we can say that this contamination might be due to the contamination of raw ingredients & packaging as suggested by Todd Ewen et al. [18].

3.2.2 Paper towels

All paper towel samples were from stacks and not in roll. The risk of contamination of the paper towel from the factory should be the same for all the collected samples. However, the contaminated samples of paper towels were limited to the one collected from the toilet, thus the environment, the closeness to the toilet seat and the open garbage bins, and/or the quality of the paper towels might be the source of this contamination.

Moreover, paper towels close to the toilet seat were all contaminated & the majority of the paper towels that were far from the toilet seat were not contaminated. This result might indicate that the closer the toilet seat from paper towel dispenser, the greater the risk of contamination by splashes from contaminated water when flushing the toilet, which is similar to the result of Jackson M, et al. [19].

Furthermore, no clear relationship was found between the quality of paper & the contamination; however, in other studies found in the literature recycled paper towels were found heavily contaminated with pathogens [16].

3.2.3 Water

Water filtration, which is a simple method of controlling the mineral level in the water, was applied in all 7 restaurants yet the water was highly contaminated, which proves that filtering the water has no effect on the safety & the microbiological status of the water. Not to mention that that filters can accumulate micro-organisms and contaminate water.

3.2.4 Hand disinfectant

None of the participating restaurants in this study had a hand disinfectant in the kitchen, which is a clear violation of the Food Code 2009's recommendations [8].

The result of the bacterial count of all the samples can be shown in Table 2.

3.4 Relationship between Compliance Level & Microbiological Results

When comparing the compliance level of the restaurants with the norms and standards to the microbiological results of the samples, one can assume that the restaurant with the lowest compliance had the higher contamination level.

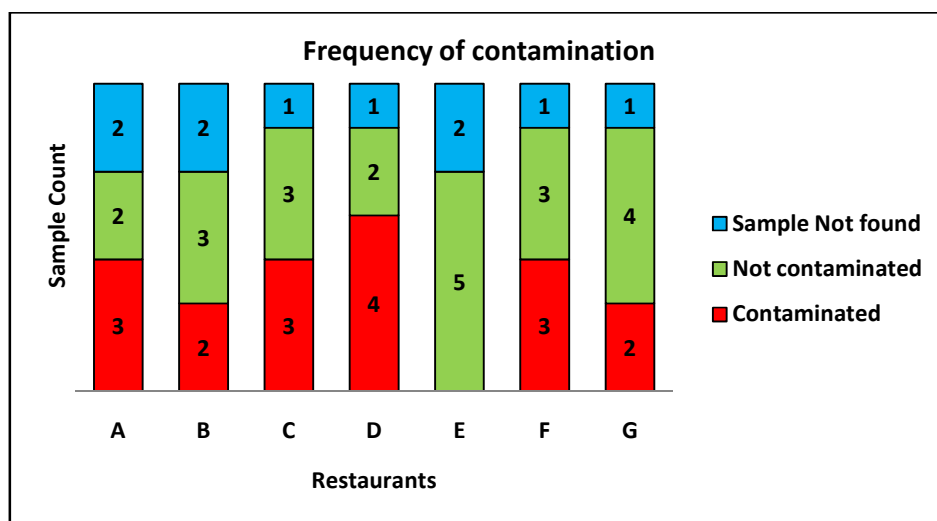


Fig. 1. Frequency of contamination among the restaurants samples

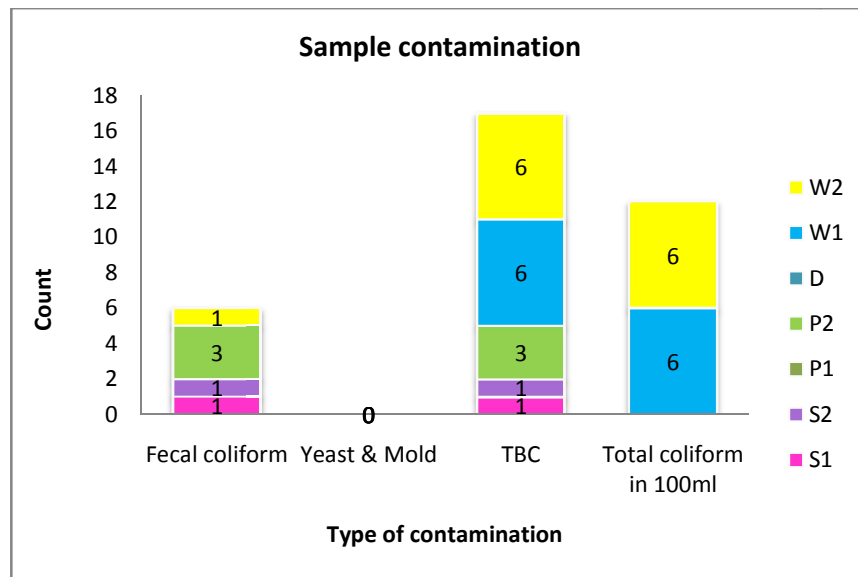


Fig. 2. Type of contamination according to the type of samples

However, when looking at the results of the restaurants, a different result appears:

- Restaurant A has the lowest compliance level (9%) and one of the highest contamination levels.
- Restaurant D had the highest compliance level (45%) and the highest level of contamination.
- Restaurant E had the highest compliance level (45%), and no detected contaminated samples.

As a result, we suggest that even if a restaurant is complied with the international recommendation for the hand washing station, this does not mean that the hand washing tools are free of contamination.

4. CONCLUSION

It has been estimated that hand washing with soap could save a million lives a year [14].

Barriers to effective hand washing are multi-dimensional in nature [1], from which the pre-contamination of hand hygiene tools can be identified.

Thus, the assessment of the hand hygiene tools' safety may be considered as complementary to the Food Code's [8] recommendations given that the safety of these products is as important as the hand hygiene itself.

Food safety is to be addressed immediately since food borne diseases constitute a fact of daily life in Lebanon according to the studies of WHO [7] and FAO.

6. FUTURE RECOMMENDATIONS OR IMPLICATIONS

The findings of this study suggest a list of intervention to improve hand-washing sanitation addressed to the food workers, restaurant owners and kitchen managers, and the governmental department responsible of the food safety in Lebanon:

- Paper towel dispensers should be placed far from the toilet seat given that the closer the toilet seat from paper towel dispenser is, the greater the risk of contamination by splashes from contaminated water when flushing the toilet.
- Bins should be closed and pedal operated, and should undergo sanitary cleaning to reduce bacterial transfer and prevent cross-contamination.
- Recycled paper towels should be replaced by virgin paper towels, because recycling papers might sometimes be heavily contaminated with pathogens [16]
- Water should not only be filtered but should be treated for pathogens and an

improved storage system should be applied to successfully prevent the growth of pathogens and avoid food poisoning through contaminated hands.

- Alcohol Based Hand Sanitizer should be used combined with the hand washing procedure to increase compliance to the sanitary hand hygiene.

- A scheduled plan to perform microbiological tests for all hand hygiene tools is required; this procedure should be implemented at least once a year to minimize the risk of cross-contamination from pre-contaminated hand hygiene tools.

- Restaurant owners and food safety officers should focus on ways of regularly training managers and food workers to recognize the barriers and threat to assure a sanitary hand washing process.

While the results of our study can be accomplished and confirmed by further analysis targeting a larger number of restaurants and analyzing a larger number of samples, then future studies targeting potential sources of contamination and identifying the type of the incriminating pathogens could complement our suggestion for a better supervision of safe hand hygiene tools.

CONSENT

All participants were presented a letter of information for consent to participate in the research. The letter outlined the study design, the risks, the benefits, the compensation, and the informed-consent process.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Grade 1 accreditation letter of the eye & ear hospital from the Lebanese ministry of public health



رقم المخطوطات: ١/٢٠٣
رقم الصادر: ١٩٧/٤٢١٩
بيروت في: ٢٨ شباط ٢٠١١

جانب مدير مستشفى العين والأذن المحترم،

إستكمالاً لإجراءات اعتماد المستشفيات وفقاً لنظام الإعتدال الصادر بالقرار رقم 1/482 تاريخ 1 حزيران 2009،

بناءً على نتيجة عملية التدقيق التي نفذت في مؤسستكم من قبل مؤسسة التدقيق التي اعتمدها لهذه الغاية وحيث أنكم كنتم قد أبلغتم اللجنة الفنية بموافقتكم على هذه العملية،

تبلغكم وزارة الصحة العامة بأن مستشفى العين والأذن

قد تم تصنيفه في فئة:

Accréditation de niveau 1

وقد توزعت الملاحظات والتحفظات وفقاً للجدول المرفق رطباً.

للإطلاع وأخذ العلم وإجراء المقتضى وفقاً للقرار المذكور.

س/وزير الصحة العامة

علي حسن خليل



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