Impact of the London 2012 Olympic and Paralympic Games on demand for microbiology gastrointestinal diagnostic services at the Public Health Laboratory London

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Planning for the London 2012 Olympic and Paralympic Games at the Public Health Laboratory London was based on the requirement to meet potential increased demand with scalable capacity. The aim of this study was to determine the impact on demand for microbiology gastrointestinal diagnostic services during the Games period. Retrospective cross-sectional time-series data analysis was used to assess the number of gastrointestinal specimens received in the laboratory and the number of positive results. There was no increase in the number of gastrointestinal specimens received during the Games period, thus the Games had no impact on demand for microbiology gastrointestinal diagnostic services at the laboratory. There was a decrease in the number of public health specimens received for culture [incidence rate ratio = 0.34, 95 % confidence interval (CI) = 0.13–0.86, P = 0.02] and a decrease in the number of culture positive community specimens (odds ratio = 0.59, 95 % CI = 0.40–0.85, P = 0.005), suggesting a decrease in gastrointestinal illness during the Games period. As previous planning assumptions were not based on actual specimen activity, the results of this study may modify the extent of additional planning for microbiological services required for mass gatherings.

INTRODUCTION

In 2012, London hosted the Olympic and Paralympic Games which involved around 15 000 athletes, 11 million spectators, 26 000 media workers and a workforce of 200 000 (London Organising Committee of the Olympic and Paralympic Games, 2012). During the Games period, the population of London was expected to increase by up to 1 million people at any given time and the additional burden on acute care medical facilities was expected to be about 5 % (Moran-Gilad et al., 2012).

Mass gatherings such as the Olympic and Paralympic Games create a potential risk for the transmission of infectious disease due to the large numbers of people in close proximity, mixing of different populations and increased international travel providing an opportunity for importation of non-endemic infections and rapid spread of infections (Abubakar et al., 2012).

Public health planning for the London 2012 Games followed the principles set out in the World Health Organization (WHO)’s Communicable Disease Alert and Response for Mass Gatherings Guidelines (McCloskey et al., 2014; WHO, 2008a). It was informed by the experiences of previous host cities, and a review of previous sporting events and mass gatherings, which identified infectious disease outbreaks and surveillance as areas for public health planning (Enock & Jacobs, 2008).

The key objective of the Health Protection Agency (HPA) (now part of Public Health England) during the 2012 Games was to identify potential health protection threats and prevent or manage them effectively (HPA, 2012). In partnership with other local, national and international agencies, the HPA undertook a public health risk assessment which informed the UK government’s Olympic planning (McCloskey et al., 2014).

Although there were no reports of major outbreaks associated with the four previous Games (Jorm et al., 2012),
In response to the risk assessment, existing surveillance systems were enhanced and new systems were developed to monitor infectious disease activity throughout the Games period (Elliott et al., 2012; Harcourt et al., 2012; Heinsbroek et al., 2012; McCloskey et al., 2014; Severi et al., 2012). In addition to this, microbiology laboratory services were enhanced in order to meet any increase in demand (Moran-Gilad et al., 2012).

The HPA Microbiology Service Division comprised eight Public Health Laboratories (PHLs), five Food, Water and Environmental (FWE) Laboratories, and two Reference Laboratories. It provided laboratory testing in support of public health for the London 2012 Games with a lower threshold than usual for response to potential public health incidents. Planning assumptions were based on the requirement to respond to a major outbreak of infectious disease whilst maintaining other services. This was referred to as an ‘enhanced business as usual’ model (HPA, 2013; Moran-Gilad et al., 2012).

The regional PHL for London is based at the Royal London Hospital in East London, 8 km from the Olympic Park in Stratford. PHL London provides a regional public health microbiology service for all London hospitals, four Health Protection Teams [previously known as Health Protection Units (HPUs)], 32 London Boroughs and the City of London local health authorities. A free-of-charge courier and diagnostic service with clinical advice is provided for all public health gastrointestinal specimens (as defined in Table 1). It also provides a clinical diagnostic microbiology service for six hospitals and local general practitioners within the London Boroughs of Newham and Tower Hamlets where the Olympic Park was based. The Royal London Hospital was one of the three hospitals in London designated to provide acute care services for the Olympic family. Polyclinics at the Olympic Villages provided medical care for athletes and accompanying personnel although public health investigations were managed by the HPUs with microbiological input provided by PHL London.

PHL London’s planning assumptions for the Games period were based on the ability to meet increased demand with scalable capacity whilst maintaining the routine public health laboratory service. An enhanced service with a lower threshold for response to potential public health incidents was provided from 2 July to 30 September 2012. Additional staff were recruited (one scientist, two laboratory support staff and one medical microbiology consultant) and on-call duty rotas were implemented with extended working hours to ensure the availability of staff 24 h a day, 7 days a week. Novel real-time PCR assays for the detection of gastrointestinal pathogens were used for Games-related gastrointestinal specimens (defined as any gastrointestinal specimen from a patient with a link to Games events or venue, including those sent from the polyclinic at the Olympic Village) (Moran-Gilad et al., 2012; O’Brien et al.; 2010). Enhanced reporting systems were also implemented to provide daily updates for public health situation reports (Severi et al., 2012).

The primary objective of this study was to determine whether the London 2012 Games had an impact on demand for microbiology gastrointestinal diagnostic services at PHL London by analysing the weekly number of public health, community and hospital gastrointestinal specimens received (as defined in Table 1), and positive results. We focused on gastrointestinal microscopy specimens as these constituted the largest number of specimens received, thus it is most likely that any small change in demand would have been detected. To avoid duplication, results from the novel real-time gastrointestinal PCR assays

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**Table 1. Definitions of categories for data analysis**

<table>
<thead>
<tr>
<th>Category (source)</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public health specimens</td>
<td>All stool specimens sent as part of a public health investigation in order to: (i) determine whether a cluster of cases was related, (ii) determine the cause and extent of an outbreak in a community, (iii) diagnose individual cases of diseases of public health significance, or to contain and/or prevent an outbreak, (iv) check for microbiological clearance, or (v) detect carriage of pathogens in asymptomatic individuals. During the Games period, this included specimens from patients with a link to Games events or venues (Games-related specimens).</td>
</tr>
<tr>
<td>Community specimens</td>
<td>All stool specimens from Accident &amp; Emergency, General Practice surgeries and walk-in clinics in Tower Hamlets and Newham.</td>
</tr>
<tr>
<td>Hospital specimens</td>
<td>All stool specimens from inpatients and outpatients at The Royal London, St Bartholomew’s, London Chest and Newham hospitals.</td>
</tr>
<tr>
<td>Other</td>
<td>All stool specimens that did not fit into one of the above categories (mainly quality assurance specimens, but also specimens from other hospitals or location unknown). This category was omitted from further analysis.</td>
</tr>
<tr>
<td>All specimens</td>
<td>Includes all community, hospital and public health specimens.</td>
</tr>
</tbody>
</table>
were excluded as all specimens tested using the PCR were also processed for routine culture and microscopy.

Gastrointestinal outbreak and incident data from the four London HPUs were also analysed as any increase in public health activity should have been reflected in the number of public health gastrointestinal specimens received at PHL London.

METHODS

Study design. Data were collected retrospectively for all public health, community and hospital stool specimens (as defined in Table 1) received by PHL London between 1 January 2010 and 31 December 2012. Cross-sectional time-series data analysis was used to ascertain whether there was a significant increase in the number of stool specimens received and/or the proportion of positive results during the Games period (2 July to 30 September 2012). Clinical reports of outbreaks to the four London HPUs were also analysed.

Ethical approval was not required for this study as patient-identifiable information was not extracted with the laboratory data and confidentiality was maintained throughout the study.

Data collection

Laboratory requests. Data were extracted retrospectively from the laboratory information management system (Winpath; CliniSys) for all stool specimens received between 1 January 2010 and 31 December 2012 with a request for one or more of the following tests: bacterial culture (for Shigella, Salmonella, Campylobacter and Escherichia coli O157), Cryptosporidium microscopy, OCP (ova, cysts and parasites) microscopy and/or norovirus PCR. The following variables were extracted for each specimen: sample number, date received in laboratory, requesting clinician, source, culture result, Cryptosporidium result, OCP result and norovirus result.

HPU outbreak and incident data. Data were collected retrospectively from the HPU online data management system (HPZone; InFact Software) for all outbreaks defined as food poisoning or gastroenteritis investigated by the London HPUs from 1 January 2010 to 31 December 2012. Date entered, organism, context, HPU and Primary Care Trust were extracted for analysis.

Data analysis

Laboratory requests. Specimens were categorized by source (public health, community, hospital or other) as defined in Table 1. Each category was analysed separately for the total number of culture, Cryptosporidium, OCP or norovirus tests during the study period was very small relative to the other specimen types (n = 711) and therefore analysis was not possible for all tests. However, the binomial regression model suggests there was a significant decrease in culture requests during the Games period [incidence rate ratio (IRR) = 0.34, 95% confidence interval (CI) 0.13–0.86, P = 0.02].

Community specimens

There was no difference in the number of specimens received during the Games period compared with outside the Games period. The odds of having a positive culture result for all specimens were lower during the Games period compared with outside the Games period [odds ratio (OR) = 0.53, 95% CI = 0.40–0.71, P = 0.005], reflecting the underlying findings for the community specimens (OR = 0.59, 95% CI = 0.40–0.85, P = 0.005).

Hospital specimens

There was no difference in the number of specimens received during the Games period. The odds of having a positive OCP result was higher during the Games period compared with outside the Games period (OR = 3.19, 95% CI 1.58–6.43, P = 0.001), with higher odds for hospital specimens (OR = 9.83, 95% CI = 2.20–43.86, P = 0.003).

HPU outbreak and incident data

The descriptive analysis suggests that there was no increase in the number of gastrointestinal outbreaks reported to the London HPUs during the Games period. A total of 34 outbreaks were reported in the months of July to September in 2012, compared with 33 during the same period in 2010 and 29 in 2011. One outbreak of gastroenteritis in a care home (pathogen not determined) was reported from the London Boroughs of Newham and Tower Hamlets during the Games period.

DISCUSSION

From July to September 2012, 698 000 overseas residents visited the UK for the Olympic or Paralympic Games, or attended a ticketed event (Office for National Statistics,
London received 27.6 million staying visits in 2012 with a peak of domestic visitors arriving to watch the Olympic Games in August (London & Partners, 2013). During the Games, up to 180,000 spectators a day attended the Olympic Park and 20 million spectator journeys were made in London, including 3 million on the busiest day of the Games (International Olympic Committee; http://www.olympic.org).

Public health planning for mass gatherings such as the Olympic and Paralympic Games is essential due to the public and political profile of the Games and the potential risk for outbreaks of infectious disease. Planning for the London 2012 Games was based on the experience from previous Games and WHO guidelines (Enock & Jacobs, 2008; McCloskey et al., 2014; Thackway et al., 2009; WHO, 2008a). There are, however, no published reports describing the impact of previous Games on microbiology laboratory services and planning assumptions have not been based on actual microbiological activity.

The results of this retrospective time-series analysis show there was no increased demand for microbiology gastrointestinal diagnostic services at PHL London during the Games period as there was no increase in the overall number of gastrointestinal specimens received or positive results.

Specifically, the number of public health specimens received for routine culture decreased during the Games period. However, the number of public health specimens received during the entire study period was small, so caution must be exercised when interpreting the significance of this finding. There was also a decrease in the number of positive culture results from community specimens despite there being no change in the overall number of specimens tested during the Games period.

There was no change in the number of hospital gastrointestinal specimens received during the Games period which is supported by a lack of increase in hospital activity, based on non-elective admissions and Accident & Emergency attendances (NHS England; http://www.england.nhs.uk). There was an increase in the number of positive hospital OCP results; however, the total number is very small with wide confidence intervals and therefore

Fig. 1. Three-week rolling averages of the number of requests and positive results from 2010 to 2012. Where possible, the y-axes are the same to allow easy comparison; however, there is a difference for the ‘Total requests’ and ‘Public health requests’ due to the difference in the number of requests each week.
Table 2. Regression model results for number of tests and positivity rate during the Games period compared with outside the Games period

<table>
<thead>
<tr>
<th>Source/test</th>
<th>Test requests (test request rate adjusted for seasonality)</th>
<th>Positive results</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n*</td>
<td>IRR</td>
<td>95% CI</td>
<td>P-value</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td>36640</td>
<td>1.02</td>
<td>0.94–1.11</td>
<td>0.7</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>10386</td>
<td>1.10</td>
<td>0.98–1.24</td>
<td>0.1</td>
</tr>
<tr>
<td>OCP</td>
<td>8717</td>
<td>1.02</td>
<td>0.88–1.19</td>
<td>0.8</td>
</tr>
<tr>
<td>Norovirus</td>
<td>6477</td>
<td>1.11</td>
<td>0.52–2.33</td>
<td>0.8</td>
</tr>
<tr>
<td>Public health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td>711</td>
<td>0.34</td>
<td>0.13–0.86</td>
<td>0.02</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>26</td>
<td>1.00</td>
<td>0.90–1.25</td>
<td>0.5</td>
</tr>
<tr>
<td>OCP</td>
<td>16</td>
<td>0.67</td>
<td>0.54–3.05</td>
<td>0.6</td>
</tr>
<tr>
<td>Norovirus</td>
<td>337</td>
<td>1.28</td>
<td>0.54–3.05</td>
<td>0.6</td>
</tr>
<tr>
<td>Community</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td>16551</td>
<td>0.97</td>
<td>0.85–1.11</td>
<td>0.7</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>6487</td>
<td>1.06</td>
<td>0.90–1.25</td>
<td>0.5</td>
</tr>
<tr>
<td>OCP</td>
<td>6768</td>
<td>0.98</td>
<td>0.82–1.17</td>
<td>0.8</td>
</tr>
<tr>
<td>Norovirus</td>
<td>572</td>
<td>0.82</td>
<td>0.53–1.27</td>
<td>0.7</td>
</tr>
<tr>
<td>Hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td>19378</td>
<td>1.07</td>
<td>0.98–1.16</td>
<td>0.1</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>3873</td>
<td>1.18</td>
<td>1.00–1.40</td>
<td>0.06</td>
</tr>
<tr>
<td>OCP</td>
<td>1933</td>
<td>1.18</td>
<td>0.93–1.49</td>
<td>0.2</td>
</tr>
<tr>
<td>Norovirus</td>
<td>5568</td>
<td>1.01</td>
<td>0.45–2.23</td>
<td>1</td>
</tr>
</tbody>
</table>

Values in italics are of statistical significance (P ≤ 0.005). IRR, incidence rate ratio; CI, confidence interval; OR, odds ratio.

*Total number of requests between 2010 and 2012.
†Total number of positive tests between 2010 and 2012.
caution needs to be applied when considering the significance of this finding.

The laboratory findings reflect the HPU outbreak and incident data. These data show that there was no increase in activity during the Games period compared with the two previous non-Games years during which there were no mass gatherings. This is in keeping with the enhanced surveillance systems which reported that there were no major public health incidents during the Games period, and that the rate of infectious disease reports was similar to that routinely seen during the summer and during other mass gatherings (HPA, 2012; McCloskey et al., 2014).

The decrease in public health specimens and positive culture results from the community during the London 2012 Games may suggest a decrease in the incidence of gastrointestinal illness. This could be due to the enhanced food hygiene inspections that were implemented prior to and during the Games period to ensure food hygiene and safety in Newham and Tower Hamlets. This would be in keeping with the Beijing 2008 Games, during which there was a 46.9% decrease in the number of gastrointestinal disease cases reported, which was attributed to food safety measures, health education, and enhanced public health investigation and control measures (WHO, 2008b).

This study looked at demand for microbiology gastrointestinal diagnostic services and did not consider other specimen types, such as respiratory specimens. Gastrointestinal specimens were chosen as they constitute the largest number of specimens received and gastrointestinal disease outbreaks associated with mass gatherings have been reported previously (Crampin et al., 1999; Lee et al., 1991; Morgan et al., 1994). Gastrointestinal infections also accounted for the majority of incidents (75%) that required clinical or microbiological input from the Microbiology Services Division during the Games period (HPA, 2012).

Whilst the majority of gastrointestinal public health specimens from across London are referred to PHL London, it is recognized that a small number of specimens will have been sent to other laboratories. However, any increase in positive results from these other laboratories would have been detected by the HPU outbreak and incident data.

The service provided by PHL London comprises diagnostic microbiology with clinical advice and support. Although there was no increase in diagnostic testing, there were a number of outbreaks/incidents that required clinical input. Unfortunately, data on clinical input was not recorded before or during the Games and hence could not be included in this study.

To put our findings in context with the rest of the UK, a total of 79 Games-related stool specimens were processed by the eight PHLs, 35 (44%) of these were processed by PHL London (HPA, 2013). Of the 35 specimens processed by PHL London, 71% were positive for a gastrointestinal pathogen compared with a positivity rate of 30% across the other seven laboratories (HPA, 2013). The Gastrointestinal Reference Unit at the National Reference Laboratory performed 18 tests on Games-related specimens (HPA, 2013). The FWE laboratories tested 831 specimens, mainly as a measure of safety and quality, but also in response to clinical incidents. The majority of this work was done in the London FWE Laboratory (HPA, 2013).

A robust microbiology service with scalable capacity for major incidents is essential for any public health system. However, the results of this study show that there was no change in demand for microbiology gastrointestinal diagnostic services at PHL London and suggest that the existing resources would have been sufficient. This study questions the extent of additional planning required, particularly as a HPA risk assessment concluded that serious infectious disease outbreaks associated with the Games were unlikely (Severi et al., 2012), and that there were no reports of major outbreaks associated with the four previous Games (Jorm et al., 2003; Meehan et al., 1998; WHO, 2004, 2008b).

As far as we are aware, this is the first report describing the impact of Olympic and Paralympic Games on microbiology laboratory services. The findings from this study will thus contribute to the overall evaluation of microbiology services for the London 2012 Games, and can be used to inform planning assumptions and preparedness for future Games or similar events.

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