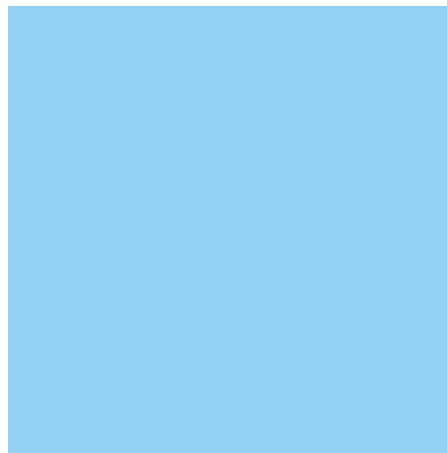


Follow-up study of hygiene practices in catering premises at large scale events in the United Kingdom



**LGR/HPA Co-ordinated Food Liaison Group Studies:
A Follow-Up Study of Hygiene Practices in Catering Premises at
Large Scale Events in the United Kingdom**

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**On behalf of Local Government Regulation and
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Summary

It is recognised that there is an increased risk of infectious disease outbreaks at large events, and previous studies have associated the use of outdoor and mobile caterers with poor food hygiene practices. The aim of this study was to investigate hygiene practices amongst caterers at large events in the UK, with a particular focus on the microbiological quality of ready-to-eat food, drinking water, food preparation surfaces, cleaning cloths and wristbands worn by food handlers.

Over a 7 month period, 1,662 samples were collected at 153 events by Local Authority sampling officers, and transported to laboratories for microbiological analysis. Eight percent of food samples were of an unsatisfactory quality, and a further 1% contained potentially hazardous levels of pathogenic bacteria. Twenty seven percent of water samples, 32% of swabs and 56% of cloths were also unsatisfactory. This represented an improvement in hygiene compared to a similar study carried out 12 months previously. A fifth of wristbands worn by food handlers for event security purposes were contaminated with Enterobacteriaceae, *E. coli* and/or coagulase-positive staphylococci. However, the sample numbers for wristbands were small, and a more detailed study of this sample type in future would be recommended.

This study provides some evidence that the food hygiene at large scale events may be improving. However, there is still a need for continued efforts in this area in order to maintain an ongoing improvement in cleaning regimes and food hygiene management.

Introduction

The risk of infectious disease outbreaks at large events and mass gatherings is recognised to be greater than in the general population (Abubakar et al., 2012). A review of mass gatherings (Abubakar et al., 2012) identified gastrointestinal infections as one of the more common infectious disease risks at religious festivals, sporting events, music festivals and trade meetings. For example, an outbreak of shigellosis was described at an outdoor music festival in Michigan (Lee et al., 1991). An estimated 3,175 women were affected, following a smaller outbreak amongst food handlers prior to the festival. The likely source was identified as tofu salad. However, limited access to soap and running water for hand-washing may also have exacerbated the spread of infection. Moreover, an outbreak of *Salmonella* Enteritidis that affected 1,435 individuals in Catalonia was found to be associated with inadequate handling of foods containing eggs, where the catering establishment exceeded its safe production capacity in order to meet the demands of customers at a large festival (Camps et al. 2005).

One common factor at many large events is the use of outdoor catering and mobile food vendors. Previous studies have associated mobile food vendors with poor food hygiene practices and water quality (Little and Sagoo, 2009; McDerment et al., 2002). The maintenance of a high standard of food hygiene in relation to temporary or mobile premises is particularly important given the nature of their structure and location. Outside caterers, for example, often work in cramped conditions, do not have much storage space and may have difficulties with on-site cleaning. They are likely to be dealing with large numbers of customers and frequently use temporary staff (CIEH, 2010). Such conditions lead to greater cross-contamination risks that can be exacerbated if good personal hygiene practices are not followed. According to the Industry Guide to Good Hygiene: Markets and Fairs Guide (Food Safety and Hygiene Working Group, 1998), separate hand-washing facilities must be present on the stall/vehicle for businesses handling open, high risk food, and communal facilities must be available for businesses selling low risk foods such as pre-packaged goods and open dried products. However, a study of vendors at farmers' markets in Wales indicated a widespread lack of

handwashing facilities (Worsfold et al., 2004). Moreover, only one of 50 traders questioned in the study had a fully documented HACCP system in place and 38% did not hold a basic food hygiene certificate.

The London 2012 Olympics was predicted to attract approximately 9 million visitors to the 34 competition venues, in addition to the 70,000 volunteers and 3,000 staff. Therefore, ensuring that food safety controls were in place at all the venues, as well as at non-competition venues such as training camps, was an essential part of the planning process for the Games. Experience from previous Olympic Games indicates that intensive inspection and sampling programmes for food businesses, both in the run-up and during the events, was important in ensuring that food hygiene standards were maintained (Meehan et al., 1998; Jorm and Visotina, 2003; Losito, 2010). A study of large events was undertaken between July and September 2009 (Willis et al., 2012), focussing particularly on events occurring at weekends, with the aims of assessing the logistical arrangements for collecting and testing samples outside of normal working hours and learning lessons in preparation for the London 2012 Olympics.

This study builds upon the findings of the study described by Willis et al. (2012). The previous study identified concerns regarding cleaning procedures, particularly at weekends and Bank Holidays, and also demonstrated that water quality in these vendors continued to be a cause for concern. The current study again aimed to include a range of large events being held both during the working week and over weekends and Bank Holidays, but was over a more extended time period that included the spring and autumn months (May to November 2010). It also involved the collection of swabs from wristbands worn by food handlers to demonstrate their authorisation to trade at the event. Since these wristbands are worn permanently throughout the period of the event, it was considered that there may be some risk of cross-contamination to food being prepared.

Materials and Methods

Sample Collection

A total of 1,662 samples of food, swabs, cleaning cloths and water were collected from 368 vendors at 153 large scale events. These included 50 concerts or music festivals, 20 sports events, 39 carnivals, fairs and fêtes, and 44 events described as “other event” or type not stated. Samples were collected by sampling officers from 103 Environmental Health Departments (EHD) in 37 Local Authority Food Liaison Groups (as shown in Annex 1) between 1 May 2010 and 30 November 2010. Large scale events were defined as indoor or outdoor gatherings of at least 200 people which, where possible, ran for more than one day. Sampling officers were requested to focus on weekend events in particular, although events occurring between Monday and Friday were also included where appropriate. They were asked to collect samples as follows: ready-to-eat foods; a cleaning cloth that had been used in areas where ready-to-eat foods were prepared; and swabs from food contact surfaces including empty, clean food containers used for ready-to-eat food, utensils, chopping boards used for ready-to-eat foods and work surfaces or serving counters. There was also an option to collect a water sample, as the customer would receive it or as the caterer would use it, from the vendor’s main supply of water, and a further option to take a swab of the outer surface of a food handler’s security wrist band.

Samples (of at least 100 g for foods and 500 ml for waters) were collected and transported in accordance with the Food Standards Agency Food Law Code of Practice (FSA, 2006) and the Local Authorities Co-ordinators of Regulatory Services (LACORS) guidance on microbiological food sampling (LACORS, 2006). These were examined by eight Official Food Control Laboratories in the UK (Health Protection Agency Food Water and Environmental Microbiology Laboratories at Ashford, Bristol, Birmingham, Chelmsford, London, Preston, Southampton and Leeds).

Information on samples and vendors was obtained by observation and enquiry and recorded on a standard questionnaire (Annex 2).

Sample Examination

a) Food Samples

A 10⁻¹ homogenate of each food sample was prepared according to Health Protection Agency standard method F2 (Health Protection Agency, 2004a), and this was used to enumerate Aerobic Colony Count, Enterobacteriaceae, *Escherichia coli*, coagulase-positive staphylococci and *Listeria* species (including *L. monocytogenes*) in accordance with Health Protection Agency standard microbiological methods (Health Protection Agency, 2004b; 2004c; 2004d; 2005; 2009a). For products containing rice, *Bacillus* species were also enumerated (Health Protection Agency, 2004e), and for meat and fish products with stock or gravy or large batch cooked meat and fish dishes, a *Clostridium perfringens* enumeration was performed (Health Protection Agency, 2004f). All samples were also examined for the presence of *Salmonella* species according to Health Protection Agency Standard Method F13 (Health Protection Agency, 2008a).

Microbiological results for food samples were compared to the HPA Guidelines for assessing the microbiological safety of ready-to-eat foods placed on the market (Health Protection Agency, 2009b).

Salmonella isolates were sent to the HPA Gastrointestinal Bacteria Reference Unit (GBRU), Microbiology Services, Colindale, for further characterisation. This included serotyping (Grimont and Weill, 2007) and antimicrobial sensitivity testing (Frost, 1994).

b) Water Samples

Water samples were examined for the presence of coliform bacteria and *E. coli* using either a membrane filtration method (Health Protection Agency, 2007) or the Idexx (Colilert 18) Quanti-tray™ procedure (Health Protection Agency, 2004g), and also for enterococci and Aerobic Colony Counts at 37°C and 22°C (Health Protection Agency, 2008b; 2006). Results were compared with The Water Supply (Water Quality) Regulations 2010 (Anon, 2010).

c) Environmental Swabs and Cloths

Sponge swabs and cloths were placed into sterile stomacher bags containing 90 ml or 500 ml of Maximum Recovery Diluent (MRD), respectively, and the contents thoroughly mixed. Sample eluents were serially diluted in MRD and appropriate dilutions were used to enumerate Aerobic Colony Counts (on swabs using a template of known surface area only), Enterobacteriaceae and *E. coli* in accordance with Health Protection Agency standard microbiological methods (Health Protection Agency, 2004b, 2004c, 2005). Cleaning cloths were also examined for coagulase-positive staphylococci and *Listeria* species (Health Protection Agency, 2004d; 2009). Microbiological results were interpreted using the guidance shown in Table 1.

d) Wrist Band Swabs

Cotton-tipped swabs were placed into 10 ml neutralising buffer after swabbing. On receipt at the laboratory, the swab and associated buffer were thoroughly mixed using a vortex mixer. The buffer was then used for direct inoculation of plates and preparation of serial dilutions in MRD. Enumeration of Enterobacteriaceae, *E. coli* and coagulase-positive staphylococci was performed in accordance with Health Protection Agency standard microbiological methods (Health Protection Agency, 2004c, 2005, 2004d). Microbiological results were interpreted using the guidance shown in Table 1.

Statistical Analysis

Descriptive and statistical analysis of the data was undertaken using Microsoft Excel. Relative proportions were compared using the Fisher's Exact Test. A probability value of less than 5% was defined as significant.

Table 1. Guidance on the interpretation of microbiological results obtained from cleaning cloth and swab samples

Sample	Microorganisms	Microbiological Status	
		Acceptable	Unsatisfactory
Cleaning cloth in use	Enterobacteriaceae	<10 ⁴ cfu / cloth	≥10 ⁴ cfu / cloth
	<i>E. coli</i>	<500 cfu / cloth	≥500 cfu / cloth
	Coagulase-positive Staphylococci	<500 cfu / cloth	≥500 cfu / cloth
	<i>Listeria species</i>	<500 cfu / cloth	≥500 cfu / cloth
Template area swab: from ready-to-eat food contact surfaces: cleaned & ready to use	Aerobic Colony Count	<10 cfu / cm ²	≥10 cfu / cm ²
	Enterobacteriaceae	<1 cfu / cm ²	≥1 cfu / cm ²
	<i>E. coli</i>	<1 cfu / cm ²	≥1 cfu / cm ²
Template area swab: from recently cleaned surfaces that are in use	Aerobic Colony Count	<10 ³ cfu / cm ²	≥10 ³ cfu / cm ²
	Enterobacteriaceae	<10 ² cfu / cm ²	≥10 ² cfu / cm ²
	<i>E. coli</i>	<1 cfu / cm ²	≥1 cfu / cm ²
Random area swab	Enterobacteriaceae	<10 ² cfu / swab	≥10 ² cfu / swab
	<i>E.coli</i>	<10 ² cfu / swab	≥10 ² cfu / swab
Wrist band swab	Enterobacteriaceae	<10 ² cfu / swab	≥10 ² cfu / swab
	<i>E.coli</i>	<10 ² cfu / swab	≥10 ² cfu / swab
	Coagulase-positive staphylococci	No guidelines available	

Results

Food Samples

A total of 659 samples of ready-to-eat food were collected. Of these, 91% were of a satisfactory or borderline microbiological quality (600/659). However, 8% of samples (53/659) were of an unsatisfactory quality (Table 2). A further 7 samples (1%) were considered to be potentially injurious to health, due to elevated levels of *Bacillus* species (n=4), *Clostridium perfringens* (n=1) or coagulase-positive staphylococci (n=1) or the presence of *Salmonella* (n=1). The *Salmonella* isolate was identified as S. Derby and was isolated from a sample of ready-to-eat pork.

Listeria monocytogenes was detected in three samples, all at levels of <100 cfu/g (20, 20 and 40 cfu/g). These were chicken in gravy, cheddar cheese and poached salmon respectively. *Listeria innocua* was detected in one sample of potato salad, at a level of 20 cfu/g. The potato salad and poached salmon were both taken from the same agricultural show (but from two different outlets).

Water samples

A total of 209 water samples were collected and microbiological results are shown in Table 3. Overall, 153 samples (73%) were of an acceptable potable quality and 56 (27%) were unsatisfactory, due to the presence of coliform bacteria, *E. coli* and/or enterococci. Indicators of faecal contamination (*E. coli* and/or enterococci) were detected in 16 samples (8%).

Although there was a greater proportion of unsatisfactory samples collected from containers/bottled supplies (15/47; 32%) than from mains supplies (27/111; 24%), this difference was not statistically significant (Fishers Exact Test: $p = 0.33$).

Table 2. Microbiology results of food samples collected from large scale events (figures indicate numbers of samples with bacterial counts within the specified range)

	Bacterial count per gram									
	<20	<200	20 - <10 ²	10 ² - <10 ³	200 - <10 ³	10 ³ - <10 ⁴	10 ⁴ - <10 ⁵	10 ⁵ - <10 ⁶	10 ⁶ - <10 ⁷	≥10 ⁷
Aerobic colony count (n = 643)	n/a ^a	336	n/a	n/a	91	68	41	39	28	40
Enterobacteriaceae (n = 634)	487	n/a	27	36	n/a	36	21 ^b	18 ^b	3 ^b	6 ^b
<i>E. coli</i> (n = 659)	638	n/a	9	5 ^b	n/a	2 ^b	3 ^b	1 ^b	0	1 ^b
Coagulase-positive staphylococci (n = 657)	647	n/a	5	3	n/a	1	0	0	1 ^c	0
<i>Listeria monocytogenes</i> (n = 651)	649	n/a	2	0	n/a	0	0	0	0	0
<i>Listeria</i> species (not <i>monocytogenes</i>) (n = 651)	650	n/a	1	0	n/a	0	0	0	0	0
<i>Clostridium perfringens</i> (n = 187) ^d	184	n/a	0	1	n/a	0	0	0	1 ^c	0
<i>Bacillus cereus</i> (n=130) ^e	n/a	129	n/a	n/a	0	1	0	0	0	0
<i>Bacillus</i> species (not <i>B. cereus</i>) (n = 130) ^e	n/a	112	n/a	n/a	6	4	4	2 ^c	1 ^c	1 ^c

^a Not applicable

^b Unsatisfactory (HPA, 2009)

^c Unsatisfactory: potentially injurious to health and/or unfit for human consumption (HPA, 2009)

^d Meat or fish products with stock or gravy or large batch cooked meat or fish dishes only

^e Products containing rice only

Table 3. Microbiology results of water samples collected from large scale events (figures indicate numbers of samples with bacterial counts within the specified range)

	Bacterial count in 100 ml				Bacterial count per ml				
	0	1 - <10	10 - <10 ²	≥10 ²	0	1 - <10	10 - <1.0 x 10 ²	1.0 x 10 ² - <1.0 x 10 ³	≥1.0 x 10 ³
Coliform bacteria (n = 209)	152	14 ^a	14 ^a	29 ^a	n/a ^b	n/a	n/a	n/a	n/a
Mains supply	84	7 ^a	8 ^a	12 ^a					
Bottles/containers	30	6 ^a	2 ^a	9 ^a					
Other supplies	38	1 ^a	4 ^a	8 ^a					
Escherichia coli (n = 209)	200	3 ^a	4 ^a	2 ^a	n/a	n/a	n/a	n/a	n/a
Mains supply	109	1 ^a	1 ^a	0					
Bottles/containers	42	2 ^a	3 ^a	0					
Other supplies	49	0	0	2 ^a					
Enterococci (n = 209)	199	5 ^a	3 ^a	2 ^a	n/a	n/a	n/a	n/a	n/a
Mains supply	108	3 ^a	0	0					
Bottles/containers	43	1 ^a	3 ^a	0					
Other supplies	48	1 ^a	0	2 ^a					
Aerobic Colony Count at 22°C (n = 209)	n/a	n/a	n/a	n/a	31	29	41	24	84
Mains supply					14	18	24	13	42
Bottles/containers					11	5	7	8	16
Other supplies					6	6	10	3	26
Aerobic Colony Count at 37°C (n = 209)	n/a	n/a	n/a	n/a	37	46	39	16	71
Mains supply					22	26	22	9	32
Bottles/containers					11	8	10	4	14
Other supplies					4	12	7	3	25

^a Unsatisfactory (Water Supply (Water Quality) Regulations 2010)

^b Not applicable

Environmental Swabs

Overall, 585 swabs were examined, of which 68% (397) were of a satisfactory microbiological quality and 32% (188) were unsatisfactory. The results for different swab sites are shown in Table 4. Swabs from chopping boards gave a significantly higher proportion of unsatisfactory results (84/141; 60%) compared to those from all other surfaces (104/444; 23%; Fishers Exact Test: $p < 0.0001$).

Cleaning Cloths

A total of 176 cleaning cloths were examined. Of these, 78 (44%) were of a satisfactory microbiological quality, whilst 98 (56%) were considered unsatisfactory according to the criteria shown in Table 1. Ninety seven cloths (55%) had an Enterobacteriaceae count of greater than 10,000 cfu per cloth, whilst *E. coli*, coagulase-positive staphylococci and/or *Listeria* species (including *L. monocytogenes*) were detected in 43 cloths (24%) (Table 5). The proportion of cloths giving unsatisfactory results was similar for both disposable (30/51; 59%) and reusable (63/115; 55%) types. A larger proportion of cloths that were replaced after 12 hours or more gave unsatisfactory results (24/40; 60%) compared to those that were replaced in under 12 hours (47/94; 50%). However, this difference was not significant (Fishers Exact Test: $p = 0.35$).

Wristbands

Of 33 swabs of wristbands sampled, six were considered to be of an unsatisfactory microbiological quality: five due to the presence of Enterobacteriaceae (with counts of 10, 10, 290, 470 and 800 cfu per swab respectively) and one due to the presence of *E. coli* (30 cfu/swab). Coagulase-positive staphylococci (10 and 60 cfu/swab) were detected in two samples.

Overall, 16 wristbands were described as being made of fabric, eight were plastic and nine were either made of another material or the material was not specified. Of the seven bands from which Enterobacteriaceae, *E. coli* and/or coagulase-positive staphylococci were

recovered, six were made of fabric. Information on the material type was not provided for the seventh band.

Timing of Sampling

Of the 368 vendors visited, samples were taken from 154 (42%) on a week day, and from 204 (55%) on a Saturday, Sunday or Bank Holiday. The date of sampling was not specified for the remainder (3%). The distribution of vendors visited for sampling by month is shown in Figure 1.

Figure 1: Number of vendors visited for sample collection in each month of the study.

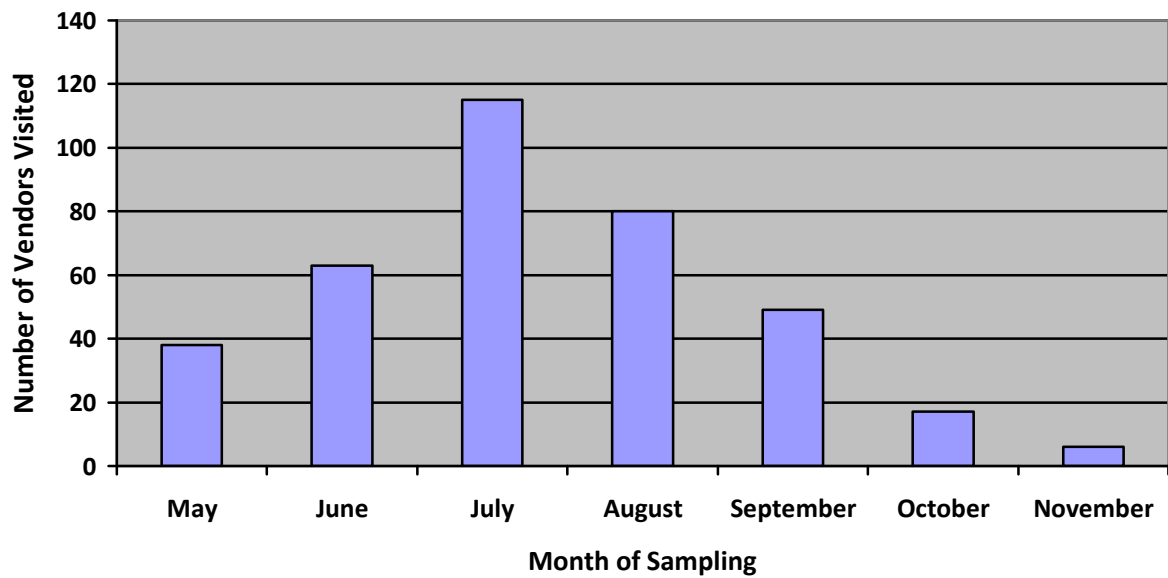


Table 4. Microbiology results of swab samples collected from large scale events

Swab site	Number of samples	Number (%) satisfactory	Number (%) unsatisfactory		Swabs with template						Random area swabs				
					Bacterial counts (cfu per cm ²)						Bacterial counts (cfu per swab)				
					<1	1- <10	10 - <10 ²	10 ² - <10 ³	10 ³ - <10 ⁴	≥10 ⁴	<10 ²	10 ² - <10 ³	10 ³ - <10 ⁴	10 ⁴ - <10 ⁵	≥10 ⁵
Chopping Boards	141	57 (40)	84 (60)	Aerobic colony count	6	2	5 ^a	11 ^a	6 ^b	11 ^b	n/a ^c	n/a	n/a	n/a	n/a
				Enterobacteriaceae	24	3 ^a	4 ^a	7 ^b	1 ^b	2 ^b	42	19 ^b	24 ^b	9 ^b	6 ^b
				<i>E. coli</i>	41	0	0	0	0	0	95	3 ^b	1 ^b	1 ^b	0
Food containers	85	66 (78)	19 (22)	Aerobic colony count	1	4	4 ^a	3 ^a	0	0	n/a	n/a	n/a	n/a	n/a
				Enterobacteriaceae	11	1 ^a	0	0	0	0	56	6 ^b	4 ^b	3 ^b	4 ^b
				<i>E. coli</i>	12	0	0	0	0	0	72	0	1 ^b	0	0
Serving counters	49	35 (71)	14 (29)	Aerobic colony count	1	3	4 ^a	4 ^a	1 ^b	2 ^b	n/a	n/a	n/a	n/a	n/a
				Enterobacteriaceae	11	1 ^a	2 ^a	1 ^b	0	0	25	4 ^b	2 ^b	2 ^b	1 ^b
				<i>E. coli</i>	15	0	0	0	0	0	34	0	0	0	0
Utensils	117	97 (83)	20 (17)	Aerobic colony count	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
				Enterobacteriaceae	n/a	n/a	n/a	n/a	n/a	n/a	96	11 ^b	5 ^b	4 ^b	1 ^b
				<i>E. coli</i>	n/a	n/a	n/a	n/a	n/a	n/a	115	1 ^b	1 ^b	0	0
Work surfaces	113	82 (73)	31 (27)	Aerobic colony count	8	4	11 ^a	9 ^a	1 ^b	0	n/a	n/a	n/a	n/a	n/a
				Enterobacteriaceae	28	1 ^a	3 ^a	0	0	1 ^b	57	10 ^b	4 ^b	7 ^b	2 ^b
				<i>E. coli</i>	33	0	0	0	0	0	75	4 ^b	1 ^b	0	0
Other / not specified	80	60 (75)	20 (25)	Aerobic colony count	2	2	0	3 ^a	1 ^b	2 ^b	n/a	n/a	n/a	n/a	n/a
				Enterobacteriaceae	8	0	0	1 ^b	1 ^b	0	55	7 ^b	5 ^b	2 ^b	1 ^b
				<i>E. coli</i>	10	0	0	0	0	0	70	0	0	0	0

^a Unsatisfactory if surface cleaned and ready for use, but acceptable if in-use at time of sampling, based on the criteria outlined in Table 1

^b Unsatisfactory based on the criteria outlined in Table 1

^c Not applicable

Table 5. Microbiology results of cleaning cloths collected from large scale events

	Bacterial count per cloth						
	<500	500 - <10 ³	10 ³ - <10 ⁴	10 ⁴ - <10 ⁵	10 ⁵ - <10 ⁶	10 ⁶ - <10 ⁷	≥10 ⁷
Enterobacteriaceae (n = 176)	53	4	22	25 ^a	24 ^a	16 ^a	32 ^a
<i>Escherichia coli</i> (n = 174)	148	5 ^a	9 ^a	3 ^a	4 ^a	3 ^a	2 ^a
Coagulase-positive staphylococci (n = 174)	155	1 ^a	10 ^a	7 ^a	1 ^a	0	0
<i>Listeria monocytogenes</i> (n = 169)	167	0	2 ^a	0	0	0	0
<i>Listeria</i> species (not <i>monocytogenes</i>) (n = 169)	164	0	2 ^a	3 ^a	0	0	0

^a Unsatisfactory based on the criteria outlined in Table 1

Discussion

Mass gatherings may require considerable public health planning, depending on their geographical spread, the number of international visitors and the duration of the event (Thackway et al., 2009). Preparations for the public health response for London 2012 began seven years before the event, and understanding the risks associated with food and water served to visitors during the Games was an important aspect of these plans. The study described by Willis et al. (2012) indicated that improvement was required in food hygiene at large scale events, with the water quality and cleaning regimes in food premises requiring particular attention.

Overall, an improvement was seen in the microbiological quality of water, swab and cloth samples in this study compared to the 2009 study described by Willis et al. (2012) and the study of mobile vendors in 2006 (Little and Sagoo, 2009) (Table 6). Although the improvement in results compared with the Little and Sagoo study may be partly due to a difference in the way that results were interpreted, this is not the case with the later study (Willis et al., 2012), which used the same criteria as this study for the interpretation of results. The observed improvement in hygiene may be partly due to the increased focus on large events and mobile vendors by Environmental Health Departments in recent years. The Chartered Institute of Environmental Health guidance on catering at outdoor events was published in 2010 (CIEH, 2010), and Local Government Regulation worked with Local Authorities to produce a standardised inspection record for mobile vendors which was also made available in 2010. However, of the 153 events visited in this study, only 24 (16%) had been visited previously as part of the 2009 study described by Willis et al. (2012) (data not shown), and therefore it is difficult to attribute the improvement in hygiene to a direct impact from previous inspections by enforcement officers.

Water quality, in particular, appears to have improved significantly compared to previous studies (Fishers Exact Test; $p < 0.0001$). It is interesting to note that the Private Water Supplies Regulations 2009 came into force on 1st January 2010, including a

requirement for Local Authorities to carry out a risk assessment of all private water supplies. This includes private distribution networks (i.e. water supplied by a licensed water supplier, which is then further distributed by another person), such as those frequently found at large scale events (Anon, 2009). Therefore, it may be that at least some of the observed improvement in water quality at large events can be explained by an increased focus on water safety as a result of the change in regulations. However, it seems unlikely that this is the only explanation, since the regulations allow Local Authorities five years from the time that they came into force to complete the risk assessments on all private water supplies, and most Local Authorities took several months to fully understand and implement the requirements.

Table 6: Comparison of results from four consecutive studies of microbiological hygiene at mobile vendors

Study	Percentage of samples giving satisfactory results			
	Food	Water	Swabs	Cloths
Mobile vendors (McDerment et al., 2002)	N/A	50	N/A	N/A
Mobile vendors, June – Nov. 2006 (Little and Sagoo, 2009)	N/A	46	46	13 ^a
Large scale events, May – Sept. 2009 (Willis et al., 2012)	90	48	62	29
Large scale events, May – Nov. 2010 (current study)	91	73	68	44

^a Note that different testing parameters and interpretative criteria were used for cloths in this study

An additional sample type included in this study that was not investigated in the previous studies shown in Table 6 was the wristband swab. Wristbands are often used at large events as an easy way of identifying people who are authorised to work on-site. They are frequently not removable, and remain in place from the beginning of the event until the end. There is therefore the potential for the bands to become contaminated and for this contamination to be transferred to food or food preparation surfaces over the course of the

event. Wristband swabs were an optional sample type in this study, and only a small number were received (n=33). It is therefore difficult to draw conclusions regarding the risk of cross-contamination from these items. However, seven bands (21%) were contaminated with Enterobacteriaceae, *E. coli* and/or coagulase-positive staphylococci. Although it is widely recommended that bracelets and wristwatches should not be worn by food handlers due to risks of microbial contamination and introduction of foreign bodies into food (FAO/WHO, 2001; Berger and Parentaeu, 2010), there are no reports in the literature describing previous studies of microbial contamination of these items or of food handler wristbands. A more in-depth study of these items would be beneficial in the future.

It is encouraging that, in the run-up to the London 2012 Olympics, the microbiological quality of food preparation surfaces, cloths and water supplies at large events appears to have improved. However, more than half of cloths and a third of swabs still showed unsatisfactory levels of contamination in this most recent study, and therefore there is still room for improvement in cleaning regimes and food hygiene management in these premises.

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References

- Abubakar, I., P. Gautret, G. Brunette, L. Blumberg, D. Johnson, G. Pomerol, Z. Memish, M. Barbeschi, and A. Khan. 2012. Global perspectives for prevention of infectious diseases associated with mass gatherings. *The Lancet Infectious Diseases* 12:66-74.
- Anon. 2009. The Private Water Supplies Regulations 2009. SI 3101. Available at: <http://www.legislation.gov.uk/ukxi/2009/3101/contents/made>. Accessed 21.8.12.
- Anon. 2010. The Water Supply (Water Quality) Regulations 2010. SI 994 (W.99). Available at: <http://www.legislation.gov.uk/wsi/2010/994/contents/made>. Accessed 3.2.12.
- Berger, L., and C. Parentaeu. 2010. Food safety for managers. Berger Food Safety Consulting, Boston.
- Camps, N., A. Dominguez, M. Company, M. Perez, J. Pardos, T. Llobet, M. Usera, and L. Salleras. 2005. A foodborne outbreak of *Salmonella* infection due to overproduction of egg-containing foods for a festival. *Epidemiology and Infection* 133:817-822.
- CIEH. 2010. CIEH National Guidance for Outdoor and Mobile Catering. Chartered Institute of Environmental Health, London.
- FAO/WHO. 2001. Codex Alimentarius: General requirements (food hygiene) Volume 1B, Second ed. FAO and WHO, Rome.
- Food Safety and Hygiene Working Group. 1998. Industry guide to good hygiene practice: markets and fairs guide. Chadwick House Group Ltd., London.
- FSA. 2008. Food Law Code of Practice (England). Food Standards Agency, London. Available at: <http://www.food.gov.uk/multimedia/pdfs/codeofpracticeeng.pdf>. Accessed 11.10.10
- Jorm, L., and M. Visotina. 2003. The Sydney Olympics: a win for public health. *New South Wales Public Health Bulletin* 14:43-45.
- Health Protection Agency. 2004a. Preparation of samples and dilutions. National Standard Method F 2 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.

- Health Protection Agency. 2004b. Aerobic Plate Count at 30°C: spiral plate method. National Standard Method F11 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2004c. Enumeration of Enterobacteriaceae by the colony count technique. National Standard Method F23 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2004d. Enumeration of *Staphylococcus aureus*. National Standard Method F12 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2004e. Enumeration of *Bacillus cereus* and other *Bacillus* species. National Standard Method F 15 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2004f. Enumeration of *Clostridium perfringens*. National Standard Method F 14 Issue 2. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2004g. Enumeration of coliforms and *Escherichia coli* by Idexx (Colilert 18) Quanti-tray™. National Standard Method W 18 Issue 2. Available at: http://www.hpa-standardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2005. Direct enumeration of *Escherichia coli*. National Standard Method F 20 Issue 1. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2006. Enumeration of enterococci by membrane filtration. National Standard Method W 3 Issue 3. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2007. Enumeration of coliform bacteria and *Escherichia coli* by membrane filtration. National Standard Method W 2 Issue 4. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.

- Health Protection Agency. 2008a. Detection of Salmonella species. National Standard Method F13 Issue 3. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2008b. Aerobic Colony count by the pour plate method. National Standard Method W 4 Issue 4. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2009a. Detection and Enumeration of Listeria monocytogenes and other Listeria species. National Standard Method F19 Issue 3. Available at: http://www.hpastandardmethods.org.uk/pdf_sops.asp. Accessed 24.3.10.
- Health Protection Agency. 2009b Guidelines for assessing the microbiological safety of ready-to-eat foods sampled placed on the market. Available at: http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1259151921557. Accessed 31.1.12
- Frost, J. 1994. *In* Methods in Practical Laboratory Bacteriology (H. Chart, ed.), pp. 73-82. CRC Press, New York.
- Lee, L., S. Ostroff, H. McGee, D. Johnson, F. Downes, D. Cameron, N. NBean, and P. Griffin. 1991. An outbreak of shigellosis at an outdoor music festival. American Journal of Epidemiology 133:608-615.
- Little, C., and S. Sagoo. 2009. Evaluation of the hygiene of ready-to-eat food preparation areas and practices in mobile food vendors in the UK. International Journal of Environmental Health Research 19:441-443.
- LACORS. 2006. LACORS Guidance on Food Sampling for Microbiological Examination; Issue 2. Available at: www.lacors.com; Accessed 20 July 2008.
- Losito, D. 2010. "With glowing hearts" - a health protection perspective on the 2010 Winter Games. Environmental Health Review Summer 2010:37-41.
- McDerment, F., Y. Hall, and P. Hunter. 2002. Microbiological quality of drinking water from mobile vendors. Communicable Disease and Public Health 5:299-300.

- Meehan, P., K. Toomey, J. Drinnon, S. Cunningham, N. Anderson, and E. Baker. 1998. Public health response for the 1996 Olympic Games. *JAMA* 279:1469-1473.
- Grimont, Patrick A. D. and Weil, I Francois-Xavier. 2007. Antigenic formulae of the Salmonella serovars, 9th edition. WHO collaborating centre for reference and research on Salmonella, Institut Pasteur, Paris.
- Thackway, S., T. Churches, J. Fizzell, D. Muscatello, and P. Armstrong. 2009. Should cities hosting mass gatherings invest in public health surveillance and planning? Reflections from a decade of mass gatherings in Sydney, Australia. *BMC Public Health* 9:324.
- Willis, C., N. Elviss, H. Aird, D. Fenelon, and J. McLauchlin. 2012. Evaluation of hygiene practices in catering premises at large-scale events in the UK: identifying risks for the Olympics 2012. *Public Health* 126:646-656.
- Worsfold, D., P. Worsfold, and C. Griffith. 2004. An assessment of food hygiene and safety at farmers' markets. *International Journal of Environmental Health Research* 14:109-119.

Annex 1: Participating Local Authority Food Liaison Groups

Local Authority Food Liaison Group

Berkshire
Buckinghamshire
Cheshire
Cornwall
Cumbria
Derbyshire
Devon
Essex
Gloucestershire
Greater Manchester
Hampshire & Isle of Wight
Hereford & Worcester
Humberside / North Lincoln
Kent
Lancashire
LFCG¹ Greater London NE Sector
LFCG Greater London NW Sector
LFCG Greater London SE Sector
LFCG Greater London SW Sector
Leicestershire
Lincolnshire
Merseyside
Norfolk
North Yorkshire
Northamptonshire
Nottinghamshire
Somerset
South Yorkshire
Suffolk
Surrey
Sussex
Tees Valley
Tyne & Wear
Warwickshire
West Midlands
West of England
West Yorkshire
Wiltshire

¹ London Food Co-ordinating Group

Annex 2: Questionnaire Used by Sampling Officers

Large Scale Events, including fêtes & fairs (1 May 2010 - 31 March 2011)

MAIN QUESTIONNAIRE

LOCAL AUTHORITY AND SAMPLE COLLECTION DETAILS

1. Local Authority.....	2. Food Liaison group
3. Sampling officer	4. Tel. No.
5. Time of collection..... am/pm	6. Date of collection/...../20.....

EVENT DETAILS

7. Name of event:.....	8. Location:.....
9. Type of event & duration: Sporting event <input type="checkbox"/> Concert/ music festival <input type="checkbox"/> Carnival <input type="checkbox"/> Fête <input type="checkbox"/>	Duration: 1d <input type="checkbox"/> 2d <input type="checkbox"/> 3d <input type="checkbox"/> Longer?
Fair <input type="checkbox"/> Other (specify) <input type="checkbox"/>	

TRADER DETAILS

10. Name of trader.....	
11. Registered address.....	Postcode.....
12. Registering LA:	13. LA Premises Ref (if available)
14. Type of trader: Temporary caterer <input type="checkbox"/> Mobile caterer <input type="checkbox"/> Other (specify) <input type="checkbox"/>	
15. Type of premises: Market stall <input type="checkbox"/> Handcart <input type="checkbox"/> Van <input type="checkbox"/> (Registration number	
Temporary/Tent <input type="checkbox"/> Other (specify) <input type="checkbox"/>	
16. Type of food used /handled by mobile vendor: RTE only <input type="checkbox"/> Both RTE and not RTE <input type="checkbox"/>	
17. Inspection Rating Category (A – E)	18. Consumers at risk score (0-15)
	19. Confidence in management score (0 – 30)
20. Are food handlers at the event required to wear security wrist bands? Yes <input type="checkbox"/> No <input type="checkbox"/>	

SAMPLE DETAILS (Please provide clear details of samples collected)

RTE food 1	Sample description (please provide a clear description of product & ingredients)	LA Reference	Laboratory Ref.
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21. How is food regenerated on-site? Not regenerated <input type="checkbox"/> Pan cooked <input type="checkbox"/> Oven cooked <input type="checkbox"/> Microwaved <input type="checkbox"/>	Other (specify) <input type="checkbox"/>
22. Is RTE food stored after preparation? Served immediately <input type="checkbox"/> In hot display cabinet <input type="checkbox"/> In fridge <input type="checkbox"/>	
23. What is the temperature of the RTE food during storage? Hot? <input type="checkbox"/> Cold? <input type="checkbox"/> Specify temp:°C	
24. What is the temperature of the RTE food at service? Hot? <input type="checkbox"/> Cold? <input type="checkbox"/> Specify temp:°C	

RTE food 2	Sample description (please provide a clear description of product & ingredients)	LA Reference	Laboratory Ref.
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25. How is food regenerated on-site? Not regenerated <input type="checkbox"/> Pan cooked <input type="checkbox"/> Oven cooked <input type="checkbox"/> Microwaved <input type="checkbox"/>	Other (specify) <input type="checkbox"/>
26. Is RTE food stored after preparation? Served immediately <input type="checkbox"/> In hot display cabinet <input type="checkbox"/> In fridge <input type="checkbox"/>	
27. What is the temperature of the RTE food during storage? Hot? <input type="checkbox"/> Cold? <input type="checkbox"/> Specify temp:°C	
28. What is the temperature of the RTE food at service? Hot? <input type="checkbox"/> Cold? <input type="checkbox"/> Specify temp:°C	

Cleaning Cloth	Sample collection point description	LA Reference	Laboratory Ref.
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29. Is the cleaning cloth: Disposable? <input type="checkbox"/> Re-useable? <input type="checkbox"/>	
30. How frequently is the cloth cleaned / replaced? <3h <input type="checkbox"/> 3-<6h <input type="checkbox"/> 6-<12h <input type="checkbox"/> <24h <input type="checkbox"/> >24h <input type="checkbox"/> Not known <input type="checkbox"/>	
31. Are separate cleaning cloths used for not RTE / RTE food preparation areas? Yes <input type="checkbox"/> No <input type="checkbox"/>	

Environmental swab 1	Chop board <input type="checkbox"/> Work surface <input type="checkbox"/> Food container <input type="checkbox"/> Serving counter <input type="checkbox"/>	LA Reference	Laboratory Ref.
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Template <input type="checkbox"/> Random <input type="checkbox"/>	Utensil (specify) <input type="checkbox"/> Other (specify) <input type="checkbox"/>		
32. Is the surface/item swabbed made of: Plastic <input type="checkbox"/> Wood <input type="checkbox"/> Metal <input type="checkbox"/> Other (specify) <input type="checkbox"/>			
33. Is the surface condition: Good <input type="checkbox"/> Scored/scratched/chipped <input type="checkbox"/>			
34. Is the surface: Clean and ready to use? <input type="checkbox"/> In use? <input type="checkbox"/> Used and ready for cleaning? <input type="checkbox"/>			
35. Is the surface/item used for raw fruit and vegetables? Yes <input type="checkbox"/> No <input type="checkbox"/>			

Environmental swab 2	Chop board <input type="checkbox"/> Work surface <input type="checkbox"/> Food container <input type="checkbox"/> Serving counter <input type="checkbox"/>	LA Reference	Laboratory Ref.
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Template <input type="checkbox"/> Random <input type="checkbox"/>	Utensil (specify) <input type="checkbox"/> Other (specify) <input type="checkbox"/>		
36. Is the surface/item swabbed made of: Plastic <input type="checkbox"/> Wood <input type="checkbox"/> Metal <input type="checkbox"/> Other (specify) <input type="checkbox"/>			
37. Is the surface condition: Good <input type="checkbox"/> Scored/scratched/chipped <input type="checkbox"/>			
38. Is the surface: Clean and ready to use? <input type="checkbox"/> In use? <input type="checkbox"/> Used and ready for cleaning? <input type="checkbox"/>			
39. Is the surface/item used for raw fruit and vegetables? Yes <input type="checkbox"/> No <input type="checkbox"/>			

Optional study performed? <i>Please complete to allow samples to be linked</i>	Water Quality <input type="checkbox"/>	LA Sample reference
	Security Wrist Bands <input type="checkbox"/>	LA Sample reference

OPTIONAL STUDY QUESTIONNAIRE

LOCAL AUTHORITY AND SAMPLE COLLECTION DETAILS

B1. Local Authority..... B2. Sampling officer

B3. Name of trader.....

OPTIONAL STUDY ONE: WATER *(Please provide clear details of sample collected)*

Water	Container / bottled supply <input type="checkbox"/> Mains potable supply <input type="checkbox"/>	LA Reference	Laboratory Ref.
	Other (specify) <input type="checkbox"/>
B4. What is the water source?	Mains piped supply <input type="checkbox"/> Container / bottles <input type="checkbox"/> Bowser <input type="checkbox"/>		
	Private water supply <input type="checkbox"/> Specify category & class		Other (specify) <input type="checkbox"/>
B5. Is the sample obtained from:	Mains tap <input type="checkbox"/> Standpipe <input type="checkbox"/> Bottled supply tap <input type="checkbox"/>		
	Water container <input type="checkbox"/> Hose <input type="checkbox"/> Other (specify) <input type="checkbox"/>		
B6. What is the temperature of the cold/supply water at storage/outlet point: °C		
B7. If containers are used, how often are they emptied & refilled?	<12h <input type="checkbox"/> 12-<24h <input type="checkbox"/> 24-<48h <input type="checkbox"/> >48h <input type="checkbox"/>		
	Not applicable <input type="checkbox"/>		
B8. Are 'clean' water supplies distinguishable from 'waste' water containers?	Yes <input type="checkbox"/> No <input type="checkbox"/>		
B9. Are hoses/containers included on the cleaning schedule?	Yes <input type="checkbox"/> No <input type="checkbox"/> No cleaning schedule in place <input type="checkbox"/>		
	Not applicable <input type="checkbox"/>		
B10. If the water supply is treated by the vendor, how is it treated?	Chlorinated <input type="checkbox"/> Chlorine tablets/Milton <input type="checkbox"/>		
	Filtered <input type="checkbox"/> UV filter <input type="checkbox"/> Untreated <input type="checkbox"/> Other (specify) <input type="checkbox"/>		
B11. Is the same water supply point used for drinking and washing/cleaning?	Yes <input type="checkbox"/> No <input type="checkbox"/> Not known <input type="checkbox"/>		
B12. What would the sampled water have been used for (tick all that apply)?	Drinking <input type="checkbox"/> Cleaning food <input type="checkbox"/> Washing up <input type="checkbox"/>		
	Cleaning/washing hands <input type="checkbox"/> Cleaning food contacts surfaces <input type="checkbox"/> Included in cold drinks or RTE foods <input type="checkbox"/>		
	Other (specify) <input type="checkbox"/>		

OPTIONAL STUDY TWO: SECURITY WRIST BANDS *(Please provide clear details of sample collected)*

Security Wrist Band	Swab sample collected from a security wrist band worn by a food handler on the premises.	LA Reference	Laboratory Ref.
	
B13. What is the wrist band made of?	Fabric <input type="checkbox"/> Plastic <input type="checkbox"/> Other <input type="checkbox"/> (Specify)		
B14. How long has the worker been wearing the wrist band sampled? (length of time in days)		
B15. Does the vendor have a dedicated hand wash sink?	Yes <input type="checkbox"/> No <input type="checkbox"/>		
B16. Is the sink for hand washing separate from that used to supply water for the preparation of beverages and/or food for sale?	Yes <input type="checkbox"/> No <input type="checkbox"/>		
B17. What is available for workers to dry their hands after washing?	Single use paper towels? Yes <input type="checkbox"/> No <input type="checkbox"/>		
	Cloth re-useable towel? Yes <input type="checkbox"/> No <input type="checkbox"/> Electric hand dryer? Yes <input type="checkbox"/> No <input type="checkbox"/>		
	Other (specify) <input type="checkbox"/>		
B18. Is antibacterial soap used?	Yes <input type="checkbox"/> No <input type="checkbox"/>		

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