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Finger licking good? An observational study of hand hygiene practices of fast food restaurant employees and consumers

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Finger licking good? An observational study of hand hygiene practices of fast food restaurant employees and consumers

Abstract

Purpose: Appropriate hand hygiene technique is a simple and effective method to reduce cross contamination and transmission of foodborne pathogens. This study aims to investigate the frequency of hand hygiene activities among food handlers and consumers in fast food restaurants.

Methodology: Twenty-five fast food restaurants and cafes were visited between May – August 2017 in North West England. A hand hygiene observational tool was adapted and modified from previous studies. The observational tool was designed to record 30 sequential hand activities of consumers and employees. Each transaction consisted of an observed action (e.g. touch with bare hands), object (e.g. exposed ready-to-eat foods) and observed hand hygiene practice (e.g. handwashing or cleaning with wipes or sanitisers). Adenosine triphosphate (ATP) swabs of hand-contact surfaces of restaurants’ restrooms were carried out.

Findings: Findings revealed that both food handlers and consumers have low hand hygiene compliance rate in fast food restaurants. Consumers were more likely to clean their hands with napkins after handling exposed ready-to-eat (RTE) food. Food handlers were observed to change into new gloves without washing their hands before handling exposed RTE food. The mean results for all hand-contact surfaces in restrooms were higher than 30 Relative Light Units (RLUs) indicating unhygienic surfaces. Male restroom exit doors’ adenosine triphosphate (ATP) levels were significantly higher than females.

Originality: This study revealed the lack of hand hygiene practices among food handlers and consumers at fast food restaurants and cafes. Restroom hand-contact surfaces revealed high ATP level indicating unhygienic surfaces. This can potentially re-contaminate washed hands upon touching unhygienic surface (e.g. exit door panel/handle) when leaving the restroom.

Keywords: behaviour; food handlers; food safety; handwashing; sanitation

Introduction

The World Health Organization (WHO) estimated that 31 foodborne hazards resulted in 600 million foodborne illnesses and more than 400,000 deaths in 2010 (WHO, 2015). In the UK, it is estimated that about a million people are affected by foodborne illnesses annually, leading to 20,000 hospitalisation and 500 deaths. It costs the UK about £1.5 billion and places a significant burden on the productivity and socio-economic development of the country (FSA, 2011).

Eating out is becoming more prevalent as consumers spent more than £1.47 trillion worldwide while UK consumers spent a total of £77 billion eating out in restaurants and cafes in 2015 (Edwards, 2013; Statista, 2017). However, restaurants have been linked to foodborne illnesses such as the multistate outbreaks of Shiga toxin producing *Escherichia coli* O26 in Chipotle Mexican Grill (CDC, 2016), community outbreak of *Salmonella enterica* serotype Typhimurium in two local restaurants (Holman, et al., 2014) and norovirus outbreaks among diners at restaurants (Smith et al., 2012; Westrell et al., 2010).

Although no single food item or ingredient ~~were-was~~ implicated in the *E. coli* O26 outbreak, it is likely that a common meal item or ingredient served at the restaurants in different states ~~were-was~~ the likely source of outbreaks (CDC, 2016). Meanwhile the *Salmonella* outbreak was traced to an asymptomatic chef who worked at both restaurants (Holman et al., 2014). The norovirus outbreak ~~were-was~~ potentially caused by consumption of raw oysters, transmission from infected food handlers or due to the restaurant environment (Smith et al., 2012; Westrell et al., 2010). Food handlers represent the critical, final stage of food production, where meals are prepared and delivered. This group is also a reservoir of pathogens, and may not always be aware if they are transmitting pathogens (Todd et al., 2008). Food workers who do not adhere to safe and hygienic practices can potentially transmit pathogens to food and food contact surfaces. However, in addition to food workers, consumers may sometimes be the source of outbreaks (Todd et al., 2007). For example, in a restaurant setting where food from a common shared platter was eaten with fingers, it is likely that guests or staff introduced the norovirus into the shared dish causing three successive gastroenteritis outbreaks (Marshall et al., 2001).

Previous studies on food safety knowledge, attitude and practices among employees and consumers (Samapundo et al., 2016; Tomaszewska et al., 2018; Zanin et al., 2017) were based on self-reported practices. Zanin et al. (2017) identified 36 studies that addressed food safety knowledge, attitudes and practices of food handlers but most still a lack of translation of knowledge/attitudes into practices. Studies on observation of food safety practices had been carried out using cameras (Evans and Redmond, 2018; Masson et al., 2017), direct observation (Her et al., 2017; Ovca et al., 2018) and discrete observation (Trafialek et al., 2017). Hand hygiene is an effective method to reduce cross contamination and transmission of foodborne pathogens (Ali et al., 2014). However, previous studies have shown that adherence to hand hygiene by food handlers is poor (Clark et al., 2018; do Prado et al., 2015; Robertson et al., 2013) whilst hand hygiene studies among consumers are still lacking. Similarly, a number of Adenosine Triphosphate (ATP) hygiene monitorings had been carried out in hospitals (Alfa et al., 2015; Amodio and Dino, 2014), kitchen (Aycicek et al., 2006) and food production facilities (Lau et al., 2016). But there is still a paucity of research on the hygienic status of hand-contact surfaces in restrooms. There was one published study on ATP swabs of restroom sinks and stall doors ~~was~~ conducted by Shaughnessy et al. (2013). Thus, it is the aim of this study to

observe hand hygiene practices of both consumers and employees and to determine the ATP level of hand-touch surfaces of restroom facilities in fast food restaurants.

Methodology

Hand hygiene observational tool

The indications for hand hygiene were based on WHO (2009) and FSA (2013). The following criteria necessitates handwashing: when entering the food handling area (e.g. after a break or going to the toilet), before preparing food, after touching raw food, after handling food waste or bin, after cleaning, after blowing their nose, after touching phones, cash registers, door handles, light switches and surfaces that could come into contact with staff handling raw food. Hand hygiene technique includes handwashing with soap and water. The procedure takes between 40 – 60 seconds. Hygienic hand rubs or gels should not be used in replacement for effective handwashing but could be used as an additional precaution. Similarly, food handlers must wash their hands thoroughly before putting on disposable gloves and after taking them off (FSA, n.d.).

Hand hygiene criteria for consumers include before handling and consuming exposed Ready-to-eat food, after handling food waste or touching the bin, after blowing their nose and touching electronic devices, cash and unhygienic surfaces. Objects such as mobile phones, tablets or other personal electronic devices (Lando et al., 2018; Walia et al., 2014), currencies (Alemu, 2014; Vriesekoop et al., 2010) had been found to harbour a range of pathogens and potential pathogens. A number of food contact surfaces such as cooking equipment, tray and utensils were contaminated with one or more food allergens (Ortiz et al., 2018). Personal items such as wallets, pens and purse were found positive for yeast and mould and *Staphylococcus aureus* (Donofrio et al., 2012). Handwashing, cleaning hands with wipes or sanitisers and handwashing and changing into new gloves were categorised as hand hygiene activities. An additional category of cleaning hands with napkins among consumers or cleaning hands with towels among food handlers were also recorded (but not categorised as hand hygiene activity). Observed behaviours that require hand hygiene activity were divided into food-related behaviour (i.e. before and after handling exposed food), after handling unsanitary objects, equipment and body parts. The observational tool used to monitor hand hygiene practices among consumers and employees was adapted from Behnke et al. (2012), Clayton and Griffith (2004) and Her et al. (2017). The observational tool was designed to record 30 sequential hand activities of consumers and employees. Her et al. (2017)'s tool was built using a mobile-friendly web-based survey platform to increase its ease of use, portability and reduces the Hawthorne effect of direct observation of consumers and staff. The author adopted a similar approach and developed the observational tool using Survey Monkey® survey platform with an android phone.

Pilot testing and modification of observational tool

The observational tool was pilot-tested in three fast food restaurants and one cafe at both peak (12 – 2pm) and non-peak hours (3 – 5pm) in Preston, UK. The 30 observations required a larger screen to determine the category of hand hygiene behaviour and actions. The scrolling and initiation of a new survey for new observation slowed the process down and the author adapted the instrument into an MS Excel sheet in a tablet. This allows a bigger screen to note down the actions, objects and hand hygiene practices that follow. The adaptation of the tool in MS Excel also excludes the need for Internet access and allows the usage of the tool in restaurants or cafes with limited wifi. There are two versions of the tool – one for the employee and one for consumers. After pilot testing the observational tool, observed actions such as 'finger licking', 'scratching' and use of unsanitary object such as 'cigarette' were added.

Sampling of food service outlets

Fast food outlets and cafes located in cities of North West England (Chester, Cumbria, Greater Manchester, Lancashire and Merseyside) were visited between May – August 2017. The author requested ~~for~~ consent from the restaurant managers to carry out the study. The food handlers and consumers were not aware of the study to prevent ~~the~~ Hawthorne effect. The participants were only observed either during peak (12 – 2pm) and non-peak hours (3 – 5 pm). Fast food operations were defined as outlets that offer standardised and simple menus within a controlled operating system (Jones et al., 2002). All fast food restaurants and cafes in this study consisted of facilities for customers to consume food on the premises. The fast food restaurants and cafes include those that sell burgers, pizza, sandwiches and finger food. Convenience sampling was used due to resource limitations and better access to fast food restaurants and cafes located in city centre or towns. A total of 25 restaurants were visited and 29 restrooms were swabbed.

Hand hygiene observation

During the start of each observation, the date, location and demographics such as gender, consumers' group size (e.g. 1, 2, 3 or more than 3) and employee working position (e.g. front service, cashier, food preparation/cooking) was recorded. Both consumers and employees were observed until 30 sequential behavioural transactions were recorded. Observation of consumers who left the restaurant or employees who left their workplace resulting in a lag in observation or less than 30 sequential transactions were discontinued. Each transaction consisted of an observed action (e.g. touch with bare hands), object (e.g. exposed ready-to-eat foods) and observed hand hygiene practice (e.g. handwashing). The type of objects are divided into food (e.g. exposed or wrapped foods), unsanitary object (e.g. electronic device), equipment (e.g. table) and human (e.g. body parts).

Adenosine triphosphate hygiene monitoring of hand-contact surfaces in restaurants' restrooms

A 10 x 10 cm² area or contact area of various restroom spaces and touch surfaces were swabbed using Ultrasnap ATP and Hygiena Ensure Version 2 ATP hygiene monitoring system (Hygiena LLC, Ca,

USA). Number of cubicles in each restroom (such as multi-use where there are 2 or more toilet cubicles) or single use (i.e. for male, female and disabled usage) were recorded. Between 5 – 7 surfaces were swabbed including toilet flush, cubicle lock and/or handle, sink faucet control, soap dispenser, hand drying controls and exit door in each restaurant’s restroom. Swabbed samples were activated and recorded using the ATP luminometer. Results were expressed numerically as relative light units (RLUs). ~~Score-A score~~ of 10.00 RLUs or less is considered “satisfactory-/-pass”; scores from 11.00 – 30.00 are considered “requires improvement-/-caution”; and a score of greater than 30.00 ~~RLU~~ is considered as a “fail” (Hygiene, 2018; Lau et al., 2016).

Statistical analysis

Descriptive statistics, chi-square test and univariate Analysis of Variance were carried out using IBM SPSS Statistics Version 24 and significance was set at $p < 0.05$. Shapiro-Wilk test values of > 0.05 were used to determine tests of normality whilst homogeneity of variance were checked using scatterplots.

Results

Demographics

Twenty-five fast food restaurants were visited. A total of 151 consumers and 47 employees were observed (Table 1). There were more females and Caucasians observed for both food handlers and consumers. More cashiers and servers were observed in the study as they represent the front service staff and their hand hygiene activities can be easily viewed and recorded. More than 80% of the observed consumers tend to dine in a party size of two or more people.

Insert Table 1 here

Hand hygiene practices among consumers and employees

A total of 4530 hand activities were observed among 151 consumers. Out of the 4,530 transactions, 33,010 required hand hygiene activity. However, consumers only practised hand hygiene activity (i.e. cleaning hands with wipes or sanitisers) in 0.33% of the transactions. The highest hand hygiene requirement was before handling exposed RTE (42.32%) but consumers only cleaned their hands less than 1% of the time. The highest cleaning frequency was after handling exposed ready-to-eat food (RTE) (Table 2). There’s a higher number of hand hygiene activity post-handling exposed RTE food. There was no or very little hand hygiene activity after handling electronic devices, personal belongings or even after handling cigarettes. About 30% of the hand activities involved touching faces, hair, other body parts, finger licking and sneezing or coughing but only one consumer was observed to carry out hand sanitisation. There was a higher rate of cleaning hands with napkins (although this is not categorised as hand hygiene). Most consumers were observed to wipe their hands with napkins post-handling exposed RTE food (5.80%) as most RTE food from fast food

190 restaurants are in the form of finger foods such as burgers, fries, sandwiches, bakery products and
 191 chicken pieces.

192
 193 One thousand four hundred and 10 hand activities were observed among 47 food handlers of which
 194 1157 required hand hygiene practices. The highest frequency of hand hygiene activity (21.28%) were
 195 observed before handling exposed RTE food while no hand hygiene was carried out before putting on
 196 new gloves, after handling exposed RTE, unsanitary objects or body parts (Table 3). However, food
 197 handlers who changed into new gloves (21.28%) did not wash their hands before putting them on.
 198 Out of the 274 equipment related behaviour requiring hand hygiene activity, only one staff was
 199 observed to clean her hands with napkins after handling the cooking equipment.

200
 201 Insert Table 2 here

202
 203 Insert Table 3 here

204
 205 There was no significant association between food handlers and consumers' hand hygiene activity χ^2
 206 = 3.18(1), $p > 0.05$. There were no statistically significant associations between employees' working
 207 position or gender and hand hygiene activities. Among consumers, females (10.30%) were more
 208 likely to clean their hands with wipes ~~ef-or~~ sanitisers compared to males (0%) $\chi^2 = 5.96(1)$, $p < 0.05$.
 209 Consumers with a party size of three or more people (13%) were more likely to carry out hand
 210 hygiene activity $\chi^2 = 6.36(2)$, $p < 0.05$. Females were also observed to use their phones (64.80%),
 211 touched their faces (67.14%) and hair (82.56%) more often compared to males (Table 4).

212
 213 Insert Table 4 here

214 215 **ATP swabs of restrooms**

216 A total of 16 female, 6 male and 7 unisex restrooms were swabbed. Fifteen were single-use type
 217 whilst the rest were categorised as multi-use (e.g. with 2 toilet cubicles or more). There was a wide
 218 variation in ATP results but the mean results for all surfaces were higher than 30 RLUs. This indicates
 219 that the surface areas were unhygienic and require re-cleaning (Hygiena, 2018). Fast Food
 220 Restaurant (FFR) 1 recorded the highest level of ATP across all surfaces (Figure 1). Out of the 29
 221 restrooms, two facilities did not have soap and one hand dryer was not working. Among the facilities,
 222 there were 27 facilities with sensor-operated hand dryers, four sensor-operated faucets and two
 223 sensor-operated flush. Toilet flushes, sink faucets, soap dispensers and restroom exit doors were
 224 significantly higher in FFR1 compared to other FFRs (Table 5). Male restrooms recorded highest
 225 values across all surfaces except door locks. Male restroom exit doors' swabs were significantly higher
 226 than females ($p < 0.05$).

1
2
3 228 Insert Figure 1 here
4 229
5 230 Insert Table 5 here
6 231

7 232 **Discussion**

8 233 The findings in this study revealed no significant difference between food handlers and consumers in
9 234 hand hygiene activities. Both groups have low hand hygiene compliance rate in fast food restaurants.
10 235 Although food handlers involved in food preparation/cooking were more likely to clean their hands,
11 236 this did not differ significantly from those who serves/work as cashiers. Fast food employees are
12 237 expected to serve a large number of people with minimum waiting time. In order to be effective, fast
13 238 food restaurants need to provide quality, consistent and timely meals and services. Jones et al.
14 239 (2002) reported that fast food retailing in the UK aims to serve customers within three minutes of
15 240 their entry into the restaurants. Fast food franchises rely on satisfied customers to continue their
16 241 patronage at the premises (Gilbert et al., 2004; Namin, 2017). Based on the constant demand and
17 242 time pressure, there is less opportunity for food handlers to carry out hand hygiene activities. This is
18 243 in agreement with Thaivalappil et al., (2018) who found that handwashing was often not carried out
19 244 during busy periods.
20 245
21 246 Lack of space and resources such as soap and poor accessibility to handwashing facilities also
22 247 contribute to reduced adherence to food safety practices (Clayton et al., 2015). Strategic placement
23 248 of hand hygiene foam dispensers were found to significantly increased the use of the dispenser
24 249 (Thomas et al., 2009). Social norms too can influence food handlers’ adherence to hand hygiene
25 250 activities. Support and guidance from managers or supervisors and co-workers will create a positive
26 251 food safety culture and better conformance to hand hygiene activity (Pragle et al., 2007). Perceptions
27 252 of optimistic bias among food handlers where they perceived themselves as less likely than their
28 253 peers to transmit foodborne diseases too can cause food handlers to overlook the food safety
29 254 procedures. Optimistic bias among food handlers can lead to food safety breaches as an optimistic
30 255 food handler may overlook hand hygiene practices and contaminate food products (da Cunha et al.,
31 256 2014; Rossi et al., 2017). Timely and correct handwashing is important to prevent spread of
32 257 pathogens. Handwashing is required before preparing food, after handling raw food, when entering
33 258 the food preparation area, after going to the toilet or break, after touching bins and items such as
34 259 door handles, light switches, cash registers, after blowing their nose or changing a dressing.
35 260 Employees should be reminded that disposable gloves are not to be used as an alternative hand
36 261 hygiene activity (FSA, 2013).
37 262
38 263 Consumers were more likely to clean their hands with napkins. Although the customers in this study
39 264 were observed for an average of 8 minutes per 30 sequential transactions, Paddock et al. (2017)
40 265 revealed that customers spend an average of 1 hour or less in the restaurant. This provides

customers with time to carry out hand hygiene activity. A high number of transactions also involved customers touching their mobile phones and skin (especially facial area) and this could have triggered customers to wipe their hands before using their phones or touching their faces. Consumers who tend to lick their fingers did not clean their hands after licking. In fact, "finger-lickin' good" is a famous catchphrase of a well-known fast food brand and signifies that customers will not be able to resist polishing the food off their fingers (Visser, 2017). However, finger licking is not an acceptable dining etiquette in some culture (Visser, 2017) nor an appropriate food safety practice especially when preparing food (Eves et al., 2006). Finger licking behaviour were also observed in popular television cooking shows where 47 finger licking behaviour were observed in the shows (Irlbeck et al., 2009).

Females were observed to clean their hands more frequently. Females also tend to touch their phones, face and hair more often compared to males. Her et al. (2017) observed similar behaviour among females in their study. Females were more likely to experience social physique anxiety (Kowalski et al., 2006) and tend to address the anxiety via appearance management and repetitive body checking behaviour (Haase et al., 2007; Reilly and Rudd, 2009; White and Warren, 2014). In this study, there was also one observation of a consumer who picked a dead fly from the table but did not clean her hands prior to eating. Flies may transmit pathogens to food or hands. Previous studies reported that houseflies can transmit *Escherichia coli* (Lindeberg et al., 2018; Talley et al., 2009) and Salmonella enterica (Pace et al., 2017) to food. A party size of three and above encourages hand hygiene activities and this could be due to subjective norm effects where individuals are influenced or pressured to comply with expectations from other individuals (Ajzen, 1985).

RLU scores greater than 30.00 indicated a fail, demonstrating that the surface areas highlighted as human touch points should be re-cleaned. The ATP on the surfaces may have derived from food residues, dead microorganisms or hand ATP (Worsfold and Griffith, 2001). Additionally, aerosol contamination of surfaces generated from the action of flushing can contribute to the high surface ATP reading. Barker and Jones (2005) simulated the effects of flushing a toilet and recorded the spread of aerosol contamination of surfaces. They found bacterial contamination of between 20 – 50 CFU per plate on the toilet seat, shelf, cistern and front of toilet within 30 minutes of flushing. The surface ATP in FF1 increased progressively from toilet stall doors to soap dispensers although the ATP reading declined 23% on the restroom exit door. The high number of surface ATP in this study is a cause for concern as the effectiveness of handwashing practices may diminish post-handwashing when touching the sink faucet and restroom door handle / panel to exit. Posting reminders or reinforcement such as effective handwashing steps, posters or consequences (e.g. fines, health violations) can influence food safety practices (Thaivalappil et al. 2018). Clark et al. (2018) developed the handwashing intervention ladder and suggested a number of methods to address the lack of hand hygiene compliance. This can potentially be applied in fast food restaurant settings to encourage food handlers and customers to wash their hands effectively.

Limitations

Due to resource limitations, the researcher could only visit a small number of fast food restaurants and cafés and the outlets were only visited once. The outlets were also limited to those located in city or town centres. The current study was only conducted in North West England and the findings should not be generalised to other locations. It is recommended that future studies should include information on how frequently the restrooms were cleaned. ATP swabs could be conducted to determine the level of hygiene before and after cleaning and during peak and non-peak use.

Conclusion

The findings from this study revealed poor hand hygiene activities among food handlers and consumers at fast food restaurants. Food handlers were observed to change into new gloves before handling exposed RTE but did not clean their hands after handling food, unsanitary objects or touching their face or other body parts. Only female consumers were observed to clean their hands with wipes or sanitisers. Consumers were observed to clean their hands with napkins more often after handling exposed RTE compared to other surfaces. This study also revealed that the hand-contact surfaces in restrooms are unhygienic and can potentially re-contaminate washed hands upon touching unhygienic surfaces such as the exit door panel or handle. Reinforcement such as posters or reminders of risk of transmission of foodborne pathogens can help to increase hand hygiene compliance. Effective handwashing and hand hygiene activities are the best methods to prevent transmission of foodborne disease.

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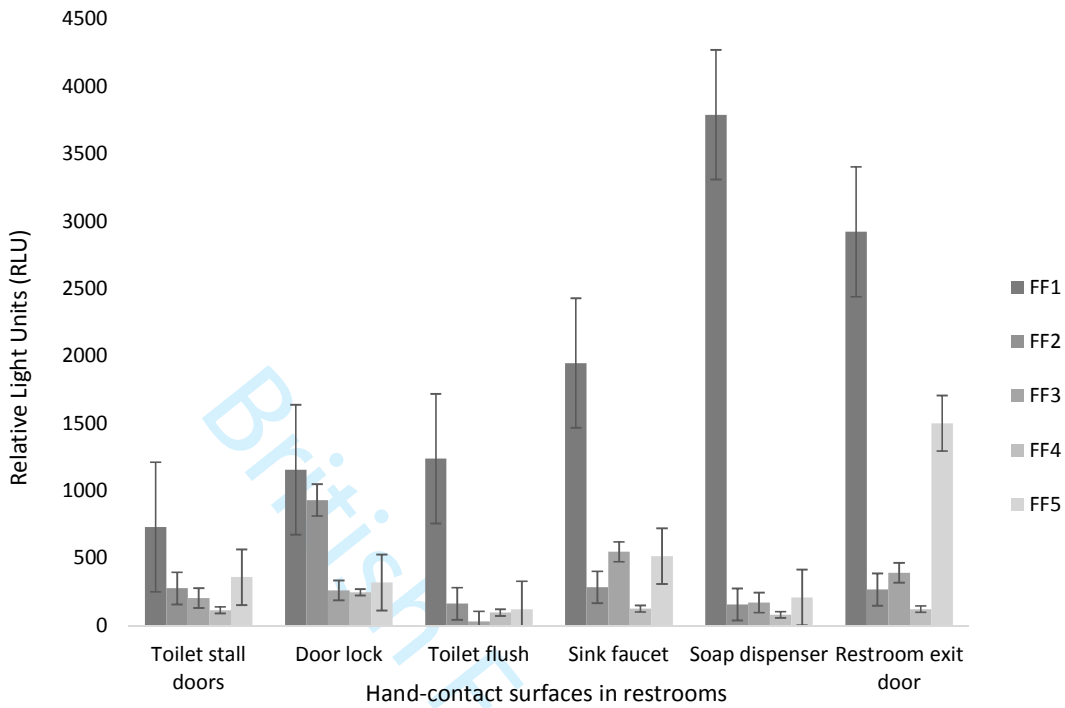


Figure 1. ATP levels (RLUs) of hand-contact surfaces in fast food restaurants' restrooms
Notes: FFR1 – FFR4 represent individual leading fast food brands i.e. FFR1: Fast food restaurant that predominantly sells burgers and finger food; FF2 and FF3: burgers and fries; FF4: sandwiches and salad; FFR5 = others [made up of five fast food brands that sell pizza, burgers and sandwiches]; vertical bars = standard error; n=29

Table 1. Demographic characteristics of observed participants

Food handlers (n=47)	Number (%)	Consumers (n=151)	Number (%)
<i>Gender</i>		<i>Gender</i>	
Male	16 (34.04)	Male	54 (35.76)
Female	31 (65.96)	Female	97 (64.24)
<i>Employee working position</i>		<i>Party size</i>	
Food preparation or cooking	17 (36.17)	One	30 (19.87)
Cashier or serving	30 (63.83)	Two	67 (44.37)
		Three and above	54 (35.77)

Table 2. Number of observed hand hygiene activity among consumers (n = 151)

Behaviours requiring hand hygiene practice	Number of observations requiring hand hygiene		Observed hand hygiene practice		Observed other forms of hand cleaning activity	
	Number	%	Number	%	Number	%
Food						
Before handling exposed ready-to-eat (RTE) food	1274	42.32	3	0.23	30	2.35
Exposed RTE food			4	0.31	74	5.80
Total	1274	42.32	7	0.55	104	8.16
Unsanitary object						
Electronic device (mobile phone, laptop, tablet)	267	8.87	0	0	1	0.37
Paper (receipt, order receipt)	43	1.43	0	0	0	0
Cash, credit card	7	0.23	0	0	0	0
Condiments	154	5.12			2	1.30
Personal belongings (wallet, purse, glasses, cap)	159	5.28	2	1.26	0	0
Pencil / pen	4	0.13	0	0	0	0
Cigarette	6	0.20	0	0	0	0
Others (e.g. tray, menu, bin door, newspaper, walking aid)	90	2.99	0	0	0	0
Total	730	24.25	2	0.27	3	0.41
Equipment						
Surface / table	111	3.69	0	0	1	0.90
Door	5	0.17	0	0	0	0
Other (e.g. vending machine)	1	0.03	0	0	0	0
Total	117	3.89	0	0	1	0.85
Human						
Body parts (e.g. face, nose, ears)	421	13.99	0	0	3	0.71
Other body parts	69	2.29	0	0	2	2.90
Hair	86	2.86	0	0	0	0
Cough, sneeze, spit	11	0.37	0	0	0	0
Finger licking	160	5.32	0	0	1	0.63
Other (e.g. skin contact other family members or friends)	142	4.72	1	0.70	0	0
Total	889	29.53	1	0.11	6	0.67
Total number of requirements and hand hygiene activities	3010		10	0.33	114	3.79

Total number of transactions – 4530; Hand hygiene activities among consumers include cleaning hands with wipes / sanitiser. Other observed form of hand cleaning activity was wiping with napkins (this is not categorised as hand hygiene)

Table 3. Number of observed hand hygiene activity among employees (n=47)

Behaviours requiring hand hygiene practice	Number of observations requiring hand hygiene		Observed hand hygiene practice and other* forms of hand cleaning activity	
	Number	%	Number	%
Food				
Before handling exposed food	47	4.06	10	21.28
After handling exposed food			0	0
Before putting on new gloves	11	0.95	0	0
Other	7	0.61	0	0
Total	65	5.62	10	15.38
Unsanitary object				
Electronic device (mobile phone, laptop, tablet, ordering machine, cash machine)	185	15.99	0	0
Paper (receipt, order receipt)	53	4.58	0	0
Cash, credit card	93	8.03	0	0
Clothes, aprons, cap	83	7.17	0	0
Condiments	6	0.52	0	0
Bottled/cup beverage	94	8.12	0	0
Pencil / pen	5	0.43	0	0
Cleaning items (broom/dishcloth)	61	5.27	0	0
Other (e.g. tray, menu, dirty utensils, food wastes, bin door)	148	12.79	0	0
Total	728	62.92	0	0
Equipment				
Cooking equipment (grilling, deep fryer, pots)	149	12.88	1*	0.67
Fridge / storage handle	16	1.38	0	0
Surface / table	96	8.30	0	0
Other (e.g. drawer, dishwasher, ordering machine)	13	1.12	0	0
Total	274	23.68	1*	0.36
Human				
Body parts (face, nose)	47	4.06	0	0
Hair	10	0.86	0	0
Other body parts	32	2.77	0	0
Other (e.g. scratching)	1	0.09	0	0
Total	90	7.78	0	0
Total number of requirements and hand hygiene activities	1157	100	11	0.95

Total number of transactions – 1410; Hand hygiene activities among employees include handwashing, changing into new gloves; cleaning hands with wipes / sanitiser. *Involved cleaning hands with napkins (this is not categorised as hand hygiene activity)

Table 4. Cross-tabulations of hand hygiene practices

Observed participants	Hand hygiene observation (%)		χ^2	p
	Yes	No		
Food handlers (n=47)	21.30	78.80	3.18	0.12
Consumers (n=151)	10.30	89.70		
Food handlers				
Male	31.30	68.80	1.44	0.20
Female	16.10	83.90		
Food preparation / cooking	35.30	64.70	3.12	0.14
Cashier / serving	13.30	86.70		
Consumers				
Male	0	100	5.96	0.014
Female	10.30	89.70		
Party size				
One	6.70	93.30	6.36	0.036
Two	1.50	98.50		
Three and above	13.00	87.00		

Table 5. Univariate analysis of variance on the effect of fast food restaurants and type of restrooms on ATP level

Dependent variable	Fast Food Restaurants (*FFRs 1 – 5)			Restrooms (gender)		
	F	<i>p</i> value	η^2	F	<i>p</i> value	η^2
Toilet stall doors	1.315	0.329	0.345	0.086	0.918	0.014
Door lock	1.363	0.276	0.185	0.374	0.692	0.028
Toilet flush	31.358	<0.0001	0.845	1.254	0.303	0.091
Sink faucet	6.698	0.001	0.538	0.435	0.652	0.034
Soap dispenser	195.292	<0.0001	0.970	0.478	0.625	0.035
Restroom exit door	17.838	<0.0001	0.836	2.703	0.097	0.253

Note: *FFR1 – FFR4 represent individual leading fast food brands i.e. FFR1: Fast food restaurant that predominantly sells burgers and finger food; FF2 and FF3: burgers and fries; FF4: sandwiches and salad; FFR5 = others (made up of five fast food brands that sell pizza, burgers and sandwiches). η^2 = effect size where 0.04 = recommended minimum effect size (RMPE); 0.25 = moderate effect; 0.64 = strong effect (Ferguson, 2009)