The Effectiveness of Different Wash Basins in Reducing the Microbial Load on the Hands of Food Handlers

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In Victoria, hands free wash hand basins in food preparation areas were a regulatory requirement introduced under the 1984 Health (Eating House and Food Premises) Regulations. *The food safety standards introduced in January 2001 replace existing state, territory and local government food hygiene regulations and the provision of a hands free wash hand basin is no longer prescribed (Australia and New Zealand Food Authority 2001). The aim of the pilot study was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash hand basins and manual tap operated basins in reducing microbial flora on hands. Thirteen premises with manual hand basins and a comparison random sample of 19 premises with hands free basins were selected from the City of Yarra in Melbourne, Australia. Data collection involved an Environmental Health Officer visiting the premises, conducting a survey and swabbing the food handler's hands prior to and post washing. The impact of variables, including the temperature of water supplied to the wash hand basin, number of food handling employees, types of food handled, time the sample was taken and approximate number of meals sold per hour, were also investigated. The results indicated that the mean percentage reduction in the number of colonies compared for the manual and hands free hand basins showed no significant difference (Manual mean = 58%, Hands free mean = 79%, p = 0.163). Overall, there was large variability in pre and post microbial counts for both basins and considerable variability in the temperature of water to wash hand basins. No clear association, however, was found between the number of employees, temperature of wash hand basin, meals served or use of either facility, with the percentage reduction in the microbial load. The pilot study has indicated that there is no difference between the use of either a manual or hands free wash hand basin for a small group of food retailers. Consideration should be given to a range of factors which might have impacted on this study, including frequency of hand washing, types of foods handled, length of mechanical wash, and number of manual wash hand basins available for the study. Education regarding the need to maintain the temperature of the wash hand basin water between 22-40°C should also be investigated among food retailers as well as strategies for the correct washing of hands.*

Key words: *Manual and Automatic Wash Hand Basins; Food Premises; Microbial Load*

The City of Yarra in conjunction with the Swinburne University of Technology conducted a pilot study into the effectiveness of hand washing facilities in owner/operated retail food premises within its municipality. The study was undertaken as a result of the Food Safety Small Grants Program, funded by the Victorian State Government, which allocated funding to local government agencies to conduct

projects which were proactive in improving food safety and can help protect the health of all consumers of food. The study was undertaken between March and October 2001.

The Australia and New Zealand Food Standards Code, Food Hygiene Standard 3.2.3, no longer requires the provision of hands free wash hand facilities in food premises (Australia and New Zealand Food Authority 2001). In Victoria, hands free wash hand basins in food preparation areas were a regulatory requirement introduced under the 1984 Health (Eating House and Food Premises) Regulations. It continued to be required by local government authorities through the application of Construction Guidelines for Food Premises introduced in 1994 (Department of Human Services 1994).

The food safety standards introduced in January 2001 replace existing state and territory and local government food hygiene regulations. Thorough washing and drying of hands is acknowledged in the food safety standards as an important factor in the prevention of food borne illness. The standard specifies occasions when food handlers are obliged to wash and dry their hands. It also requires the provision of "basins or other facilities" that can be easily accessed by food handlers within areas where food handlers work if their hands are likely to be a source of contamination of food. However, the provision of a "hands free wash hand basin" in food preparation areas is no longer prescribed as this is considered to present businesses with unnecessary cost and difficulties, and cannot be justified in terms of public health and safety (Australia and New Zealand Food Authority 2001).

Published research regarding the effectiveness of hands free wash hand basins compared to manual wash hand basins in food preparation areas in reducing microbiological flora on the hands of food handlers is limited. A study by Turner et al. (1994) used image analysis to compare the hand washing effectiveness of manual hand washing to an automated system through the application of an oil-based suspension. Results involving 65 food handlers found that manual handwashing was decidedly superior to the use of an automated system for the removal of oil-based soil on the hands. However, the study only focused on the removal of gross contamination and not microbial removal. In this study, the focus is on the contamination of food handlers hands from a microbiological perspective in a realistic food setting, rather than through gross contamination.

Another study, which evaluated manual hand wash procedures and automated handwashing procedures involving the application of a test organism found little difference in manual handwashing (if done correctly) and automated handwashing (Paulson 1992). Other published studies involving automated hand washing practices have focused on hand washing practices and attitudes of health care staff. Two studies focused on the effects of replacing a manually operated wash hand basin with an electric wash hand basin and found that hands were washed significantly better, but less often with an automated sink ($p < .001$). Staff also expressed negative attitudes to the use of an automated sink (Larson et al. 1991; Larson et al. 1997).

An unpublished experimental laboratory based project, involving the comparison of the two facilities among students at Swinburne University, showed no significant difference between the use of the two facilities (p=0.89) (Holt & Cannard 2001). However, the study had a range of limitations including the need to control the type of soap and washing technique used in the experiment. Also, a more realistic environment involving food handlers is required to provide results with greater validity. The pilot study was undertaken to explore the difference in effectiveness of the hands free basins and manual tap operated basins in reducing the microbial flora on the hands of food handlers in food premises.

Method

The aim of the project was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash basins and manual tap operated basins in reducing microbial flora on hands by:

(i) using a realistic environment by targeting owner/operator retail food premises in the City of Yarra, and

(ii) investigating the impact of the variables of water temperature supplied to the wash hand basin, number of food handling employees, types of food handled, time sample was taken and approximate number of meals sold per hour.

Sample selection

As there were only 13 premises with manual hand basins in the City of Yarra all were included in the study. For comparison a random sample of 19 premises with hands free basins was selected from the City of Yarra food premises database. "Hands free basins" included either electronic or foot operated hand basins.

The total sample size of 32 was determined by keeping the hands free sample, for statistical reasons, to no more than double that of the manual hand basins. For the purposes of analysis the set of premises with a manual hand basin were considered to be a sample from a wider population (such as would have existed before hands free hand basins were introduced).

Data collection and microbiological analysis

All proprietors were invited to participate in the project by the City of Yarra Environmental Health Officer (EHO). Once recruited, the EHO visited the premises, conducted a survey and swabbed the food handler's hands prior to and post washing. Prior to hand washing a sample was taken from the wrist to the index finger of the food handler. The hands were swabbed using sterile cotton-tipped swabs moistened in 1/4 strength peptone water (Oxoid Ltd.).

The food handler was instructed on the method for hand washing and provided with a standard amount of liquid soap (5mL) for use during the procedure. The method involved the food handler wetting his/her hands, applying liquid soap, washing the entire surface then drying with a paper towel, as per Australia and New Zealand Food Safety Standard 3.2.2. 15 (4) (b). The liquid soap was provided to try and eliminate variability between different types of disinfectants (Paulson 1992).

After hand washing, the hands were dried using a disposable paper towel and a second sample of the ring finger of the same hand was taken using a fresh swab. All samples were promptly transported on ice to the microbiology laboratory, Swinburne University of Technology and plated directly onto Plate Count Agar (Oxoid Ltd.). Plates were incubated at 30°C for 48 hours and the number of colonies arising was counted.

The EHO also conducted a survey on site. The officer collected data regarding the types of foods prepared, number of food handling employees, water temperature supplied to the hand basin and number of meals served per hour.

The data collection instruments were pre-tested. Both the survey and the hand washing procedure were trialed at a food premises, with pre-testing for the detection of microbial flora on the hands using the finger swabbing technique also taking place.

Evaluation

A process evaluation was carried out with the project officers involved in the project (Hawe, Degeling & Hall 1990). This evaluation involved obtaining positive and negative feedback to the project development and implementation through the completion of a short questionnaire.

Data analysis

In view of the small size of the dataset, several variables were re-coded into two categories in order to facilitate the analysis. These were the time the swab was taken, the number of employees, the number of meals sold per hour, and the number of types of food.

The percentage reduction of the number of colonies from the pre to post samples for both the manual and hands free hand basins was calculated and used as the key variable for comparison of the hand basin types and other groupings. The distributions of the pre, post and percentage reduction were examined and all variables summarised.

The two hand basin types were compared on percentage reduction using a t-test. Linear regression was used to determine if any of the pre, post and percentage reduction was related to temperature. The two hand basin types were compared on the percentage reduction for the categories of the four recoded variables using a t-test.

Results

The data as analysed are presented in Tables 1 and 2, separated into the manual and hands free wash basin groups. The sampled premises with manual wash hand basins employed an average of three food handlers and sold a range of foods which have been categorised into either four or fewer types or four or more types with the majority, 77%, selling four or more types. Food premises mostly sold between 20-40 meals per hour (53%), followed by 0-20 per hour (30%), with two selling 40-60 meals and 0-20 per hour respectively.

The sampled premises with hands free wash hand basins employed an average of three food handlers and sold a range of foods which have been categorised into either four or more types or four or less types with the majority, 84%, selling four or more types. Food premises mostly sold between 20-40 meals per hour (59%), followed by 0-20 per hour (32%), with one premises selling 40-60 meals per hour.

Table 1: Number of colonies recovered from food handlers and variables measured in food premises containing manual wash hand basins in food preparation areas

Food Premises *N*= 13	Number of colonies		Variables measured					Percentage reduction in number of colonies (post-pre)
	Pre washing	Post washing	Temp	Number of employees	Food Category*	Time taken: (between 10am and 2pm)	Meals per hour	
1	42	3	41	4	>4	10-11	20-40	92.9
2	1260	316	16	3	>4	10-11	20-40	74.9
3	67	2	22	3	>4	10-11	0-20	97.0
4	129	51	38	7	>4	11-12	20-40	60.5
5	53	0	35	2	>4	1-2	20-40	100
6	82	25	46	3	>4	11-12	0-20	69.5
7	112	31	46	4	≤4	11-12	40-60	72.3
8	24	23	32	1	≤4	11-12	0-20	4.2
9	736	70	43	2	>4	12-1	20-40	90.5
10	117	1	43	2	>4	12-1	0-20	99.1
11	0	0	40	2	>4	10-11	20-40	0
12	2	3	39	3	<4	10-11	20-40	- 50
13	13	8	29	2	>4	12-1	0-20	38.5

** Category of food includes either 4 or more or 4 or less of the following groups: cooked, cold; frozen; fruit and vegetables; meat, poultry and fish; sandwiches; cakes and pastries; coffee and teas; pasta and rice; small goods.*

Table 2: Number of colonies recovered from food handlers and variables measured in food premises containing hands free wash hand basins in food preparation areas

Food Premises *N*= 19	Number of colonies		Variables measured					Percentage reduction in number of colonies (post-pre)
	Pre washing	Post washing	Temp	Number of employees	Food Category*	Time taken: (between 10am and 2pm)	Meals per hour	
1	17	2	43	3	>4	10-11	0-20	88.2
2	44	21	31	2	>4	10-11	0-20	52.3
3	112	36	45	2	>4	10-11	0-20	67.9
4	5	4	44	3	>4	11-12	0-20	20.0
5	256	4	39	3	>4	10-11	20-40	98.4
6	33	23	15	2	>4	10-11	20-40	30.3
7	12	0	44	4	>4	12-1	20-40	100
8	2	0	31	2	>4	12-1	20-40	100
9	2	1	38	6	>4	10-11	20-40	50.0
10	18	1	34	2	>4	11-12	20-40	94.4
11	1008	28	44	3	>4	12-1	20-40	97.2
12	464	8	28	4	≤4	11-12	20-40	98.3
13	192	2	18	2	≤4	12-1	20-40	98.9
14	113	2	13	2	≤4	12-1	20-40	98.2
15	880	61	41	8	>4	10-11	40-60	93.1
16	12	7	20	4	>4	1-2	20-40	41.7
17	404	10	43	3	>4	10-11	0-20	97.5
18	496	140	22	2	>4	1-2	20-40	71.8
19	18	1	34	2	>4	11-12	0-20	94.4

** Category of food includes either 4 or more or 4 or less of the following groups: cooked, cold; frozen; fruit and vegetables; meat, poultry and fish; sandwiches; cakes and pastries; coffee and teas; pasta and rice; small goods.*

There was wide variation in the water temperature supplied to the basins. For the manual wash hand basins the range was 16-46°C and for the hands free 13-45°C. A plot of the pre count, post count and percentage reduction in the number of colonies against temperature showed no connection between these three variables and temperature (data not shown). This showed that the pre count, post count and percentage reduction in the number of colonies were not related to water temperature.

The mean percentage reduction for the re-coded categories of time, number of employees, number of meals served, and number of types of foods served showed no significant difference between the two types of hand basin on all four of these variables. Thus there was no overall difference in the percentage reduction in the number of colonies for the two hand basin types when compared at the two times (10am-12pm and 12pm-2pm), for the three employee sizes (1, 2 and 3 or more), for the number of meals served (0-20 and 20-60), and for the number of different types of food (4 or less and 4 or more).

It can be seen in Tables 1 and 2 that the pre and post counts were extremely variable. The large pre counts (>100) were evenly distributed over the numbers of employees variable showing that size of the enterprise had no bearing on the size of the (large) pre counts. The mean number of employees for large pre counts at 3.36 was greater than that for small pre counts at 2.78 but the difference was not significant (p=0.33). Similarly, there was no clear association between large pre counts and the time of swab.

The data showed some tendency for the larger pre counts to be associated with more than 20 meals served per hour, but the association was not significant (p=0.13).

The percentage reduction variable is probably only useful for non-trivial pre counts. Its values for both types of basin are shown in Figure 1. Ignoring the five pre counts less than 10, however, the microbial counts for both basins still shows a wide range of values of the percentage reduction with 4 out of 27 less than 50% and 11 out of 27 less than 75%. The efficacy of the hand washing is clearly not adequate to produce more desirable reductions, such as all reductions above 95%.

Evaluation

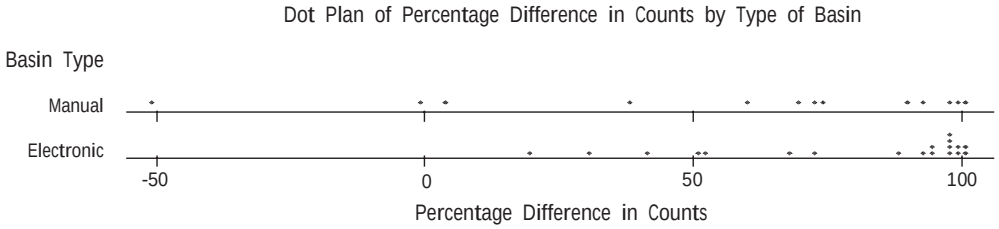
Overall, the evaluation results raised a number of positive aspects including general satisfaction with the planning, coordination and implementation of the project, with the EHOs perceiving the opportunity to be involved in the research as favourable. Negative issues included concerns of some proprietors regarding the sorts of outcomes the project would achieve, and the "poor" English skills of some proprietors, thus making it difficult to explain the project.

Discussion

The aim of the project was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash basins and manual tap operated basins in reducing microbial flora on hands. The study has shown that no significant difference was found between the use of a manual or hands free wash hand basin. The range of variables tested had no significant effect on reducing the microbial load through the use of either a manual or hands free wash hand basin. The results of this project are in accord with the hypothesis for a small group of food retailers in the City of Yarra. However, given the nature of the pilot project, it might not be appropriate to conclude that this is the outcome for all food settings, and consideration needs to be given to a number of factors.

The limitations of the study included the small number of manual wash hand basins

Figure 1: Percentage difference in microbial counts for the manual and electronic hand basins



The mean percentage reduction in the number of colonies was compared for the manual and hands free basins using a t-test. This showed no significant difference in the mean percentage reduction (Manual mean = 58%, Hands free mean=79%, p=0.163). Although the difference in these two percentages (21 percentage points) may seem fairly large, the non-significance is due to both the small sample sizes and the wide variation in the percentage reductions. In addition, if the three smallest values are removed, namely -50, 0 and 4.2, all from the manual hand basins, the difference between the two types of hand basins disappears. Thus, apart from three particular hand basins, there is no noticeable difference between the two types.

available for the project, particular differences in hand washing techniques, and the difficulty of controlling the level of contamination of the hands through either preparation of foods or other food handler activities prior to washing.

As the legislative requirement to provide "hands free" wash hand basins has been in effect since 1984, the pilot study found it difficult to source manual wash hand basins to use as a comparison. Therefore, only a small sample size was available, which affected the ability to provide greater validity to the study. However, as a pilot study it has provided some base data, and suggested some other issues for consideration, which will be useful in planning further studies surrounding the washing of hands by food handlers.

The results indicated, particularly, that there was great variability in the microbial loads in the pre and post samples. Other studies involving hand washing found reduction with pre and post washing in a controlled environment of approximately 99% (Holt & Canard 2000; Paulson 1992), whereas in this study the reduction ranged from 4.2% to 100%. This could be attributed to differences in levels of dryness of hands, pre and post washing, frequency of washing by the food handler prior to the washing of hands, and the amount of mechanical pressure exerted during washing.

Hands which have more residual moisture have been shown to transfer a greater load of bacteria, thus differences in the amount of moisture remaining on hands after drying, depending on the techniques of the food handlers, could impact on the result (Patrick, Findon & Miller 1997). More frequent washing has been shown to result in a reduced bacterial load (Restanio & Wind 1990; Troller 1983), and other studies have found that the immediate antimicrobial effectiveness depends upon the amount of time spent washing hands, the mechanical pressure and friction exerted in the washing, and the temperature of the water (Paulson 1996). These factors might have impacted on the effectiveness of either of the two types of hand basins.

Even though the pilot study attempted to address these issues through the instructions in washing technique given to each food handler, the results indicated more rigorous techniques need to be put in place to control for these factors. This would include timing the length of hand washing, developing indicators to account for frequency of washing prior to swabbing as well as measuring the level of hand dryness pre and post washing. The evaluation also highlighted the fact that some proprietors had difficulty in understanding the procedures for hand washing due to language difficulties, which is another consideration in this type of research.

Even though it was outside the scope of the study, it would be useful to explore further the types of bacteria remaining on the food handlers hands post washing. The results did indicate the presence of Gram negative bacteria (data not shown), and, even though the loads were considerably reduced in some cases, it would be useful to investigate the relationship between hand washing technique and the types of remaining bacteria. One study found that even though "normal" washing of hands resulted in a lower number of transient microorganisms, it did not influence the resident flora organisms such as *Staphylococcus aureus* (de Wit & Kampelmacher 1994). It is also interesting to note that the mean percentage reduction for the hands free hand basin was slightly more than that of the manual hand basin. Even though this was not a significant reduction, the above factors such as frequency of washing, dryness of hands, and handwashing technique might have influenced these results.

While the pilot project was not designed specifically to explore the operating conditions of the wash hand basin, it is worthwhile noting that there were large temperature variations in the water applied to the hands. Standard 3.2.3 of the Australia

and New Zealand Food Standards Code, 15(4)(b)(2001) recommends the use of warm running water at around 40°C and not below 22°C to assist in the removal of grease and encourage food handlers to wash their hands. Our results indicated that in 16% of premises hand basins were not operating within this temperature range. Even though the variation did not impact on the effectiveness of either of the two facilities, further exploration into the impact of temperature on the use of either facility may be worthwhile.

The purpose of the research was to investigate the effectiveness of the two wash hand basins in a realistic food premises setting, and has explored a number of variables, which may have impacted on the study. The study revealed that there was great variability in the reduced microbial loads both pre and post washing for both types of wash hand basins. Without access to a larger number of manual wash hand basins and the provision of a more controlled experiment (which would have greater resource implications), the pilot study has highlighted that regardless of the type of basin available, strategies to promote proper hand washing techniques, including frequency of washing and the proper drying of hands should be explored. The message of proper and frequent hand washing regardless of the type of facility should be strongly promoted.

Recommendations for further studies of this nature include addressing issues such as:

(i) the availability of manual wash hand basins in food preparation areas to enable an increase in the study population;

(ii) investigating methods of controlling the frequency of hand washing and types of foods handled prior to the swabbing of hands, length of time of hand washing and amount of residual water left on hands post drying;

(iii) developing strategies for the education of food handlers on the correct temperature of the water for wash hand basins; and

(iv) investigating the types of microorganisms that remain after washing.

Conclusion

The results of the pilot study indicated that there was no difference between the use of either a manual or hands free wash hand basin taking into consideration a number of variables for a small group of food retailers in the City of Yarra. Consideration should be given to a range of factors which might have impacted on the study, including frequency of hand washing, types of foods handled, length of mechanical wash, and the number of manual wash hand basins available for the study. Education regarding the need to maintain the temperature of the wash hand basin water between 22-40°C should also be investigated among food retailers as well as strategies for the correct washing of hands.

Overall, the study provided a useful opportunity to investigate the effectiveness of the two hand basins in a realistic setting, and highlighted the challenges involved in conducting research of this nature and the need to encourage proper and thorough hand washing regardless of the facility available.

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