Did London 2012 deliver a sports participation legacy?

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Abstract

Despite the increasing academic interest in the analysis of the Olympic legacy, there is a relative knowledge gap as far as sports participation legacy is concerned. The authors bridge this gap by analysing the short-term sports participation legacy of the London 2012 Olympic and Paralympic Games on the adult population in England. By using data from the Active People Survey and considering different sports participation variables and the effect of the economic climate, results demonstrate a positive association with participation from hosting the Games. Participation rates were adjusted to take into account seasonality and changes in the gross domestic product (GDP), accounting in this way for the effect of the recent economic recession. The biggest effect was observed in relation to frequent participation (at least three times per week for at least 30 minutes) in the year immediately after the Games. In 2014, the sports participation rates fell relative to 2013 but remained higher than pre-Olympic levels. The sport participation legacy of the Olympic Games appeared to have significant differences between socio-demographic groups.

Keywords: Sports participation, Olympic Games, Olympic legacy, demonstration or trickle-down effect, health.

1. Introduction

The relationship between physical activity and health, as well as the costs of physical inactivity, has been researched to a great extent during the last decade. According to the World Health Organisation (WHO, 2010), physical inactivity is the principal cause for approximately 21–25% of breast and colon cancer, 27% of diabetes, and approximately 30% of ischaemic heart diseases. The health-care costs associated with physical inactivity have been estimated to be €80.4 billion per year in Europe (International Sport Culture Association and Centre for Economics and Business Research, 2015) and £7.4 billion in the UK (HM Government, 2015). The European Commission (2016) recognises "the undeniable and important health benefits of sport and physical activity and their crucial role in tackling obesity and other non-communicable diseases" (p. 13). Nevertheless, the number of individuals in many countries reporting engagement in sports participation has either stagnated or decreased over time, both in the European Union (European Commission, 2014) and in the US (Berg, Warner, & Das, 2015).

In order to tackle this issue, many countries have developed different strategies to boost sports participation, including hosting sport events. One of the main justifications for organising a major sporting event is the legacy that remains when the competition is over. The term “sports participation legacy” has become a recurrent one in academic and non-academic discourse about the impacts of mega-sport events since the International Olympic Committee (IOC) introduced it as its 14th mission (Chappelet, 2008; IOC, 2011). Consequently, bidding cities have to consider and estimate the impacts of the Olympic Games on their communities in areas beyond infrastructure (Sousa-Mast, Reis, Gurgel & Duarte, 2013). In the case of the London 2012 Games, the sports participation legacy was a core component of the wider legacy of the Olympic Games in the UK (Cabinet Office,

2013). London 2012 was the first Olympic Games to explicitly define and attempt to deliver this type of legacy (Department for Culture, Media and Sport, 2008).

Despite the increasing academic interest in this field of study, there is a relative knowledge gap when considering the Olympic legacy in terms of sports participation (Reis et al., 2014). Until now, the evidence about the sports participation legacy of the Olympic Games is ambiguous. Previous researchers have indicated a poor empirical base to inform the development of direct sports participation legacies derived from the Olympic Games (Hanstad & Skille, 2010; London East Research Institute, 2007; Weed, Coren, & Fiore, 2009; Weed et al., 2012). Coalter (2004) argued that only those already involved in sports increase their levels of participation after a mega-sport event.

Weed et al. (2009) emphasized that "there is a clear need for more sustained research and more robust evaluation to inform the development of such legacies" (p. 58). Moreover, Wicker and Sotiriadou (2013) contend that "the inconclusive and sometimes contradicting results suggest that further research is necessary to illuminate the role of major sport events on people's decision to start exercise or increase their participation frequency" (p. 27). Hence, the jury is still out on whether changes in participation behaviour can in reality be accomplished by events of this magnitude (Ramchandani, Coleman, & Bigham, 2017). In this context, it should be highlighted that there are many factors beyond hosting the Olympic Games that can shape sports participation (Downward, Lera-López, & Rascuite, 2014).

In this paper, we analyse the sports participation legacy of London 2012 in the two year period immediately following the Games. Specifically we examine if there has been a step change in sports participation among adults in England using data from the Active People Survey (APS). An overview of the APS dataset and the participation variables examined is provided in section 3.1. We also examine differences in sports

participation rates before and after the Games for different socio-demographic groups, an issue that has been scarcely analysed (Potwarka & Leatherdale, 2016). According to Charlton (2010), overall participation rates in England are stagnant despite significant investment by government and the boost of funding provided by the National Lottery from the second half of the 1990s and several reorganizations of the sports system. From a practical point of view, a better understanding of the impact of the Olympic Games on sports participation is therefore of interest for the UK and for other countries interested in hosting the event.

2. Sports participation legacies of events

The interest in sports participation legacy associated with an Olympic Game has been fuelled by the stagnation of participation rates in many countries (e.g. European Commission, 2014) as well as the drastically rising costs of hosting the Games. The terminology commonly used to describe the potential sports participation legacy of an event is a demonstration effect or a trickle-down effect. Regardless of the choice of term, this effect refers to "a process by which people are inspired by elite sport, sports people or sports events to participate themselves" (Weed et al. 2015, p. 197). Weed et al. (2009) contended that a demonstration effect is more likely to appeal to existing or lapsed sport participants.

Systematic reviews by Weed et al. (2009, 2012, 2015), Mahtani et al. (2013), and McCartney et al. (2010) found no reliable evidence to confirm that any previous Olympic Games had succeeded in encouraging and increasing sports participation rates for the hosting nations. Some studies suggest some short-term positive effects (i.e., Chen & Henry, 2016; Department for Culture, Media and Sport, 2013a; Hanstad & Skille, 2010; Pappous, 2011; Potwarka & Leatherdale, 2016; Truño, 1995); others have demonstrated no relationship (i.e., Bauman, Bellew, & Craig, 2014; Feng & Hong, 2013; Veal, Toohey,

& Frawkey, 2012) whereas some others find decreases in participation (Veal, 2003). Moreover, the systematic reviews show that the sports participation legacy is more likely to materialise in terms of increasing the participation frequency or in activity switching rather than increasing the number of participants (Taks, Green, Misener, & Chalip, 2014).

From a methodological perspective, we divide empirical evidence into two different strands. On the one hand, many studies have developed a quantitative approach, trying to estimate the impact on sports participation through objective indicators, mainly sports participation rates. These studies neither develop nor apply a particular theoretical approach. The lack of longitudinal data and/or the appropriate population-level data and differences in sample sizes make it difficult to compare the results obtained (Veal et al., 2012). For example, some studies are based only on a small number of interviews (i.e., Feng & Hong, 2013) while other studies use large-scale cross-section data (Downward, Dawson, & Mills, 2013). It might also be speculative to attribute any changes in sports participation in a country to hosting the Olympic Games exclusively (Coalter, 2007; Ramchandani et al., 2015). In addition, different models have been applied, with a logistic regression used often to estimate the trickle-down effect (i.e., Bauman et al., 2014; Craig & Bauman, 2014; Wicker & Sotiriadou, 2013). Finally, the effect of major sport events can differ among different population groups and might depend on some socio-demographic characteristics, such as age, gender, level of education, occupation, ethnicity, and geographical proximity (Frawley & Cush, 2011; Potwarka & Leatherdale, 2016; Wicker & Sotiriadou, 2013).

On the other hand, some studies have followed a qualitative approach to measure the impact of hosting the Olympic Games. For example, in some studies, the trickle-down effect is measured only through the subjective perceptions of people (Wicker & Sotiriadou, 2013). Recently, some scholars have analysed how individual attitudes and

motivations about sports participation might change after hosting the Games (i.e., Boardley, 2013, Potwarka, 2015; Potwarka et al. 2016). These researchers have applied some psychological theories, such as the theory of planned behaviour (Ajzen, 1991), to justify these changes in motivations. We now consider some empirical evidence for past Summer and Winter editions of the Olympic Games.

2.1 Evidence from past Olympic Games

2.1.1 Barcelona 1992 - Atlanta 1996

Truño (1995) reported an increased participation rate (at least once a week) between 1985 and 1995, from 36% to 51% respectively, in connection with the 1992 Summer Games in Barcelona. Nevertheless, some authors have stated that these findings could be due to a wide range of factors besides the Olympic Games (Veal et al., 2012). For the 1994 Olympic Winter Games in Lillehammer (Norway), Hanstad and Skille (2010) showed a short-term increase in sports participation but not a long-term/lasting legacy. While there is no empirical evidence about the sports participation legacy of Atlanta 1996, London Assembly (2007) cited an increase of expenditure on sporting goods in the US after the Olympic Games, which might be associated with an increase in sports participation.

2.1.2 Sydney 2000

Different authors have considered the effect of hosting the 2000 Sydney Olympics. Bauman et al. (2014) and Veal et al. (2012) studied physical activity levels in Australia before and immediately (six weeks) after the event. Using national statistics about physical activity, they found no significant change in the percentage of adults doing enough physical activity for health benefits (five sessions and at least 150 total minutes) from 1999 to 2000. Only 4% of the adults surveyed reported that they had increased their physical activity as a direct result of Australia hosting the event. Using a similar approach, Toohey (2008, p. 1959) concluded that “it remains doubtful whether Australians have

become more active as a result of the Olympic Games" and that the most significant impact of the Games was an increase in attending and watching sports events. Nevertheless, Cashman (2006) suggests a significant increase in participation (11%, particularly in non-Olympic sports) in the year following the Games.

2.1.3 Athens 2004 - Vancouver 2010

Pappous (2011), using information provided by Eurostat, tested the impact of Athens 2004 on sports participation rates in Greece. He found that sports participation increased significantly immediately after the Games. However, the rises in participation had a short-term character; five years after the Games the data showed a significant decline in participation rates as well as increased inactivity (+10%). He concluded that the demonstration effect was only temporary, with no long-lasting effect on the overall sports participation rates of the host country.

In the case of the Beijing Olympic Games, Feng and Hong (2013) argued that shortage of sport facilities, unsound sport management systems and lack of policy support restricted the legacy impact. Nevertheless, other authors argue that hosting the Games "has helped raised the generally low level of popular participation in sports, especially among the young" (Jinxia & Mangan, 2008, p. 2026).

Potwarka and Leatherdale (2016) have analysed the evidence of a trickle-down effect among Canadian youth following the Vancouver 2010 Winter Olympic Games. They showed that the Games had a trickle-down effect in the sports participation rates for at least two years following the event. Nevertheless, this impact was localised within certain regions close to where the Games were staged and among particular segments of population, in particular, among young females.

2.1.4 London 2012

In the case of London 2012, the research conducted can be classified in two groups. On the one hand, some researchers have conducted qualitative studies and concluded that the Games have not developed a sports participation legacy (Carter & Lorenc, 2013), in spite of the positive impact on the motivation to be more physically active (Darko & Mackintosh, 2016; Mackintosh, Darko, & May-Wilkins, 2016). On the other hand, other studies have considered only regional impacts (Chen & Henry, 2016) or some particular sports (Pappous & Hayday, 2016) or have analysed some specific groups of people (Müther, Williamson, & Williamson, 2014). For example, Chen and Henry (2016) found that, for the region of Leicestershire, the Olympic Games were associated with raised awareness of the benefits of participating in sport and with increased motivation to take part in new sports. Their evidence suggests that the promotion of participation was less effective among non-participants, but more effective among occasional participants. Pappous and Hayday (2016) estimated the impact of the 2012 London Olympic Game on the participation rates in judo and fencing. They concluded that an increase of participation occurred in these sports after the Games.

Recent studies indicate that the Games significantly helped to motivate people to participate in sports (Department for Culture, Media & Sport, 2013a, b; Downward et al., 2013). Downward et al. (2013) used monthly data from the Taking Part Survey and showed that in the run up to London 2012 since the Beijing Games, there was an increase in participation of those doing sport most intensively. They also found that during the Games, there was a drop (10%) in sports participation, particularly in Olympic sports, arguing that watching the Games was a substitute good for practising sport.

Our study builds on these research efforts and takes into account the relative influence of economic conditions in order to judge any variations in sports participation rates around the Olympic Games more effectively. Several researchers (Ruseski &

Maresova, 2014; van Tuyckom, 2011) have found that GDP per capita is associated with sports participation. Gratton and Kokolakakis (2012) have shown a direct and strong relationship between the economic climate (measured using GDP) and sports participation levels in England. In particular, they found that reductions in GDP lower sports participation after a lag of three quarters.

3. Methods

3.1. Data and variables

The research was conducted by analysing the dataset provided by the eight waves of the APS between 2005 (first year of the APS) and 2014. The APS is the largest survey of sport and active recreation in Europe. The survey starts in mid-October and runs continuously for 12 months. Around 165,000 English adults (age 16, recently 14, and over) are interviewed by telephone across the country. The sample is randomly stratified, and the results are representative of the total adult population in the country. Because of its size, the APS data are a useful resource for analysing the demographic determinants of participation in sport in England (Carmichael, Grix, & Palacio-Marqués, 2013).

For the purpose of this research, sports participation data were collected from the fourth quarter of 2005 to the third quarter of 2014 (36 data points). Quarters were selected (rather than months) in order to facilitate the use of the GDP figures from the National Accounts, which are also published on a quarterly basis. This, in turn, necessitated a seasonal adjustment of both participation rates and GDP in order to smooth the data. Based on the APS, the following variables were constructed considering participation in sport of adults aged 16 and over (as early APSs had age 16 as their starting point):

- *3×30*: The proportion of adults (aged 16 and over) participating in at least 30 minutes of sport and active recreation, at moderate intensity, on at least 12 days out of the last 28 days (equivalent to 3 or more days a week). The definition

includes any walking for the purpose of health and recreation. Walking just to get from place to place is not included.

- *1×30*: The proportion of adults (aged 16 and over) participating in at least 30 minutes of sport and active recreation, at least moderate intensity, on at least 4 days out of the last 28 days.
- *1×m*: The proportion of adults (aged 16 and over) participating at least once a month for at least 30 minutes of sport and active recreation; at least moderate intensity.

Since previous research suggests that participation in sport is affected by several individual factors (i.e., Cabane & Lechner, 2015; Downward et al., 2014; Kokokakis, Lera-López, & Panagouleas, 2012), we include a set of individual socio-economic variables: gender, age, number of children in the household, educational levels, socio-economic category, working status, ethnicity, housing, and health level (see Table 1 for definitions and measurement details) in the context of logistic regressions for the analysis of participation.

Insert Table 1

3.2 Methodology and model

An innovation of the current methodology was the decision to seasonally adjust the participation data in order to facilitate a like for like comparison across quarterly observations. Any modelling of the raw data set would have to address the dominant seasonal pattern picking up in the third quarter and dropping strongly in the fourth. However the seasonality pattern is of little interest to the objective of this research, obscuring the real effect as we move from one quarter to another. Furthermore, we calculated expected sports participation rates for the period 2012-2014 based on seasonally adjusted quarterly data from 2005-2011 alongside variations in GDP

(establishing in this way a pre-Olympic trend in sports participation adjusted for changes in the economy). The difference between the expected participation rates (using the aforementioned approach) and the actual seasonally adjusted participation rates (from the APS) provides a measure of the Olympic association with sports participation.

The research was conducted using a combination of Excel spreadsheets and specialist data analysis software (SPSS and X-12-ARIMA). The X-12-ARIMA seasonal adjustment package (developed by the United States Bureau of Census (2007) and freely available from their website) was chosen for de-seasoning the participation data. This software is used by the Office for National Statistics (ONS, 2007) as the standard software for the official statistics. It is also consistent with both European best practice and the Bank of England. The seasonal adjustment was done using an optimum ARIMA model that was chosen automatically from the software package, on the basis of work by Gómez and Maravall (1998). The chosen moving average process was ARIMA (010)(011), as described in Table 2 below; through this, the levels of annual participation were preserved. This approach ensured consistency in adjustment between participation and GDP. For ease of comprehension note that the first part of the ARIMA model (the first bracket) is the non-seasonal part while the second the seasonal part (in this case over quarterly data). Here, the non seasonal part is defined by a random walk while the seasonal part by a single seasonal difference and a single moving average term. The first number in each bracket indicates the autoregressive process (AR, lagged dependent variable), the second the degree of difference (Integration) used, and the third the moving average process (MA, the regression error expressed as a linear combination of error terms). Through the ARIMA model we generate as much as possible a stationary series which eases the calculation process.

Insert Table 2

The participation rates trend (for 2012-2014) was estimated by using seasonally adjusted GDP at constant (2011) prices and a time trend. Based on previous literature, if there is any trickle-down effect, this would be apparent in the full year of the Olympic Games and thereafter (Cashman, 2006; Hanstad & Skille, 2010; London Assembly, 2007; Pappous, 2011; Pappous & Hayday, 2016). This time-frame for the trickle-down effect was tested in this research through the examined dataset. The period 2012-2014 was used for examining the sports participation legacy of the Games. We developed a pre-Olympic regression to calculate a trend for sports participation without the effect of London 2012, whilst simultaneously abstracting from the effects of changes in GDP and sport seasonality.

The chosen model had participation regressed on a constant, a time trend and the percentage change of GDP three quarters before (Gratton & Kokolakakis, 2012):

$$P_t = 20.83 + 0.03t + 0.12\Delta G_{t-3}$$

$$(0.11) \quad (0.01) \quad (0.06) \qquad R^2=61\%$$

where P and ΔG stand for percentage of sports participation and percentage change in GDP (between successive quarters) respectively. The time period for the regression is from 2005 Q4 to 2011 Q4. This time period creates a model that can help us trace the trend of sports participation in the subsequent period. The advantage of this approach is that the Participation data set is seasonally adjusted in exactly the same way as the national GDP and that in the formation of the expected participation rate (2012-2014), GDP is taken explicitly into account following the greatest recession of recent times.

After conducting the analysis of the sports participation effect, we proceed to compare the socio-demographic characteristics of the participants in the year of the London Olympic Games (2012) and four years earlier (2008). The years 2012 and 2008 correspond to the London Olympics and the last year before the 2009/10 recession

respectively. The latter, according to Gratton and Kokolakakis (2012), affected the pattern of sports participation negatively; hence for comparison purposes 2008 is the latest year that can be used. For those years, we estimate two logistic regressions based on the third and the seventh waves of the APS. Each wave contained approximately 160,000 adult respondents.

We made the comparison by considering the change in the odds ratios from APS3 to APS7 for the same set of covariates. To avoid multicollinearity, a correlation matrix was constructed and combinations of variables with excessive r-values (above 0.7) were excluded. An example of building and comparing models through the odds ratios can be found in the Kokolakakis et al.'s (2012) study. The odds ratio expresses information in relation to a base category. The latter has been chosen to correspond to an average condition across the categories. For example in the case of age, this average is represented by the 45-54 category which is treated as the base for comparison purposes. In the case of ethnicity, the majority group is white-British, which is then treated as the average condition and provides the base for ethnic comparisons. The advantage of this choice of bases is that the subsequent odds ratios provide a comparison not only against a particular group but a general average in terms of sports participation rates. The comparability of the odds ratios generated by the two regressions is ensured by the shapes of the logistic function, the similarity of the two sample sizes, the identical bases used, the identical regression models, and even the similar methodologies of the surveys (Kokolakakis et al. 2012).

4. Results

4.1 Actual sports participation rates (seasonally unadjusted)

To provide an overall view of the dataset, and to illustrate the effect of seasonality on sports participation, Figure 1 below shows the actual 3×30 sports participation rates for

adults aged 16 and over in England per quarter over the period 2005-2014. There is a strong seasonal pattern marked by a decline in participation between the third and four quarters. Such a pattern must be seasonally adjusted in order to draw conclusions for the participation effect associated with London 2012; however, even at this stage, it is obvious that there is a noticeable peak following the Games that sets them apart from the previous pattern. For example, as Figure 1 indicates, in the third quarter of 2013, the 3×30 sports participation rate reached 26.9%, which is higher than any of quarterly participation rates in the pre-Olympic period (2005-2011).

Insert Figure 1

The data in Figure 1 also allow us to compare the participation rates around London 2012 with Beijing 2008. At face value, there is only limited evidence of an increase in 3×30 participation following Beijing 2008. The most obvious peak in the aftermath of Beijing 2008 was in the third quarter of 2009, where participation increased from 22.2% in 2008 to 23.1%. However this increase was not comparable to the magnitude of the increase evident post London 2012.

4.2 Expected sports participation and the total Olympic effect for 2012-2014

Figure 2 shows the seasonally adjusted 3×30 sports participation rates for each quarter between 2005 Q4 and 2014 Q3 (the solid line). In Figure 2, the dashed line shows the pre-Olympic participation trend extrapolated to 2014 Q3 by using the regression model (presented in section 3.2) and, hence, accounting for economic change and allowing remaining variations to be attributed to genuine changes in sports participation. The extrapolated line is consistently below the actual seasonally adjusted participation rate (the solid line); this difference becomes more striking during the period 2012 Q4 -2014 Q1.

The area between the two lines, for the period 2012-2014 can be considered to be the impact of the Olympic Games on frequent (3 x 30) sports participation in England. Consequently, it seems that there was a significant Olympic legacy effect immediately after the Olympic Games (2012 Q3 and 2013 Q4), although it decreased in 2014. In the next section we examine the trickle-down effect over this period of time.

Insert Figure 2

4.3 The distribution of the trickle-down effect

For each quarter between 2012 Q1 and 2014 Q3, Table 3 shows the difference between the actual 3×30 sports participation rate (seasonally adjusted) and the predicted 3×30 sports participation rate based on pre-Olympic trend. The corresponding values for the 1×30 and 1×m sports participation categories are also shown in Table 3. The sum of the differences across the 11 quarters is an indication of the trickle-down effect.

Insert Table 3

In the case of frequent sports participation, there was a cumulative gain between 2012 Q1 and 2014 Q3 of around 26 percentage points compared with the pre-Olympic trend. Hence, the trickle-down effect for the 3×30 definition equates to a 2.4% increase per quarter (25.883/11 quarters). Expressed in terms of the total adult population in England, this equates to an increase of 1.03 million participants in an average quarter. As the definition of participation becomes less frequent, the size of the total trickle-down effect becomes less pronounced (10.53% for 1×30 and 1.40% for 1×m). The findings indicate that the primary effect was one of moving existing sports participants to higher levels of activity rather than broadening the base of participants, which resonates with previous research (Taks et al., 2014; Weed et al., 2015; Wicker & Sotiriadou, 2013). The effect appears to be much stronger in 2013 (i.e. the year following the Games) than in 2012 (i.e. the year of the Games) across all definitions considered. There is also some evidence of

a negative effect for 1×m participation in 2012 and the three quarters in 2014. These results must be interpreted with the caveat that they express associations between participation and the Olympic Games; they do not, in this form, postulate a causality claim. The dataset used does not allow expanding the analysis in order to address causality in a formal sense.

4.4 Comparison of the socio-demographic profile of sport participants (3×30)

Having established that the greatest sports participation effect is achieved in the most frequent 3×30 category, we proceed to compare the socio-demographic characteristics of the participants in the year of the Olympic Games (2012) and four years earlier (2008), using the 3×30 sports participation definition via the execution of comparable logistic regressions. The results can be seen in Table 4. We consider significant effects at the 10% and 5% levels of significance. By using the odds ratios, as explained in section 3.2, we draw conclusions about the change of importance in some of the considered demographic variables as we 'move' from 2008 to 2012. Note that, as before, we explore issues of association, not causality-which cannot be analysed in the present research framework. The shaded lines do not satisfy this condition of significance, and hence do not provide reliable evidence.

For some sets of covariates the odds ratios increased over the 2008-20012 time period. These include: age intervals 16-24 and 55-74; higher, lower managerial and intermediate SECs (these are the three top SEC categories); ethnic minorities (Asian, black and mixed); and owning a house outright.

In terms of age there was an improvement of the influence of the age categories 16-24 and 55-74 on the general sports participation (3×30). In terms of income and employment classification an improved position has been expressed by moderately to well off individuals as expressed by the Higher, Lower Managerial and Intermediate

SECs, and owing outright a house. Finally many ethnic minorities, despite having an odds ratio of less than one, have improved their weight and as a result have benefited from the Olympic Games' influence on sports participation. To demonstrate the relevance of the logistic analysis compared to the time series trend Figure 3 compares the pattern of 3×30 participation of the adult population against the youngest 16-24 element. As suggested by the logistic analysis the latter has a more profound shift in participation during the period of analysis.

Insert Figure 3

On the other hand, there are only two categories that, compared to their bases, are worse off following the Olympics. These include: Not working/other; and having higher education. The former are likely to have suffered in the intermediate period because of loss of income and the latter because of loss of free time as they worked more in order to maintain stability in their living standards.

Insert Table 4

5. Discussion

In this paper, we have estimated a positive trickle-down effect of the London 2012 Olympic Games on sports participation among adults in England over the time period 2012-2014. We have made a distinction among different socio-demographic groups and among alternative sports participation definitions. We have obtained three significant results. Firstly, as in previous empirical evidence for other Olympic Games and major sporting events (Coalter, 2004, Taks et al., 2014, Weed et al., 2015; Wicker & Sotiriadou, 2013), the biggest trickle-down effects are observed in relation to frequent participation (at least three time per week for at least 30 minutes). Smaller gains were observed in the more inclusive participation definitions. As Potwarka (2015) has previously argued, it is

possible that the Olympic Games are more likely to make already moderately active people even more active than to motivate sedentary people to take up sport.

Secondly, whilst sports participation rates peaked immediately after the Olympic Games and have fallen back since, they still remain higher than pre-Olympic levels and the predicted trend (as evidenced by the data in Figure 2). This finding is in line with Downward et al. (2013), who concluded that there was some participation impact after the Olympic Games. Our research reveals that the main impact occurred in the year after the Olympic Games. This finding is in agreement with some previous studies on Olympic Games participation (e.g. Cashman, 2006; Pappous, 2011), suggesting that the main participation effect takes place in the year following the Olympic Games.

Thirdly, we found differences in the sports participation legacy of London 2012 on demographic groups that have been scarcely analysed (Potwarka & Leatherdale, 2016). The improvement in the odds ratios in the youngest category 16-24 confirms the findings of the Department for Culture, Media & Sport (2013a) and Jinxia and Mangan, (2008) about young people's increasing sports participation around the Olympic Games and the differences between young and senior sport participants shown by Frawley and Cush (2011). Further, we found positive effects in the top occupations (according to SEC codes), ethnic minorities, people aged 55-74, and owning a house outright.

Until London 2012, the empirical evidence was unclear about the sports participation legacy of the Olympic Games. This situation could be attributed to the fact that no sustained participation programs were developed in the Sydney, Beijing, or Athens Olympic Games to generate a sports participation legacy (Weed et al., 2009; Craig & Bauman, 2014). As Weed et al. (2009) recognise: “no previous Games has employed strategies towards raising physical activity or sports participation. As such, the use of an

Olympic Games to raise physical activity and sport participation has not been attempted in any real sense" (p. 8).

In this respect, our findings support the notion that the trickle-down effect is a reality, but at the same time, this effect may be conditioned by actions taken by national governing bodies to promote healthy life-styles, to increase sport facilities, and access to sport venues. In London, in the context of the Olympic Games, there has been an attitude change by organisers, and for the first time programmes and policies were developed to boost sports participation legacy (Department for Culture, Media & Sport, 2013a, 2013b). As a consequence, a positive impact was shown, although it was more significant in terms of increasing frequency of participation than attracting new participants.

Hosting Olympic Games might be a tool for boosting sports participation rates, thereby leading to positive effects on health outcomes at population level. This is particularly relevant among older adults (aged 55 years and over), who seem to be positively affected by the Olympic Games. Any increase in the participation rates of this demographic might have a positive impact on health, as evidenced by other researchers (Lera-Lopez et al., 2017). In addition, hosting the Olympic Games has a positive association with sports participation of some ethnic minority groups. Considering that ethnicity has traditionally been a barrier to sports participation (Kokolakakis, Lera-Lopez, & Castellanos, 2014), hosting the Games was associated with a reduction in the gap between white population and ethnic minorities in England.

It is important to recognise the limitations of our research, some of which give rise to areas of future research. As noted by Coalter (2007), it is difficult to draw definitive conclusions regarding the impact of the Olympic Games on sports participation because a simple cause and effect cannot be established. Other external variables might influence this relationship. At the same time, it has not been possible to make a distinction between

the direct effects of hosting the Games and the impact of the different programs designed to boost sports participation. Consequently, the leveraging impact cannot be estimated and this could be a natural direction for further research. Furthermore, this study has been restricted to the two years following the Olympic Games. Although a short-term impact has been established, further analysis should be developed to check the longer-term impact of hosting the Olympic Games. Additionally, a detailed trickle down analysis should be performed for specific sports and regions of England, establishing a better understanding of the dynamics of change in sports participation around the Olympic Games and the potential effect of specific leverage impacts for some sports and different regions. In particular it would be interesting to compare the effect of the hosting city on the remaining regions. Finally, the development of a primary data set at individual level about changes in motivations and attitudes towards participation after the Olympic Games might help to confirm the validity of the different theoretical approaches under consideration.

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Table 1. Overview of independent variables

Variables and description	% in APS7
Age *(base: age 45-54)*	
Age: 16-24	14.5
Age 25-34	16.5
Age 35-44	14.9
Age 55-64	13.1
Age 65-74	11.4
Age 75+	9.6
Gender (*base: males*) *Females*	51.2
Socio-Economic Classification: This is a standardised socio economic index reflecting the place of an individual at work (*base: self-employed, small employers, not classified)*	
Higher	9.6
Lower Managerial	22.6
Intermediate	12.7
Lower supervisory	7.6
Semi routine	15.6
Routine	9.4
Never worked	1.6
Working status (*base: unemployed*)	
Working full time	41.7
Working part time	16.8
Retired	21.8
Student	4.1
Not working /other	5.9
Ethnicity (*base: white British*)	
White (British -other)	84.8
Asian	6.5
Black	3.6
Mixed	1.6
Education (*base 'good' GCSE*)	
Higher, degree	16.1
Higher, below degree	4.3
A Lever or trade qualification: Secondary pre-University education	9.7
Low GCSE grade: Secondary education	9.5
Other	1.5
Health	
Illness limiting movement	17
Children in household (*base: none*)	
One	14
Two	12.1
Three	3.5
Four +	1.3
Housing (*base: house rented privately)*	
House owned outright	32.5
Mortgage: House purchase financed through loan	37.7
Social rent: Owned by Local Authorities	7.8

Table 2. Results of ARIMA (0 1 0)(0 1 1) modelling, 1997.1 to 2013.2

Variables	Parameter estimates	Standard error	t-value
Constant	-0.0005	0.00056	-0.80
LS2008.2	-0.0200	0.00517	-3.86
AO2008.4	0.0191	0.00483	3.96
LS2008.4	-0.0489	0.00683	-7.16
LS2009.2	-0.0273	0.00517	-5.29

Critical |t| for Additive Outliers (AO) outliers: 3.71; critical |t| for Level Shift (LS): 3.71

Table 3. Difference between actual participation (seasonally adjusted) and predicted participation based on pre-Olympic trend

Quarter	3×30	1×30	1×m
2012 Q1	0.80	-0.32	-0.79
2012 Q2	0.85	-0.42	-2.24
2012 Q3	0.40	-0.77	-2.25
2012 Q4	3.21	1.73	1.97
2013 Q1	3.24	2.00	1.76
2013 Q2	3.51	2.37	2.03
2013 Q3	3.63	2.18	1.91
2013 Q4	3.78	2.48	2.53
2014 Q1	3.72	2.56	2.68
2014 Q2	1.39	-0.52	-3.04
2014 Q3	1.35	-0.76	-3.19
Total 2012 (Q1-Q4)	**5.26**	**0.22**	**-3.31**
Total 2013 (Q1-Q4)	**14.16**	**9.03**	**8.24**
Total 2014 (Q1-Q3)	**6.46**	**1.28**	**-3.55**
Total 2012Q1 - 2014Q3	**25.88**	**10.53**	**1.40**

Table 4. Logistic models of 3×30 sports participation in England for 2008 (APS3) and 2012 (APS7).

	Model I, APS 3			Model II, APS 7		
	S. E.	p	odds	S. E.	p	odds
Age variables (base: 45-54)						
Age: 16-24	0.02	0.00	2.0	0.02	0.00	2.1
Age 25-34	0.02	0.00	1.4	0.02	0.00	1.4
Age 35-44	0.02	0.00	1.2	0.02	0.00	1.2
Age 55-64	0.02	0.00	0.6	0.02	0.00	0.7
Age 65-74	0.04	0.00	0.4	0.03	0.00	0.5
Age 75+	0.04	0.00	0.2	0.04	0.00	0.2
Gender (base: males)						
Females	0.01	0.00	0.7	0.01	0.00	0.7
SEC (base: self-employed, small employers, not classified)						
Higher	0.02	0.00	1.1	0.02	0.00	1.3
Lower Managerial	0.02	0.00	1.1	0.02	0.00	1.2
Intermediate	0.03	0.00	0.9	0.02	0.05	1.0
Lower supervisory	0.03	0.00	0.9	0.03	0.02	0.9
Semi routine	0.02	0.00	0.8	0.02	0.00	0.8
Routine	0.03	0.00	0.7	0.03	0.00	0.7
Never worked	0.04	0.00	0.7	0.06	0.00	0.7
Working status (base: unemployed)						
Working full time	0.03	0.00	0.9	0.03	0.20	1.0
Working part time	0.03	0.49	1.0	0.03	0.00	1.1
Retired	0.04	0.06	1.1	0.04	0.00	1.1
Student	0.03	0.00	0.9	0.04	0.30	1.0
Not working /other	0.04	0.00	0.9	0.04	0.00	0.7
Ethnicity (base: white British)						
White-other	0.03	0.85	1.0	0.03	0.01	0.9
Asian	0.03	0.00	0.5	0.03	0.00	0.6
Black	0.04	0.00	0.6	0.03	0.00	0.7
Mixed	0.05	0.10	1.1	0.05	0.00	1.2
Education (base 'good' GCSE)						
Higher	0.02	0.00	1.3	0.02	0.00	1.1
Higher below degree	0.02	0.00	1.2	0.03	0.43	1.0
A Lever or trade	0.02	0.00	1.1	0.02	0.01	1.1
Low GCSE grades	0.02	0.00	0.8	0.03	0.00	0.8
Other	0.84	0.22	2.8	0.06	0.00	0.7
Health						
Illness limiting movement	0.02	0.00	0.5	0.02	0.00	0.5
Children in household (base: none)						
One	0.02	0.00	0.9	0.02	0.00	0.9
Two	0.02	0.00	0.9	0.02	0.00	0.9
Three	0.03	0.00	0.9	0.03	0.98	1.0
Four +	0.06	0.00	0.8	0.05	0.11	0.9
Housing (base: house rented privately)						
House owned outright	0.02	0.00	1.3	0.02	0.00	1.4
Mortgage	0.02	0.00	1.2	0.02	0.00	1.2
Social rent	0.03	0.00	0.8	0.03	0.00	0.8

-2Log Likelihood statistic: 169910 (APS7), 184929 (APS3).

Figure 1. Actual 3×30 participation rates

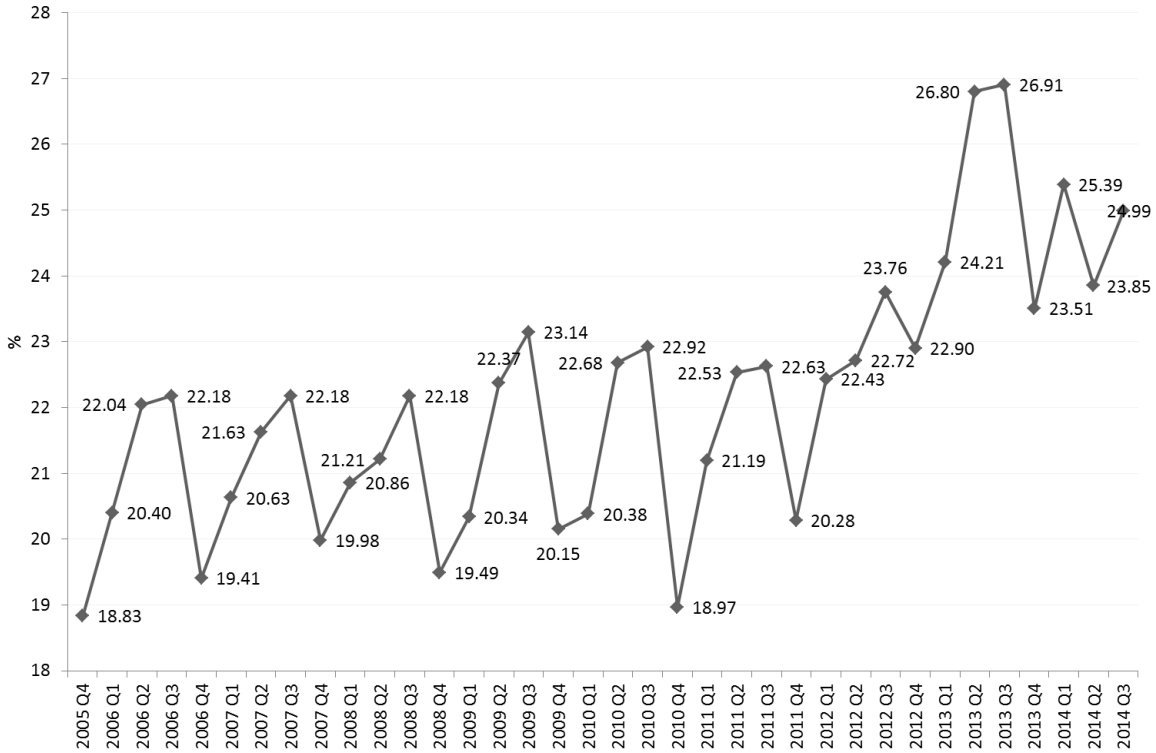

Figure 2. Actual 3×30 participation rates versus pre-Olympic trend (seasonally adjusted)

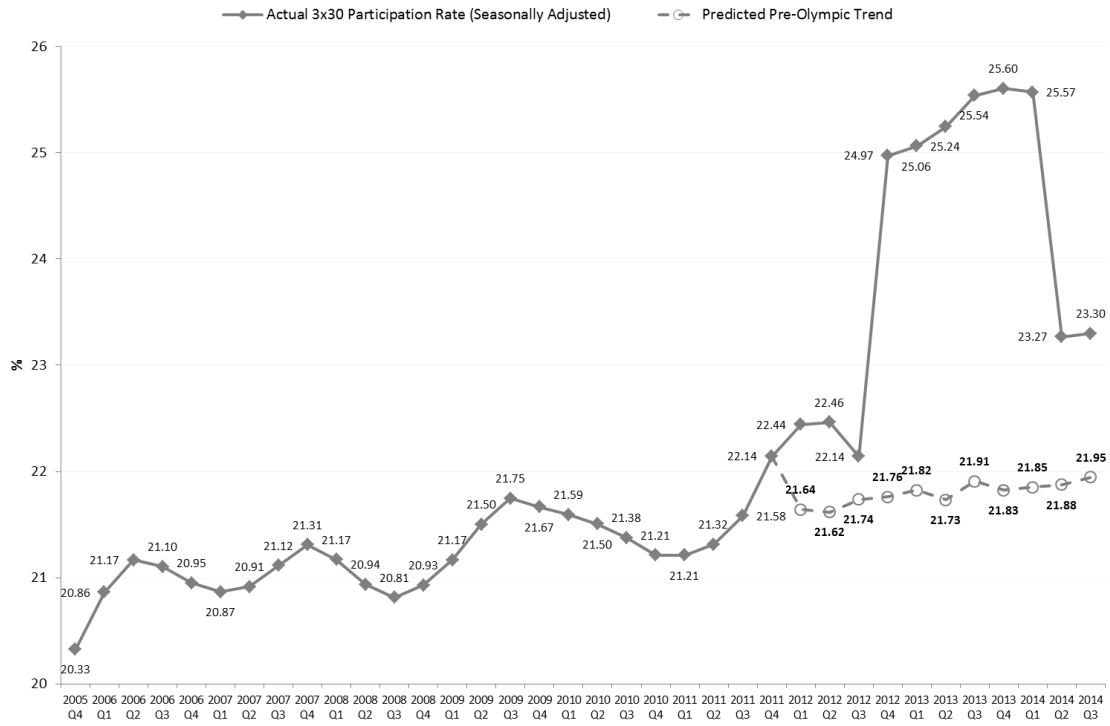

Figure 3. 3×30 participation rates for all adults and 16-24 year olds (seasonally adjusted)