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Complete List of Authors:	Mahtani, Kamal; University of Oxford, Department of Primary Health Care Sciences Protheroe, Joanne; Institute of Primary Care and Health Sciences, Keele University, UK, Arthritis Research UK Primary Care Centre Slight, Sarah; The University of Nottingham, Nottingham, UK, Division of Primary Care; Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA, Division of General Internal Medicine Demarzo, Marcelo; Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil, General Practice Unit Blakeman, Thomas; University of Manchester, School of Community Based Medicine Barton, Christopher; Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia, Social Health Sciences Brijnath, Bianca; Monash University, Melbourne, Australia, Department of General Practice Roberts, Nia; University of Oxford, UK, Knowledge Centre, Bodleian Health Care Libraries,
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Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Kamal R. Mahtani[1,3] *NIHR Clinical Lecturer in General Practice*

Joanne Protheroe[1,4] *Senior Lecturer in General Practice*

Sarah Patricia Slight[1,5,6] *NIHR Postdoctoral Research Fellow*

Marcelo Marcos Piva Demarzo[1,7] *Assistant Professor in General Practice*

Thomas Blakeman[1,8] *NIHR Clinical Lecturer in General Practice*

Christopher A. Barton[1,9] *Lecturer in Quantitative Research Methods*

Bianca Brijnath[1,10] *NHMRC Early Career Public Health Fellow*

Nia Roberts[2] *Outreach librarian*

Corresponding author: kamal.mahtani@phc.ox.ac.uk

[1] Members of the Brisbane Initiative (Cohort 7), International Leadership Programme in Primary Care, Oxford, UK

[2] Knowledge Centre, Bodleian Health Care Libraries, University of Oxford, UK

Further affiliations

[3] Department of Primary Health Care Sciences, University of Oxford, UK
[4] Institute of Primary Care and Health Sciences, Arthritis Research UK Primary Care Centre, Keele University, UK
[5] Division of Primary Care, The University of Nottingham, Nottingham, UK
[6] Division of General Internal Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA
[7] General Practice Unit, Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil
[8] Primary Care Research, Health Sciences Research Group, School of Community Based Medicine, University of Manchester, UK
[9] Social Health Sciences, Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia
[10] Department of General Practice, Monash University, Melbourne, Australia

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Article summary

Article focus

- Increased levels of physical activity are linked with improved health and may play a key role in the prevention or treatment of most non-communicable diseases (NCD).
- The London 2012 Olympic and Paralympic Games aims to leave a long term legacy, which includes population level increases in physical and sporting activity.
- We conducted a systematic review of systematic reviews to establish whether hosting an Olympic games leads to increased participation in such activities.

Key messages

- There is little evidence that international elite sporting events such as the Olympics leads to increased participation in physical or sporting activities at the population health level. We found no evidence, in particular, relating to the Paralympic games.
- High quality, evidence based studies are needed to measure the true impact of the London 2012 games.

Strengths and limitations of this study

- Strengths: This is a systematic review of existing systematic reviews.
- Limitations: We restricted our search to those studies published in English on previous Olympic and Paralympic Games.

Objective:

Is there an increased participation in physical or sporting activities following an Olympic or Paralympic games?

Design:

Overview of systematic reviews

Methods:

We searched the Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. In addition, we searched for "grey literature" in Google, Google scholar and on the International Olympic Committee websites. We restricted our search to those studies published in English. We used the AMSTAR tool to assess the methodological quality of those systematic reviews included.

Primary and secondary outcome measures:

The primary outcome was evidence for an increased participation in physical or sporting activities. Secondary outcomes included public perceptions of sport during and after an Olympic Games, barriers to increased sports participation, and any other non-sporting health benefits.

Results:

Our systematic search revealed 844 citations, of which only two matched our inclusion criteria. The quality of these two studies was assessed by three independent reviewers as 'good' using the AMSTAR tool for quality appraisal. Both reviews reported little evidence of an increased uptake of sporting activity following an Olympic Games event. Other effects on health, for example changes in hospital admissions, suicide rates and drug use, were cited although there was insufficient evidence to see an overall effect.

Conclusions:

There is a paucity of evidence to support the notion that hosting an Olympic games leads to an increased participation in physical or sporting activities for host countries. We also found little evidence to suggest other health benefits. We conclude that the true success of these and future games should be evaluated by high quality, evidence based studies that have been commissioned before, during and following the completion of the event. Only then can the true success and legacy of the games be established.

Introduction

The cost of hosting the 2012 Games of the XXX Olympiad in London has been estimated to be over £8 billion (UK) pounds.[1] Part of the justification for spending this amount and bidding to host the games, comes from the belief that the event will leave a legacy in the United Kingdom. The theme of the games, "Inspire a generation", reflected this desire to promote participation in sport in the run-up to, during and after the event.[2]

In 2010, the Department for Culture, Media and Sport outlined the UK Government's plans for this legacy, and included "harnessing the United Kingdom's passion for sport to increase grass roots participation, particularly by young people – and to encourage the whole population to be more physically active".[3] However, since the games were awarded to London in 2005, there has been an overall decline among 16-25 year olds in sport participation.[4] These findings are a cause for concern especially as a recent analysis of the burden of disease and life expectancy showed that physical inactivity has a major negative health effect worldwide linked to coronary heart disease, diabetes and cancer. It is also estimated that around 1.3 million deaths could be averted every year if physical inactivity decreased by 25%.[5]

A previous systematic review of literature published between 1978 and 2008 found insufficient evidence to support or refute any health or socioeconomic impacts from major multi-sport events.[6] We saw value in conducting an "overview of systematic reviews", thus allowing the findings of separate reviews to be compared and contrasted.[7] Secondly, we restricted our search to the impact of the Olympic and Paralympic games only, with our primary outcome of interest an increased participation in sport or recreational activities subsequent to hosting these games. Our aim was to highlight new areas that could possibly guide policy makers on decision making and planning of future games.

Methods

Search strategy

We searched Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. For each database, we applied two search filters for identifying systematic reviews.[8] We also performed searches on Google, Google Scholar and the International Olympic Committee websites. We restricted the inclusion of papers to those published in English. (Full details of the search strategy used are given in Appendix 1).

Criteria for study selection

Given the broad nature of non-systematic reviews, commentaries, and general opinion based articles, we restricted our search to only systematic reviews. We included studies which systematically appraised published literature within the remit of the review. No restriction was placed on age, gender or race. We included studies from all countries, and accepted studies that presented their results quantitatively or as a narrative. We excluded reviews that *only* focused on other multi-sporting events (such as Winter Olympics, Commonwealth Games) as well as single sporting events (such as World cups, World Championships).

Outcomes

The primary outcome for this overview was an increased involvement in physical or sporting activity following an Olympic Games. We define "increased uptake" as any means to demonstrate increased participation, and held no restriction on whether this was demonstrated qualitatively or quantitatively. We applied the term 'sporting activity' to include any of the 36 Olympic sports (Archery, Athletics (including walking), Badminton, Basketball, Beach Volleyball, Boxing, Canoe Slalom, Canoe Sprint, Cycling – BMX, Cycling - Mountain Bike, Cycling – Road, Cycling – Track, Diving, Equestrian, Fencing, Football, Gymnastics – Artistic, Gymnastics – Rhythmic, Handball, Hockey, Judo, Modern Pentathlon, Rowing, Sailing, Shooting, Swimming, Synchronised Swimming, Table Tennis, Taekwondo, Tennis, Trampoline, Triathlon, Volleyball, Water Polo, Weightlifting and Wrestling) and 21 Paralympic sports (Archery, Athletics, Boccia, Cycling Road, Cycling Track, Football 5-a-side, Football 7-a-side, Goalball, Equestrian, Judo, Powerlifting, Rowing, Sailing, Shooting, Swimming, Table Tennis, Sitting Volleyball, Wheelchair Basketball, Wheelchair Fencing, Wheelchair Rugby and Wheelchair Tennis). We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[9]

Secondary outcomes included:

- Increases in other forms of physical activity;
- Public perceptions of sport during and after an Olympic games;
- Barriers to increased sports participation;
- Non-sporting (physical or mental) health benefits.

Critical appraisal

We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.[10]

Review synthesis

Two authors (NR, KRM) devised the search strategy. Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Quality assessment of included studies was carried out by two authors (CB, BB), verified by a third (KRM), and assessed using the AMSTAR tool for the methodological quality of systematic reviews. Three authors independently extracted data from these reviews (KRM, TB, MD), using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

Results

Results of search strategy

Figure 1 summarises the results of our search strategy. We initially identified 844 references after removal of duplicates. Of these, 798 references were excluded based on titles alone by three reviewers (KRM, JP, SPS) for a lack of relevance. Of the remaining 46 papers, a further 42 were dismissed after review of the abstracts. The majority of excluded studies were non-systematic reviews, commentaries and books. Where possible, relevant chapters of books were reviewed and included if they met our criteria. Four studies were reviewed in detail. Of these, two were subsequently excluded. Although one of these excluded studies searched key databases, specialist bibliographic databases, and different types of evidence including grey literature, as well as contacted relevant individuals and organisations, we were unclear if its review process was carried out systematically.[11] We contacted the authors of this paper who confirmed that their study was *not* a systematic review and as a result it was excluded from our review.[12] The other excluded study[13] was an abbreviated version of one of our included studies.[14] Personal communication with the lead author of both papers confirmed that the abbreviated version contained no additional information.[15] As a result we excluded it from our review. It was finally agreed that only two studies were eligible for quality assessment and data extraction. The first of these was a systematic review of the evidence base for developing a physical activity and health legacy from the London 2012 Olympic and Paralympic games, commissioned by the UK Department of Health.[14] The second included study was a systematic review evaluating the health and socioeconomic impacts of major multi-sporting events between 1978 and 2008.[16] Table 1 summarises the main characteristics from the included studies.

Quality assessment of included reviews

We only selected reviews where the objective of the study was clearly stated and fitted within the remit of this review. We used the AMSTAR methodological quality assessment tool to appraise our included studies.[10] Overall, we found the quality of the included studies to be good. Table 2 summarises the results of our quality appraisal using the AMSTAR tool.

Increased uptake of sporting activity following an Olympic games

Both included studies reported that the evidence to support an uptake of sport or physical activities after an Olympic games was generally weak and inconclusive. McCartney et al. reported no overall change in the recreational impact of hosting an Olympic Games.[16] They cited some evidence, however, of an upward trend in sports participation from the early 1980s until 1994, and in association with the 1992 Barcelona games in Spain. They graded the cited evidence as being of the

lowest level according to their quality appraisal. Weed et. al. also referred to evidence for increased participation following the 1992 Barcelona games.[14] The authors noted that the results were drawn from data taken 7 years prior and 3 years after the 1992 games, and highlighted a possible limitation in comparing data taken at different times and by different designs. The authors also concluded that the evidence was mixed for a "trickle down" effect on participation; it was possible that some short term benefits may have been seen but little evidence of a long term effect.

Public perceptions to sporting activity after an Olympic games

McCartney et al. did not cite any specific evidence of changes in the public's perception of sporting or physical activity following an Olympic games.[16] In contrast, Weed et al. made reference to a positive perception following elite sporting success.[14] However, they also cited evidence for a negative effect with the potential of elite sports deterring individual participation because of a perceived competence gap. The review also cited evidence for a lack of increased physical activity following the 2000 Sydney Olympics in Australia, despite the 'euphoria' that was documented as following the Games. Weed et al. also made reference to evidence from Sport England (UK) that found "more than a quarter of the population in England (26%) have been inspired by British medal-winning performances at the Olympic Games in Athens (2004)". However, they suggested that this was likely to be due to increased participation from people already partaking in sporting activity. They did however acknowledge the importance of an Olympic games in generating a "festival effect" with evidence that such a perception has the potential to increase the desire to participate in all aspects of the Games, including the increased uptake of physical activity.

Barriers to partaking in increased sporting activity

Weed et al. cite evidence that a negative perception to the Games could act as a barrier or negate completely the potential to use such an event for the development of physical activity or sport, or the promotion of health.[14] The authors also infer from their results, that the absence of planning supplemental activities to leverage and follow the main event, may also act as a barrier to further participation. Community and social empowerment were themes that were reported as being important facilitators in increasing sporting activity.

Other health benefits

The McCartney et al. study examined a number of other outcomes relating to health, wellbeing, quality of life, health service use, as well as recreation.[16] They found the quality of evidence to be mixed with no overall conclusion for a clear benefit. A moderate grade of evidence was ascribed to data relating to suicide rates which were found to be unchanged after the 1988 Seoul Olympics in South Korea. In contrast, lower levels of evidence were awarded to data showing an increase in

paediatric health service demand, and a decrease in childhood asthma acute care events following the 1996 Olympics in Atlanta, USA. A low level of evidence was given to data relating to an increase in hospital presentations related to illicit drugs following the 2000 Olympics in Sydney, Australia. Weed et al. also report no overall clear benefit on health after an Olympic Games event.[14] They cite smoking cessation data, following a campaign to reduce smoking around the Barcelona Olympics that were inconclusive in showing a positive link. They also referred to data from China in the build-up to the 2008 Beijing Olympics suggesting that general health and extended life expectancy improved using data gained from a 'national physique examination'. However, Weed et al. point out that such results should be interpreted with caution as it may not be possible to extrapolate them to other environments. A broader but similar point is discussed in the McCartney et al. review who point out that "both the commissioning of studies and their publication could well be biased towards positive results".

Discussion

Few systematic reviews have been published on the physical and sporting impact(s) that Olympic Games can have on the public. To the best of our knowledge, this is the first systematic review of systematic reviews to assess whether an Olympic event leads to an increased uptake in physical or sporting activities, in addition to other health benefits.

Overall we found little evidence to support a clear positive impact either on the uptake of activities or on other health benefits linked to hosting an Olympic games. Our review suggests that a number of factors are likely to have contributed to this. Firstly, it cannot be expected that such events will automatically increase activity simply by the event taking place. If this was the case we would have expected significantly more data from our searches following previous games. Instead, we found that a number of factors were likely to be needed, such as a "positive" perception in advance of the games, the idea that participation in physical activity need not be limited to elite sportsmen, and that there will be sufficient infrastructure to access and partake in activities within the community and schools setting after the games. As pointed out by Weed et al., the generation of a "festival" feel is likely to generate short-term positive perceptions and increased participation in a number of areas including sporting activity.[14] We also noted that both included studies eluded that collecting data on increased physical activity after such an event may be challenging, poor or absent. As a result we recommend that evidence based strategies to record this data, locally and regionally, should already be in place following the 2012 London Games. We further recommend that such methods are executed in advance and following the 2016 Olympic Games in Rio, Brazil.

We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17]

Limitations of our review

We were aware of several limitations to our review. We chose to only include data relating to the summer Olympic and Paralympic games, thus excluding the Winter Olympics as we felt that the summer games would have a greater potential of encouraging events that could be transferable and available for mass participation worldwide. We also avoided including data from other multi-sporting events, such as the Commonwealth games, on the basis that no other single, multi-sporting,

event had the same breadth of included sports or public interest as the Olympics. However, we noted that data did exist, particularly following the 2002 Manchester Commonwealth games, but evidence of a definite link to increased activity was inconclusive. It was, therefore, unlikely to have changed the conclusions of our review.

We also limited our searching of "grey literature" to Google, Google scholar and the International Olympic Committee websites, as we felt that there would be a significant number of non-systematic reviews and commentaries on other sites that would not meet our inclusion criteria.

Overall conclusion

The evidence to support the notion that hosting an Olympic games leads to an automatic increase in mass sporting or physical activity is poor. Our review has found several areas of potential that could be capitalised on to test this hypothesis. Having existing routes into increased participation is likely to prove beneficial. An emphasis of involvement as well as targeting certain populations such as children and those contemplating activity, rather than just those already involved in it. The framing of an Olympic games in a broader sense, such as through a positive public perception and within a "festival" feeling, is also likely to reap benefits. The United Kingdom will host the 2014 Glasgow Commonwealth games and has a unique opportunity to build on the public interest generated from the London 2012 games. We also suggest that in the interim, smaller events relating to increase sporting or physical activity, be put into place to keep the momentum generated from London 2012 going. Such events could then be capitalised on in the lead up to the 2016 Olympics in Brazil. The effects should be recorded using high quality, evidence based methods. Through such means the true success and legacy of the London 2012 games will be determined.

Figure 1

PRISMA flow diagram

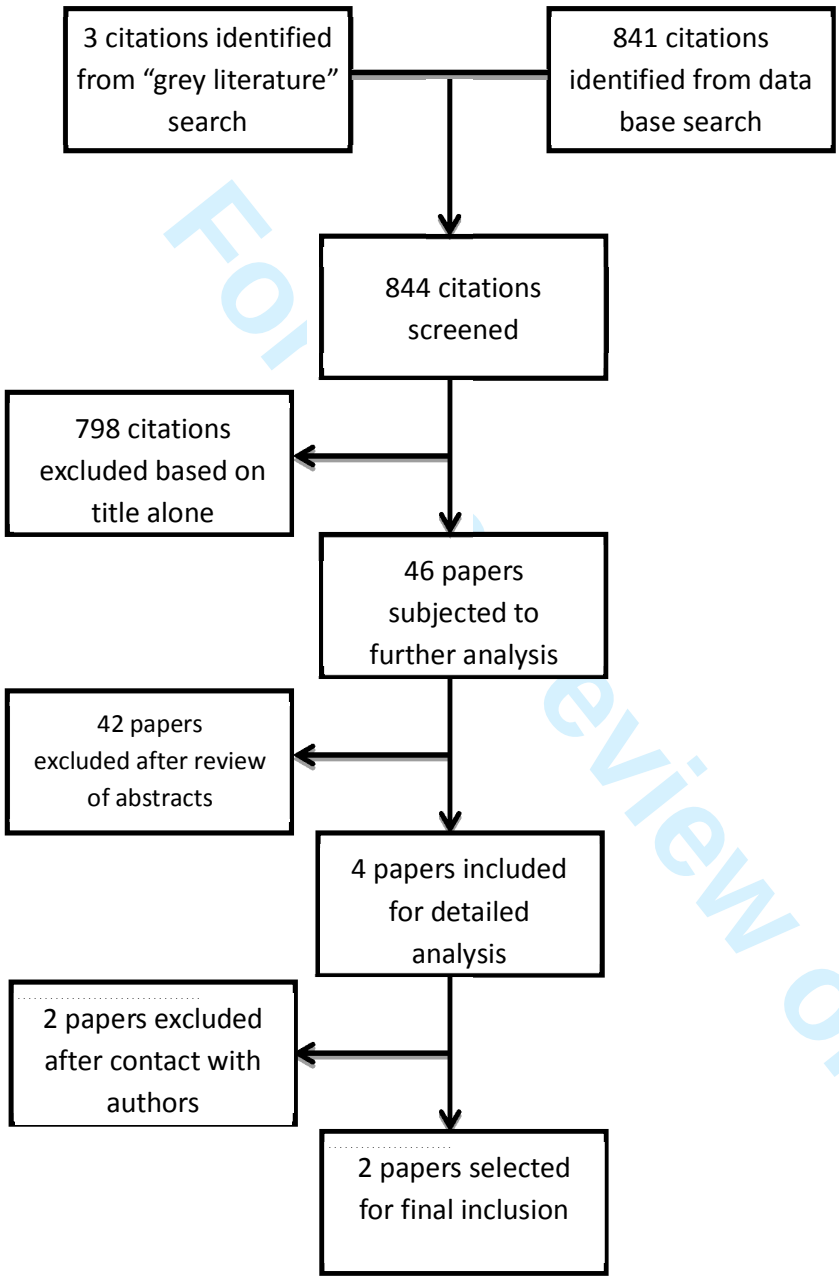

Table 1

Characteristics of included studies

Review	Weed et al[14]	McCartney et al[16]
Year	2009	2010
Question posed by review	Four questions were established for the review: i) What evidence exists that the Olympic Games, sports events or sports franchises can impact upon physical activity and sport participation and upon health-related behaviours? ii) By what processes have physical activity and sport participation and health-related behaviours been leveraged from the Olympic Games, sports events or sports franchises? iii) What processes that have been used to leverage, inter alia, volunteering, community engagement and tourism from the Olympic Games, sports events and sports franchises might inform leveraging strategies for physical activity, sport and health? iv) How has the leveraging of a range of opportunities from Olympic Games, sports events and sports franchises been evaluated?	To assess the effects of major multi-sport events on health and socioeconomic determinants of health in the population of the city hosting the event.
Search strategy	Published literature via SPORTS DISCUS ,CINAHL, PsychINFO, MEDLINE, • Web of Knowledge (General Science and Social Science Database) In addition several sources for "grey literature" were searched (see full paper for more details)	Papers published between 1978 and 2008. From Applied Social Science Index and Abstracts (ASSIA), British Humanities Index (BHI), Cochrane database of systematic reviews, Econlit database, Embase, Education Resources Information Center (ERIC)database, Health Management Information Consortium (HMIC) database, International Bibliography of the Social Sciences (IBSS), Medline ,PreMedline, PsycINFO, Sociological Abstracts, Sportdiscus , Web of

		Knowledge, Worldwide Political Science Abstracts In addition an 'extensive' search of the grey literature (between April & October 2008) was carried out (see individual review for full details).
No of included studies	24	54
Quality appraisal tool used to assess included studies	A rudimentary quality appraisal sheet was agreed by all authors and review panel as being relevant to the research question.[15]	Assessed using a modified version of the Hamilton quality assessment tool.
Overall comment on quality of included studies	Variable. With reference to our primary outcome, was assessed to be generally poor.	Study quality was 'poor'

Table 2

Quality assessment of included studies using the AMSTAR tool

1.	Question	Weed et al[14]	McCartney et al[6]
2.	Was an 'a priori' design provided?	Y	Y
3.	Was there duplicate study selection and data extraction?	Y	Y
4.	Was a comprehensive literature search performed?	Y	Y
5.	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Y	Y
6.	Was a list of studies (included and excluded) provided?	N-only included studies	N-only included studies
7.	Were the characteristics of the included studies provided?	Y	Y
8.	Was the scientific quality of the included studies assessed and documented?	Y	Y
9.	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Y	Y
10.	Were the methods used to combine the findings of studies appropriate?	Y	Y
11.	Was the likelihood of publication bias assessed	Y	N/A - authors state this not possible
12.	Was the conflict of interest stated?	U (although commissioned by Department of Health	Y
	Total	9	9

Key: Y=Yes, N=No, U=Unclear, N/A= Not Applicable

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Footnotes

Contributors

KRM, JP, SPS, MD, TB, CB, and BB are all members of Cohort 7 of The International Primary Care Research Leadership programme, part of The Brisbane Initiative to develop future leaders in primary care research. KRM had the initial idea for the review and drafted the first protocol. All authors commented and advised on this draft. KRM and NR devised the search strategy which was conducted by NR. KRM, JP and SPS screened the results of the searches and agreed on the final list of included studies. CB and BB assed the included studies for quality. TB and MD carried out the data extraction. KRM wrote the first draft of the final papers with contributions and edits from all remaining authors. All authors contributed to the final draft.

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Competing interests

None declared.

Appendix 1

Search strategies:

Medline (OvidSP) [1946 - , In process] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2255
2	(sport* adj (event* or mega-event*)).ti,ab.	505
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	15
4	((international or multination* or multi-nation*) adj games).ti,ab.	10
5	1 or 2 or 3 or 4	2730
6	(Medline or systematic review).tw. or meta-analysis.pt.	87371
7	5 and 6	20
8	meta-analysis.mp,pt. or review.pt. or search:.tw.	1884987
9	5 and 8	358

Embase (OvidSP) [1974 -] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2799
2	(sport* adj (event* or mega-event*)).ti,ab.	649
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	23
4	((international or multination* or multi-nation*) adj games).ti,ab.	17
5	1 or 2 or 3 or 4	3417
6	(meta-analysis or systematic review or MEDLINE).tw.	111218
7	5 and 6	19
8	meta-analy*:.mp. or search*.tw. or review.pt.	2102017
9	5 and 8	458

Cochrane Database of Systematic Reviews & Database of Abstracts of Reviews of Effectiveness (Cochrane Library, Wiley) – 8th August 2012

#1	(olympic* or paralympic* or special olympic*):ti,ab,kw	71
#2	(sport* near (event* or mega-event*)):ti,ab,kw	25
#3	(international or multination* or multi-nation*) near event* and sport*:ti,ab,kw	1
#4	((international or multination* or multi-nation*) near games):ti,ab,kw	1

SportDISCUS (EBSCOHost) [1980 -] – 9th August 2012

S9	S5 and S8	(485)
S8	TI (meta-analy* or review) OR AB (meta-analy* or search*)	(27026)
S7	S5 and S6	(7)
S6	TI (meta-analysis or systematic review or MEDLINE) OR AB (meta-analysis or systematic review or MEDLINE) OR KW (meta-analysis or systematic review or MEDLINE)	(4396)
S5	S1 or S2 or S3 or S4	(51244)
S4	TI (((international or multination* or multi-nation*) n2 games)) OR AB (((international or multination* or multi-nation*) n2 games))	(517)
S3	TI (((international or multination* or multi-nation*) n2 event*)) OR AB (((international or multination* or multi-nation*) n2 event*))	(1201)
S2	TI ((sport* n2 (event* or mega-event*))) OR AB ((sport* n2 (event* or mega-event*)))	(6927)
S1	TI (olympic* or paralympic*) OR AB (olympic* or paralympic*)	(44061)

Science Citation Index-EXPANDED, Social Science Citation Index [Web of Knowledge] (All years)

4 68 Topic=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
3 23 #2 OR #1
2 21 Title=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
1 3 Topic=(olympic* OR paralympic*) AND Title=(meta-analys* OR "systematic review" OR "evidence review")

Limits applied:

- **Systematic review search filters taken from the following 2 articles**:

Highly specific(1) and balance between sensitivity & specificity(2).

Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team. BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.

EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.

- **Excluded papers prior to 1987**
- **Excluded animal studies**

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	n/a
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	10
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	17

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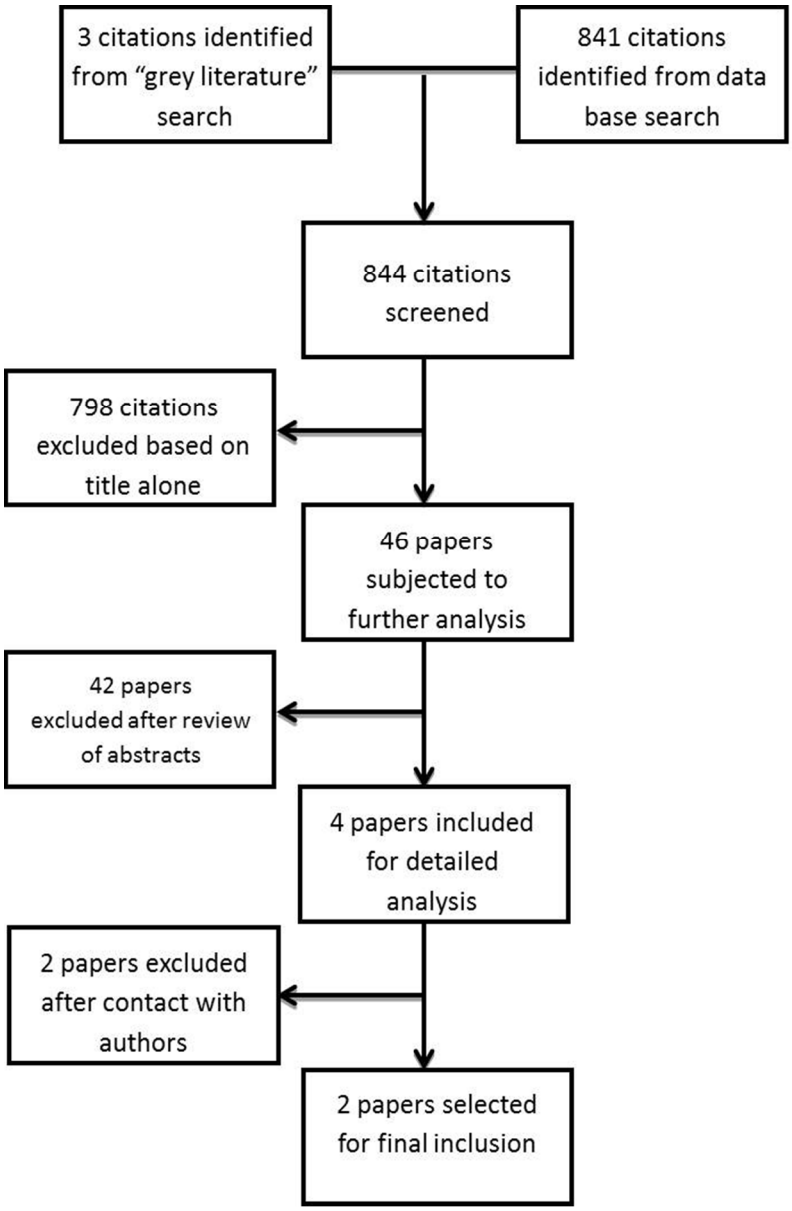

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Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

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Complete List of Authors:	Mahtani, Kamal; University of Oxford, Department of Primary Health Care Sciences Protheroe, Joanne; Institute of Primary Care and Health Sciences, Keele University, UK, Arthritis Research UK Primary Care Centre Slight, Sarah; The University of Nottingham, Nottingham, UK, Division of Primary Care; Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA, Division of General Internal Medicine Demarzo, Marcelo; Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil, General Practice Unit Blakeman, Thomas; University of Manchester, School of Community Based Medicine Barton, Christopher; Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia, Social Health Sciences Brijnath, Bianca; Monash University, Melbourne, Australia, Department of General Practice Roberts, Nia; University of Oxford, UK, Knowledge Centre, Bodleian Health Care Libraries,
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Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Kamal R. Mahtani[1,3] *NIHR Clinical Lecturer in General Practice*

Joanne Protheroe[1,4] *Senior Lecturer in General Practice*

Sarah Patricia Slight[1,5,6] *NIHR Postdoctoral Research Fellow*

Marcelo Marcos Piva Demarzo[1,7] *Assistant Professor in General Practice*

Thomas Blakeman[1,8] *NIHR Clinical Lecturer in General Practice*

Christopher A. Barton[1,9] *Lecturer in Quantitative Research Methods*

Bianca Brijnath[1,10] *NHMRC Early Career Public Health Fellow*

Nia Roberts[2] *Outreach librarian*

Corresponding author: kamal.mahtani@phc.ox.ac.uk

[1] Members of the Brisbane Initiative (Cohort 7), International Leadership Programme in Primary Care, Oxford, UK

[2] Knowledge Centre, Bodleian Health Care Libraries, University of Oxford, UK

Further affiliations

[3] Department of Primary Health Care Sciences, University of Oxford, UK
[4] Institute of Primary Care and Health Sciences, Arthritis Research UK Primary Care Centre, Keele University, UK
[5] Division of Primary Care, The University of Nottingham, Nottingham, UK
[6] Division of General Internal Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA
[7] General Practice Unit, Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil
[8] Primary Care Research, Health Sciences Research Group, School of Community Based Medicine, University of Manchester, UK
[9] Social Health Sciences, Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia
[10] Department of General Practice, Monash University, Melbourne, Australia

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Article summary

Article focus

- Increased levels of physical activity are linked with improved health and may play a key role in the prevention or treatment of most non-communicable diseases (NCD).
- The London 2012 Olympic and Paralympic Games aims to leave a long term legacy, which includes population level increases in physical and sporting activity.
- We conducted a systematic review of systematic reviews to establish whether hosting an Olympic games leads to increased participation in such activities.

Key messages

- There is little evidence that international elite sporting events such as the Olympics leads to increased participation in physical or sporting activities at the population health level. We found no evidence, in particular, relating to the Paralympic games.
- High quality, evidence based studies are needed to measure the true impact of the London 2012 games.

Strengths and limitations of this study

- Strengths: This is a systematic review of existing systematic reviews.
- Limitations: We restricted our search to those reviews published in English on previous Olympic and Paralympic Games.

Objective:

To examine if there is there an increased participation in physical or sporting activities following an Olympic or Paralympic games.

Design:

Overview of systematic reviews

Methods:

We searched the Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. In addition, we searched for "grey literature" in Google, Google scholar and on the International Olympic Committee websites. We restricted our search to those reviews published in English. We used the AMSTAR tool to assess the methodological quality of those systematic reviews included.

Primary and secondary outcome measures:

The primary outcome was evidence for an increased participation in physical or sporting activities. Secondary outcomes included public perceptions of sport during and after an Olympic Games, barriers to increased sports participation, and any other non-sporting health benefits.

Results:

Our systematic search revealed 844 citations, of which only two matched our inclusion criteria. The quality of these two reviews was assessed by three independent reviewers as 'good' using the AMSTAR tool for quality appraisal. Both reviews reported little evidence of an increased uptake of sporting activity following an Olympic Games event. Other effects on health, for example changes in hospital admissions, suicide rates and drug use, were cited although there was insufficient evidence to see an overall effect.

Conclusions:

There is a paucity of evidence to support the notion that hosting an Olympic games leads to an increased participation in physical or sporting activities for host countries. We also found little evidence to suggest other health benefits. We conclude that the true success of these and future games should be evaluated by high quality, evidence based studies that have been commissioned before, during and following the completion of the event. Only then can the true success and legacy of the games be established.

Introduction

The cost of hosting the 2012 Games of the XXX Olympiad in London has been estimated to be over £8 billion (UK) pounds.[1] Part of the justification for spending this amount and bidding to host the games, comes from the belief that the event will leave a legacy in the United Kingdom. The theme of the games, "Inspire a generation", reflected this desire to promote participation in sport in the run-up to, during and after the event.[2]

In 2010, the Department for Culture, Media and Sport outlined the UK Government's plans for this legacy, and included "harnessing the United Kingdom's passion for sport to increase grass roots participation, particularly by young people – and to encourage the whole population to be more physically active".[3] However, since the games were awarded to London in 2005, there has been an overall decline among 16-25 year olds in sport participation.[4] These findings are a cause for concern especially as a recent analysis of the burden of disease and life expectancy showed that physical inactivity has a major negative health effect worldwide linked to coronary heart disease, diabetes and cancer. It is also estimated that around 1.3 million deaths could be averted every year if physical inactivity decreased by 25%.[5]

A previous systematic review of literature published between 1978 and 2008 found insufficient evidence to support or refute any health or socioeconomic impacts from major multi-sport events.[6] We saw value in conducting an "overview of systematic reviews", thus allowing the findings of separate reviews to be compared and contrasted.[7] Secondly, we restricted our search to the impact of the Olympic and Paralympic games only, with our primary outcome of interest an increased participation in sport or recreational activities subsequent to hosting these games. Our aim was to highlight new areas that could possibly guide policy makers on decision making and planning of future games.

Methods

Data Sources and Search Strategy

Two authors (NR, KRM) devised the search strategy. One author (NR) searched Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. For each database, we applied two search filters for identifying systematic reviews.[8] We also performed searches on Google, Google Scholar and the International Olympic Committee websites. We restricted the inclusion of papers to those published in English. (Full details of the search strategy used are given in Appendix 1).

Study selection

Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Given the broad nature of non-systematic reviews, commentaries, and general opinion based articles, we restricted our search to only systematic reviews. We used the Cochrane Handbook for Systematic Reviews of Interventions for a definition of a systematic review.[9] We included reviews which systematically appraised published literature within the remit of the review. No restriction was placed on age, gender or race. We included reviews from all countries, and accepted reviews that presented their results quantitatively or as a narrative. We excluded reviews that *only* focused on other multi-sporting events (such as Winter Olympics, Commonwealth Games) as well as single sporting events (such as World cups, World Championships).

Outcomes

The primary outcome for this overview was an increased involvement in sporting activity following an Olympic Games. We define "increased uptake" as any means to demonstrate increased participation, and held no restriction on whether this was demonstrated qualitatively or quantitatively. We applied the term "sporting activity" to include any of the 36 Olympic sports (Archery, Athletics (including walking), Badminton, Basketball, Beach Volleyball, Boxing, Canoe Slalom, Canoe Sprint, Cycling – BMX, Cycling - Mountain Bike, Cycling – Road, Cycling – Track, Diving, Equestrian, Fencing, Football, Gymnastics – Artistic, Gymnastics – Rhythmic, Handball, Hockey, Judo, Modern Pentathlon, Rowing, Sailing, Shooting, Swimming, Synchronised Swimming, Table Tennis, Taekwondo, Tennis, Trampoline, Triathlon, Volleyball, Water Polo, Weightlifting and Wrestling) and 21 Paralympic sports (Archery, Athletics, Boccia, Cycling Road, Cycling Track, Football 5-a-side, Football 7-a-side, Goalball, Equestrian, Judo, Powerlifting, Rowing, Sailing, Shooting, Swimming,

Table Tennis, Sitting Volleyball, Wheelchair Basketball, Wheelchair Fencing, Wheelchair Rugby and Wheelchair Tennis).

Secondary outcomes included:

- Increases in other forms of physical activity;
- Public perceptions of sport during and after an Olympic games;
- Barriers to increased sports participation;
- Non-sporting (physical or mental) health benefits.

We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc.

Quality assessment of included reviews

Quality assessment of included reviews was carried out independently by two authors (CB, BB), verified by a third (KRM). We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.[11]

Data extraction

Three authors (KRM, TB, MD) independently extracted data from included reviews using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

Review synthesis

All extracted data was tabulated according to study ID, year of publication, AMSTAR quality score, data relating to our primary outcome, data relating to secondary outcome. The sections relating to our primary outcome were further divided into the Olympic event to which they refer, the sporting activity and the overall impact. Quantitative synthesis was not possible and as a result it was agreed that all results be reported as a narrative.

Results

Results of search strategy

Figure 1 summarises the results of our search strategy. We initially identified 844 references after removal of duplicates. Of these, 798 references were excluded based on titles alone for a lack of relevance. Of the remaining 46 papers, a further 42 were dismissed after review of the abstracts. The majority of excluded citations were non-systematic reviews, commentaries and books. Where possible, relevant chapters of books were reviewed and included if they met our criteria. Four reviews were analysed in detail. Of these, two were subsequently excluded. Although one of these excluded reviews searched key databases, specialist bibliographic databases, and different types of evidence including grey literature, as well as contacted relevant individuals and organisations, we were unclear if its review process was carried out systematically.[12] We contacted the authors of this paper who confirmed that their study was *not* a systematic review and as a result it was excluded from our review.[13] The other excluded study[14] was an abbreviated version of one of our included reviews.[15] Personal communication with the lead author of both papers confirmed that the abbreviated version contained no additional information.[16] As a result we excluded it from our review. It was finally agreed that only two reviews were eligible for quality assessment and data extraction. The first of these was a systematic review of the evidence base for developing a physical activity and health legacy from the London 2012 Olympic and Paralympic games, commissioned by the UK Department of Health.[15] The second included study was a systematic review evaluating the health and socioeconomic impacts of major multi-sporting events between 1978 and 2008.[6] Table 1 summarises the main characteristics from the included reviews.

Quality assessment of included reviews

We only selected reviews where the objective of the study was clearly stated and fitted within the remit of this review. We used the AMSTAR methodological quality assessment tool to appraise our included reviews.[11] Overall, we found the quality of the included reviews to be good. Table 2 summarises the results of our quality appraisal using the AMSTAR tool.

Increased uptake of sporting or physical activity following an Olympic games

Both included reviews reported that the evidence to support an uptake of sport or physical activities after an Olympic games was generally weak and inconclusive. McCartney et al. reported no overall change in the recreational impact of hosting an Olympic Games.[6] They cited some evidence, however, of an upward trend in sports participation from the early 1980s until 1994, and in association with the 1992 Barcelona games in Spain. They graded the cited evidence as being of the lowest level according to their quality appraisal. Weed et. al. also referred to evidence for increased

participation following the 1992 Barcelona games.[15] The authors noted that the results were drawn from data taken 7 years prior and 3 years after the 1992 games, and highlighted a possible limitation in comparing data taken at different times and by different designs. The authors also concluded that the evidence was mixed for a "trickle down" effect on participation; it was possible that some short term benefits may have been seen but little evidence of a long term effect.

Public perceptions to sporting activity after an Olympic games

McCartney et al. did not cite any specific evidence of changes in the public's perception of sporting or physical activity following an Olympic games.[6] In contrast, Weed et al. made reference to a positive perception following elite sporting success.[15] However, they also cited evidence for a negative effect with the potential of elite sports deterring individual participation because of a perceived competence gap. The review also cited evidence for a lack of increased physical activity following the 2000 Sydney Olympics in Australia, despite the 'euphoria' that was documented as following the Games. Weed et al. also made reference to evidence from Sport England (UK) that found "more than a quarter of the population in England (26%) have been inspired by British medal-winning performances at the Olympic Games in Athens (2004)". However, they suggested that this was likely to be due to increased participation from people already partaking in sporting activity. They did however acknowledge the importance of an Olympic games in generating a "festival effect" with evidence that such a perception has the potential to increase the desire to participate in all aspects of the Games, including the increased uptake of physical activity.

Barriers to partaking in increased sporting activity

Weed et al. cite evidence that a negative perception to the Games could act as a barrier or negate completely the potential to use such an event for the development of physical activity or sport, or the promotion of health.[15] The authors also infer from their results, that the absence of planning supplemental activities to leverage and follow the main event, may also act as a barrier to further participation. Community and social empowerment were themes that were reported as being important facilitators in increasing sporting activity.

Other health benefits

The McCartney et al. study examined a number of other outcomes relating to health, wellbeing, quality of life, health service use, as well as recreation.[6] They found the quality of evidence to be mixed with no overall conclusion for a clear benefit. A moderate grade of evidence was ascribed to data relating to suicide rates which were found to be unchanged after the 1988 Seoul Olympics in South Korea. In contrast, lower levels of evidence were awarded to data showing an increase in paediatric health service demand, and a decrease in childhood asthma acute care events following

the 1996 Olympics in Atlanta, USA. A low level of evidence was given to data relating to an increase in hospital presentations related to illicit drugs following the 2000 Olympics in Sydney, Australia. Weed et al. also report no overall clear benefit on health after an Olympic Games event.[15] They cite smoking cessation data, following a campaign to reduce smoking around the Barcelona Olympics that were inconclusive in showing a positive link. They also referred to data from China in the build-up to the 2008 Beijing Olympics suggesting that general health and extended life expectancy improved using data gained from a 'national physique examination'. However, Weed et al. point out that such results should be interpreted with caution as it may not be possible to extrapolate them to other environments. A broader but similar point is discussed in the McCartney et al. review who point out that "both the commissioning of studies and their publication could well be biased towards positive results".

Discussion

Few systematic reviews have been published on the physical and sporting impact(s) that Olympic Games can have on the public. To the best of our knowledge, this is the first systematic review of systematic reviews to assess whether an Olympic event leads to an increased uptake in physical or sporting activities, in addition to other health benefits.

Overall we found little evidence to support a clear positive impact either on the uptake of activities or on other health benefits linked to hosting an Olympic games. Our review suggests that a number of factors are likely to have contributed to this. Firstly, it cannot be expected that such events will automatically increase activity simply by the event taking place. Instead, we found that a number of factors were likely to be needed, such as a "positive" perception in advance of the games, the idea that participation in physical activity need not be limited to elite sportsmen, and that there will be sufficient infrastructure to access and partake in activities within the community and schools setting after the games. As pointed out by Weed et al., the generation of a "festival" feel is likely to generate short-term positive perceptions and increased participation in a number of areas including sporting activity.[15] We also noted that both included reviews eluded that collecting data on increased physical activity after such an event may be challenging, poor or absent. As a result we recommend that evidence based strategies to record this data, locally and regionally, should already be in place following the 2012 London Games. We further recommend that such methods are executed in advance and following the 2016 Olympic Games in Rio, Brazil.

We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]

Limitations of our review

We were aware of several limitations to our review. We chose to only include data relating to the summer Olympic and Paralympic games, thus excluding the Winter Olympics as we felt that the

summer games would have a greater potential of encouraging events that could be transferable and available for mass participation worldwide. We also avoided including data from other multi-sporting events, such as the Commonwealth games, on the basis that no other single, multi-sporting, event had the same breadth of included sports or public interest as the Olympics. However, we note that data did exist, particularly following the 2002 Manchester Commonwealth games, but evidence of a definite link to increased activity was inconclusive. It was, therefore, unlikely to have changed the conclusions of our review.

We also limited our searching of "grey literature" to Google, Google scholar and the International Olympic Committee websites, as we felt that there would be a significant number of non-systematic reviews and commentaries on other sites that would not meet our inclusion criteria.

Overall conclusion

The evidence to support the notion that hosting an Olympic games leads to an automatic increase in mass sporting or physical activity is poor. Our review has found several areas of potential that could be capitalised on to test this hypothesis. Having existing routes into increased participation is likely to prove beneficial. An emphasis of involvement as well as targeting certain populations such as children and those contemplating activity, rather than just those already involved in it. The framing of an Olympic games in a broader sense, such as through a positive public perception and within a "festival" feeling, is also likely to reap benefits. The United Kingdom will host the 2014 Glasgow Commonwealth games and has a unique opportunity to build on the public interest generated from the London 2012 games.[19] We also suggest that in the interim, smaller events relating to increase sporting or physical activity, be put into place to keep the momentum generated from London 2012 going. Such events could then be capitalised on in the lead up to the 2016 Olympics in Brazil. The effects should be recorded using high quality, evidence based methods. Through such means the true success and legacy of the London 2012 games will be determined.

Figure 1

PRISMA flow diagram

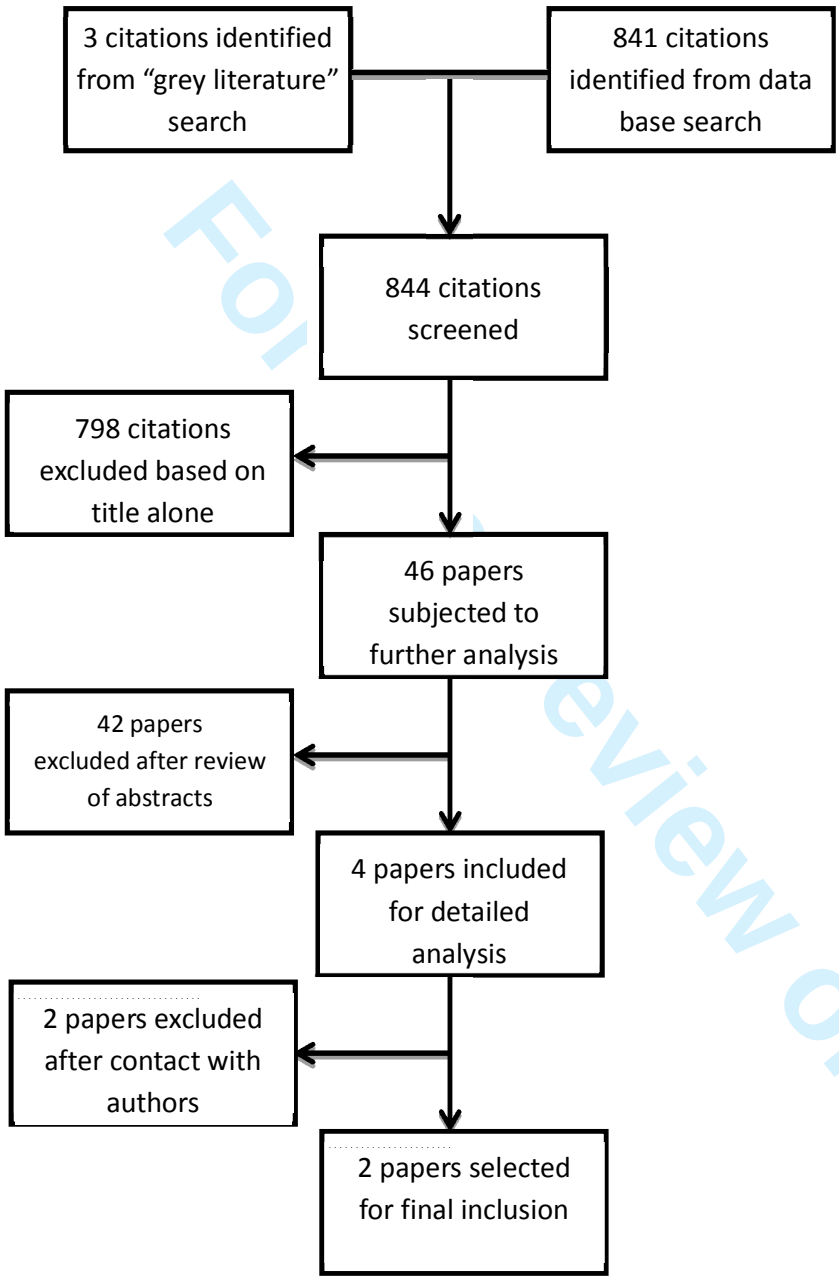

Table 1

Characteristics of included reviews

Review	Weed et al[15]	McCartney et al[19]
Year	2009	2010
Question posed by review	Four questions were established for the review: i) What evidence exists that the Olympic Games, sports events or sports franchises can impact upon physical activity and sport participation and upon health-related behaviours? ii) By what processes have physical activity and sport participation and health-related behaviours been leveraged from the Olympic Games, sports events or sports franchises? iii) What processes that have been used to leverage, inter alia, volunteering, community engagement and tourism from the Olympic Games, sports events and sports franchises might inform leveraging strategies for physical activity, sport and health? iv) How has the leveraging of a range of opportunities from Olympic Games, sports events and sports franchises been evaluated?	To assess the effects of major multi-sport events on health and socioeconomic determinants of health in the population of the city hosting the event.
Search strategy	Published literature via SPORTS DISCUS ,CINAHL, PsychINFO, MEDLINE, • Web of Knowledge (General Science and Social Science Database) In addition several sources for "grey literature" were searched (see full paper for more details)	Papers published between 1978 and 2008. From Applied Social Science Index and Abstracts (ASSIA), British Humanities Index (BHI), Cochrane database of systematic reviews, Econlit database, Embase, Education Resources Information Center (ERIC)database, Health Management Information Consortium (HMIC) database, International Bibliography of the Social Sciences (IBSS), Medline ,PreMedline, PsycINFO, Sociological Abstracts, Sportdiscus , Web of

		Knowledge, Worldwide Political Science Abstracts In addition an 'extensive' search of the grey literature (between April & October 2008) was carried out (see individual review for full details).
No of included studies	24	54
Quality appraisal tool used to assess included studies	A rudimentary quality appraisal sheet was agreed by all authors and review panel as being relevant to the research question.[16]	Assessed using a modified version of the Hamilton quality assessment tool.
Overall comment on quality of included studies	Variable. With reference to our primary outcome, was assessed to be generally poor.	Study quality was 'poor'

Table 2

Quality assessment of included reviews using the AMSTAR tool

1.	Question	Weed et al[15]	McCartney et al[6]
2.	Was an 'a priori' design provided?	Y	Y
3.	Was there duplicate study selection and data extraction?	Y	Y
4.	Was a comprehensive literature search performed?	Y	Y
5.	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Y	Y
6.	Was a list of studies (included and excluded) provided?	N-only included studies	N-only included studies
7.	Were the characteristics of the included studies provided?	Y	Y
8.	Was the scientific quality of the included studies assessed and documented?	Y	Y
9.	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Y	Y
10.	Were the methods used to combine the findings of studies appropriate?	Y	Y
11.	Was the likelihood of publication bias assessed	Y	N/A - authors state this not possible
12.	Was the conflict of interest stated?	U (although commissioned by Department of Health	Y
	Total	9	9

Key: Y=Yes, N=No, U=Unclear, N/A= Not Applicable

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Footnotes

Contributors

KRM, JP, SPS, MD, TB, CB, and BB are all members of Cohort 7 of The International Primary Care Research Leadership programme, part of The Brisbane Initiative to develop future leaders in primary care research. KRM had the initial idea for the review and drafted the first protocol. All authors commented and advised on this draft. KRM and NR devised the search strategy which was conducted by NR. KRM, JP and SPS screened the results of the searches and agreed on the final list of included reviews. CB and BB assed the included reviews for quality. TB and MD carried out the data extraction. KRM wrote the first draft of the final papers with contributions and edits from all remaining authors. All authors contributed to the final draft.

Acknowledgements

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Competing interests

None declared.

Appendix 1

Search strategies:

Medline (OvidSP) [1946 - , In process] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2255
2	(sport* adj (event* or mega-event*)).ti,ab.	505
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	15
4	((international or multination* or multi-nation*) adj games).ti,ab.	10
5	1 or 2 or 3 or 4	2730
6	(Medline or systematic review).tw. or meta-analysis.pt.	87371
7	5 and 6	20
8	meta-analysis.mp,pt. or review.pt. or search:.tw.	1884987
9	5 and 8	358

Embase (OvidSP) [1974 -] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2799
2	(sport* adj (event* or mega-event*)).ti,ab.	649
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	23
4	((international or multination* or multi-nation*) adj games).ti,ab.	17
5	1 or 2 or 3 or 4	3417
6	(meta-analysis or systematic review or MEDLINE).tw.	111218
7	5 and 6	19
8	meta-analy*:.mp. or search*.tw. or review.pt.	2102017
9	5 and 8	458

Cochrane Database of Systematic Reviews & Database of Abstracts of Reviews of Effectiveness (Cochrane Library, Wiley) – 8th August 2012

#1	(olympic* or paralympic* or special olympic*):ti,ab,kw	71
#2	(sport* near (event* or mega-event*)):ti,ab,kw	25
#3	(international or multination* or multi-nation*) near event* and sport*:ti,ab,kw	1
#4	((international or multination* or multi-nation*) near games):ti,ab,kw	1

SportDISCUS (EBSCOHost) [1980 -] – 9th August 2012

S9	S5 and S8	(485)
S8	TI (meta-analy* or review) OR AB (meta-analy* or search*)	(27026)
S7	S5 and S6	(7)
S6	TI (meta-analysis or systematic review or MEDLINE) OR AB (meta-analysis or systematic review or MEDLINE) OR KW (meta-analysis or systematic review or MEDLINE)	(4396)
S5	S1 or S2 or S3 or S4	(51244)
S4	TI (((international or multination* or multi-nation*) n2 games)) OR AB (((international or multination* or multi-nation*) n2 games))	(517)
S3	TI (((international or multination* or multi-nation*) n2 event*)) OR AB (((international or multination* or multi-nation*) n2 event*))	(1201)
S2	TI ((sport* n2 (event* or mega-event*))) OR AB ((sport* n2 (event* or mega-event*)))	(6927)
S1	TI (olympic* or paralympic*) OR AB (olympic* or paralympic*)	(44061)

Science Citation Index-EXPANDED, Social Science Citation Index [Web of Knowledge] (All years)

4 68 Topic=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
3 23 #2 OR #1
2 21 Title=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
1 3 Topic=(olympic* OR paralympic*) AND Title=(meta-analys* OR "systematic review" OR "evidence review")

Search filters used:

The validated search filters for Medline and Embase were taken from the following publications. The search of Cochrane Library is self-limiting as we included references within Cochrane Database of Systematic Reviews (CDSR) & Database of Abstracts of reviews of Effectiveness (DARE). There are no validated filters for SportsDISCUS or Web of Science – we applied keywords adapted from those used in the Medline & Embase searches for these 2 databases.

EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.

J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.

Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team.

BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.

Search line 7 = Best specificity

(Medline or systematic review).tw. or meta-analysis.pt.

99.2 (99.1 to 99.3)

Search line 9 = Top strategy minimising the difference between sensitivity and specificity

meta-analysis.mp,pt. or review.pt or search:.tw.

Sensitivity reported as 98.0 (97.0 to 99.0)

- **Excluded papers prior to 1987**
- **Excluded animal studies**

Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Kamal R. Mahtani[1,3] *NIHR Clinical Lecturer in General Practice*

Joanne Protheroe[1,4] *Senior Lecturer in General Practice*

Sarah Patricia Slight[1,5,6] *NIHR Postdoctoral Research Fellow*

Marcelo Marcos Piva Demarzo[1,7] *Assistant Professor in General Practice*

Thomas Blakeman[1,8] *NIHR Clinical Lecturer in General Practice*

Christopher A. Barton[1,9] *Lecturer in Quantitative Research Methods*

Bianca Brijnath[1,10] *NHMRC Early Career Public Health Fellow*

Nia Roberts[2] *Outreach librarian*

Corresponding author: kamal.mahtani@phc.ox.ac.uk

[1] Members of the Brisbane Initiative (Cohort 7), International Leadership Programme in Primary Care, Oxford, UK

[2] Knowledge Centre, Bodleian Health Care Libraries, University of Oxford, UK

Further affiliations

[3] Department of Primary Health Care Sciences, University of Oxford, UK
[4] Institute of Primary Care and Health Sciences, Arthritis Research UK Primary Care Centre, Keele University, UK
[5] Division of Primary Care, The University of Nottingham, Nottingham, UK
[6] Division of General Internal Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA
[7] General Practice Unit, Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil
[8] Primary Care Research, Health Sciences Research Group, School of Community Based Medicine, University of Manchester, UK
[9] Social Health Sciences, Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia
[10] Department of General Practice, Monash University, Melbourne, Australia

Word count: 3500

Article summary

Article focus

- Increased levels of physical activity are linked with improved health and may play a key role in the prevention or treatment of most non-communicable diseases (NCD).
- The London 2012 Olympic and Paralympic Games aims to leave a long term legacy, which includes population level increases in physical and sporting activity.
- We conducted a systematic review of systematic reviews to establish whether hosting an Olympic games leads to increased participation in such activities.

Key messages

- There is little evidence that international elite sporting events such as the Olympics leads to increased participation in physical or sporting activities at the population health level. We found no evidence, in particular, relating to the Paralympic games.
- High quality, evidence based studies are needed to measure the true impact of the London 2012 games.

Strengths and limitations of this study

- Strengths: This is a systematic review of existing systematic reviews.
- Limitations: We restricted our search to those ~~studies~~reviews published in English on previous Olympic and Paralympic Games.

Objective:

To examine if there i~~t~~s there an increased participation in physical or sporting activities following an Olympic or Paralympic games.~~?~~

Design:

Overview of systematic reviews

Methods:

We searched the Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. In addition, we searched for "grey literature" in Google, Google scholar and on the International Olympic Committee websites. We restricted our search to those ~~studies~~reviews published in English. We used the AMSTAR tool to assess the methodological quality of those systematic reviews included.

Primary and secondary outcome measures:

The primary outcome was evidence for an increased participation in physical or sporting activities. Secondary outcomes included public perceptions of sport during and after an Olympic Games, barriers to increased sports participation, and any other non-sporting health benefits.

Results:

Our systematic search revealed 844 citations, of which only two matched our inclusion criteria. The quality of these two reviews~~studies~~ was assessed by three independent reviewers as 'good' using the AMSTAR tool for quality appraisal. Both reviews reported little evidence of an increased uptake of sporting activity following an Olympic Games event. Other effects on health, for example changes in hospital admissions, suicide rates and drug use, were cited although there was insufficient evidence to see an overall effect.

Conclusions:

There is a paucity of evidence to support the notion that hosting an Olympic games leads to an increased participation in physical or sporting activities for host countries. We also found little evidence to suggest other health benefits. We conclude that the true success of these and future games should be evaluated by high quality, evidence based studies that have been commissioned before, during and following the completion of the event. Only then can the true success and legacy of the games be established.

Introduction

The cost of hosting the 2012 Games of the XXX Olympiad in London has been estimated to be over £8 billion (UK) pounds.[1] Part of the justification for spending this amount and bidding to host the games, comes from the belief that the event will leave a legacy in the United Kingdom. The theme of the games, "Inspire a generation", reflected this desire to promote participation in sport in the run-up to, during and after the event.[2]

In 2010, the Department for Culture, Media and Sport outlined the UK Government's plans for this legacy, and included "harnessing the United Kingdom's passion for sport to increase grass roots participation, particularly by young people – and to encourage the whole population to be more physically active".[3] However, since the games were awarded to London in 2005, there has been an overall decline among 16-25 year olds in sport participation.[4] These findings are a cause for concern especially as a recent analysis of the burden of disease and life expectancy showed that physical inactivity has a major negative health effect worldwide linked to coronary heart disease, diabetes and cancer. It is also estimated that around 1.3 million deaths could be averted every year if physical inactivity decreased by 25%.[5]

A previous systematic review of literature published between 1978 and 2008 found insufficient evidence to support or refute any health or socioeconomic impacts from major multi-sport events.[6] We saw value in conducting an "overview of systematic reviews", thus allowing the findings of separate reviews to be compared and contrasted.[7] Secondly, we restricted our search to the impact of the Olympic and Paralympic games only, with our primary outcome of interest an increased participation in sport or recreational activities subsequent to hosting these games. Our aim was to highlight new areas that could possibly guide policy makers on decision making and planning of future games.

Methods

Data Sources and Search Sstrategy

Two authors (NR, KRM) devised the search strategy. ~~We~~One author (NR) searched Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. For each database, we applied two search filters for identifying systematic reviews.[8] We also performed searches on Google, Google Scholar and the International Olympic Committee websites. We restricted the inclusion of papers to those published in English. (Full details of the search strategy used are given in Appendix 1).

~~Criteria for~~ Sstudy selection

Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Given the broad nature of non-systematic reviews, commentaries, and general opinion based articles, we restricted our search to only systematic reviews. We used the Cochrane Handbook for Systematic Reviews of Interventions for a definition of a systematic review.[9] We included reviews~~studies~~ which systematically appraised published literature within the remit of the review. No restriction was placed on age, gender or race. We included ~~studies~~ reviews from all countries, and accepted ~~studies~~ reviews that presented their results quantitatively or as a narrative. We excluded reviews that *only* focused on other multi-sporting events (such as Winter Olympics, Commonwealth Games) as well as single sporting events (such as World cups, World Championships).

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Outcomes

The primary outcome for this overview was an increased involvement in ~~physical or~~ sporting activity following an Olympic Games. We define "increased uptake" as any means to demonstrate increased participation, and held no restriction on whether this was demonstrated qualitatively or quantitatively. We applied the term "~~"~~sporting activity"~~'~~ to include any of the 36 Olympic sports (Archery, Athletics (including walking), Badminton, Basketball, Beach Volleyball, Boxing, Canoe Slalom, Canoe Sprint, Cycling – BMX, Cycling - Mountain Bike, Cycling – Road, Cycling – Track, Diving, Equestrian, Fencing, Football, Gymnastics – Artistic, Gymnastics – Rhythmic, Handball, Hockey, Judo, Modern Pentathlon, Rowing, Sailing, Shooting, Swimming, Synchronised Swimming, Table Tennis, Taekwondo, Tennis, Trampoline, Triathlon, Volleyball, Water Polo, Weightlifting and Wrestling) and 21 Paralympic sports (Archery, Athletics, Boccia, Cycling Road, Cycling Track, Football 5-a-side, Football 7-a-side, Goalball, Equestrian, Judo, Powerlifting, Rowing, Sailing, Shooting, Swimming,

Table Tennis, Sitting Volleyball, Wheelchair Basketball, Wheelchair Fencing, Wheelchair Rugby and Wheelchair Tennis). ~~We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.~~[10]

Secondary outcomes included:

- Increases in other forms of physical activity;
- Public perceptions of sport during and after an Olympic games;
- Barriers to increased sports participation;
- Non-sporting (physical or mental) health benefits.

-We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc.

~~Critical appraisal~~Quality assessment of included reviews~~studies~~

Quality assessment of included ~~studies~~reviews was carried out independently by two authors (CB, BB), verified by a third (KRM). We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.[11]

Data extraction

Three authors (KRM, TB, MD~~) independently~~) independently extracted data from included reviews using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included ~~studies~~studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

Review synthesis

All extracted data was tabulated according to study ID, year of publication, AMSTAR quality score, data relating to our primary outcome, data relating to secondary outcome. The sections relating to our primary outcome were further divided into the Olympic event to which they refer, the sporting activity and the overall impact. Quantitative synthesis was not possible and as a result it was agreed that all results be reported as a narrative.

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Review synthesis

Two authors (NR, KRM) devised the search strategy. Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Quality assessment of included studies was carried out by two authors (CB, BB), verified by a third (KRM), and assessed using the AMSTAR tool for the methodological quality of systematic reviews. Three authors independently extracted data from these reviews (KRM, TB, MD), using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

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Results

Results of search strategy

Figure 1 summarises the results of our search strategy. We initially identified 844 references after removal of duplicates. Of these, 798 references were excluded based on titles alone ~~by three reviewers (KRM, JP, SPS)~~ for a lack of relevance. Of the remaining 46 papers, a further 42 were dismissed after review of the abstracts. The majority of excluded ~~studies~~citations were non-systematic reviews, commentaries and books. Where possible, relevant chapters of books were reviewed and included if they met our criteria. Four ~~studies~~reviews were ~~reviewed~~ analysed in detail. Of these, two were subsequently excluded. Although one of these excluded ~~studies~~reviews searched key databases, specialist bibliographic databases, and different types of evidence including grey literature, as well as contacted relevant individuals and organisations, we were unclear if its review process was carried out systematically.[12] We contacted the authors of this paper who confirmed that their study was *not* a systematic review and as a result it was excluded from our review.[13] The other excluded study[14] was an abbreviated version of one of our included ~~studies~~reviews.[15] Personal communication with the lead author of both papers confirmed that the abbreviated version contained no additional information.[16] As a result we excluded it from our review. It was finally agreed that only two ~~studies~~reviews were eligible for quality assessment and data extraction. The first of these was a systematic review of the evidence base for developing a physical activity and health legacy from the London 2012 Olympic and Paralympic games, commissioned by the UK Department of Health.[15] The second included study was a systematic review evaluating the health and socioeconomic impacts of major multi-sporting events between 1978 and 2008.[6] Table 1 summarises the main characteristics from the included ~~studies~~reviews.

Quality assessment of included reviews

We only selected reviews where the objective of the study was clearly stated and fitted within the remit of this review. We used the AMSTAR methodological quality assessment tool to appraise our included ~~studies~~reviews.[11] Overall, we found the quality of the included ~~studies~~reviews to be good. Table 2 summarises the results of our quality appraisal using the AMSTAR tool.

Increased uptake of sporting or physical activity following an Olympic games

Both included ~~studies~~reviews reported that the evidence to support an uptake of sport or physical activities after an Olympic games was generally weak and inconclusive. McCartney et al. reported no overall change in the recreational impact of hosting an Olympic Games.[6] They cited some evidence, however, of an upward trend in sports participation from the early 1980s until 1994, and in association with the 1992 Barcelona games in Spain. They graded the cited evidence as being of the

lowest level according to their quality appraisal. Weed et. al. also referred to evidence for increased participation following the 1992 Barcelona games.[15] The authors noted that the results were drawn from data taken 7 years prior and 3 years after the 1992 games, and highlighted a possible limitation in comparing data taken at different times and by different designs. The authors also concluded that the evidence was mixed for a "trickle down" effect on participation; it was possible that some short term benefits may have been seen but little evidence of a long term effect.

Public perceptions to sporting activity after an Olympic games

McCartney et al. did not cite any specific evidence of changes in the public's perception of sporting or physical activity following an Olympic games.[6] In contrast, Weed et al. made reference to a positive perception following elite sporting success.[15] However, they also cited evidence for a negative effect with the potential of elite sports deterring individual participation because of a perceived competence gap. The review also cited evidence for a lack of increased physical activity following the 2000 Sydney Olympics in Australia, despite the 'euphoria' that was documented as following the Games. Weed et al. also made reference to evidence from Sport England (UK) that found "more than a quarter of the population in England (26%) have been inspired by British medal-winning performances at the Olympic Games in Athens (2004)". However, they suggested that this was likely to be due to increased participation from people already partaking in sporting activity. They did however acknowledge the importance of an Olympic games in generating a "festival effect" with evidence that such a perception has the potential to increase the desire to participate in all aspects of the Games, including the increased uptake of physical activity.

Barriers to partaking in increased sporting activity

Weed et al. cite evidence that a negative perception to the Games could act as a barrier or negate completely the potential to use such an event for the development of physical activity or sport, or the promotion of health.[15] The authors also infer from their results, that the absence of planning supplemental activities to leverage and follow the main event, may also act as a barrier to further participation. Community and social empowerment were themes that were reported as being important facilitators in increasing sporting activity.

Other health benefits

The McCartney et al. study examined a number of other outcomes relating to health, wellbeing, quality of life, health service use, as well as recreation.[6] They found the quality of evidence to be mixed with no overall conclusion for a clear benefit. A moderate grade of evidence was ascribed to data relating to suicide rates which were found to be unchanged after the 1988 Seoul Olympics in South Korea. In contrast, lower levels of evidence were awarded to data showing an increase in

paediatric health service demand, and a decrease in childhood asthma acute care events following the 1996 Olympics in Atlanta, USA. A low level of evidence was given to data relating to an increase in hospital presentations related to illicit drugs following the 2000 Olympics in Sydney, Australia. Weed et al. also report no overall clear benefit on health after an Olympic Games event.[15] They cite smoking cessation data, following a campaign to reduce smoking around the Barcelona Olympics that were inconclusive in showing a positive link. They also referred to data from China in the build-up to the 2008 Beijing Olympics suggesting that general health and extended life expectancy improved using data gained from a 'national physique examination'. However, Weed et al. point out that such results should be interpreted with caution as it may not be possible to extrapolate them to other environments. A broader but similar point is discussed in the McCartney et al. review who point out that "both the commissioning of studies and their publication could well be biased towards positive results".

Discussion

Few systematic reviews have been published on the physical and sporting impact(s) that Olympic Games can have on the public. To the best of our knowledge, this is the first systematic review of systematic reviews to assess whether an Olympic event leads to an increased uptake in physical or sporting activities, in addition to other health benefits.

Overall we found little evidence to support a clear positive impact either on the uptake of activities or on other health benefits linked to hosting an Olympic games. Our review suggests that a number of factors are likely to have contributed to this. Firstly, it cannot be expected that such events will automatically increase activity simply by the event taking place. ~~If this was the case we would have expected significantly more data from our searches following previous games.~~ Instead, we found that a number of factors were likely to be needed, such as a "positive" perception in advance of the games, the idea that participation in physical activity need not be limited to elite sportsmen, and that there will be sufficient infrastructure to access and partake in activities within the community and schools setting after the games. As pointed out by Weed et al., the generation of a "festival" feel is likely to generate short-term positive perceptions and increased participation in a number of areas including sporting activity.[15] We also noted that both included ~~studies~~reviews eluded that collecting data on increased physical activity after such an event may be challenging, poor or absent. As a result we recommend that evidence based strategies to record this data, locally and regionally, should already be in place following the 2012 London Games. We further recommend that such methods are executed in advance and following the 2016 Olympic Games in Rio, Brazil.

We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]

Limitations of our review

We were aware of several limitations to our review. We chose to only include data relating to the summer Olympic and Paralympic games, thus excluding the Winter Olympics as we felt that the summer games would have a greater potential of encouraging events that could be transferable and available for mass participation worldwide. We also avoided including data from other multi-sporting events, such as the Commonwealth games, on the basis that no other single, multi-sporting, event had the same breadth of included sports or public interest as the Olympics. However, we noted that data did exist, particularly following the 2002 Manchester Commonwealth games, but evidence of a definite link to increased activity was inconclusive. It was, therefore, unlikely to have changed the conclusions of our review.

We also limited our searching of "grey literature" to Google, Google scholar and the International Olympic Committee websites, as we felt that there would be a significant number of non-systematic reviews and commentaries on other sites that would not meet our inclusion criteria.

Overall conclusion

The evidence to support the notion that hosting an Olympic games leads to an automatic increase in mass sporting or physical activity is poor. Our review has found several areas of potential that could be capitalised on to test this hypothesis. Having existing routes into increased participation is likely to prove beneficial. An emphasis of involvement as well as targeting certain populations such as children and those contemplating activity, rather than just those already involved in it. The framing of an Olympic games in a broader sense, such as through a positive public perception and within a "festival" feeling, is also likely to reap benefits. The United Kingdom will host the 2014 Glasgow Commonwealth games and has a unique opportunity to build on the public interest generated from the London 2012 games.[19] We also suggest that in the interim, smaller events relating to increase sporting or physical activity, be put into place to keep the momentum generated from London 2012 going. Such events could then be capitalised on in the lead up to the 2016 Olympics in Brazil. The effects should be recorded using high quality, evidence based methods. Through such means the true success and legacy of the London 2012 games will be determined.

Figure 1

PRISMA flow diagram

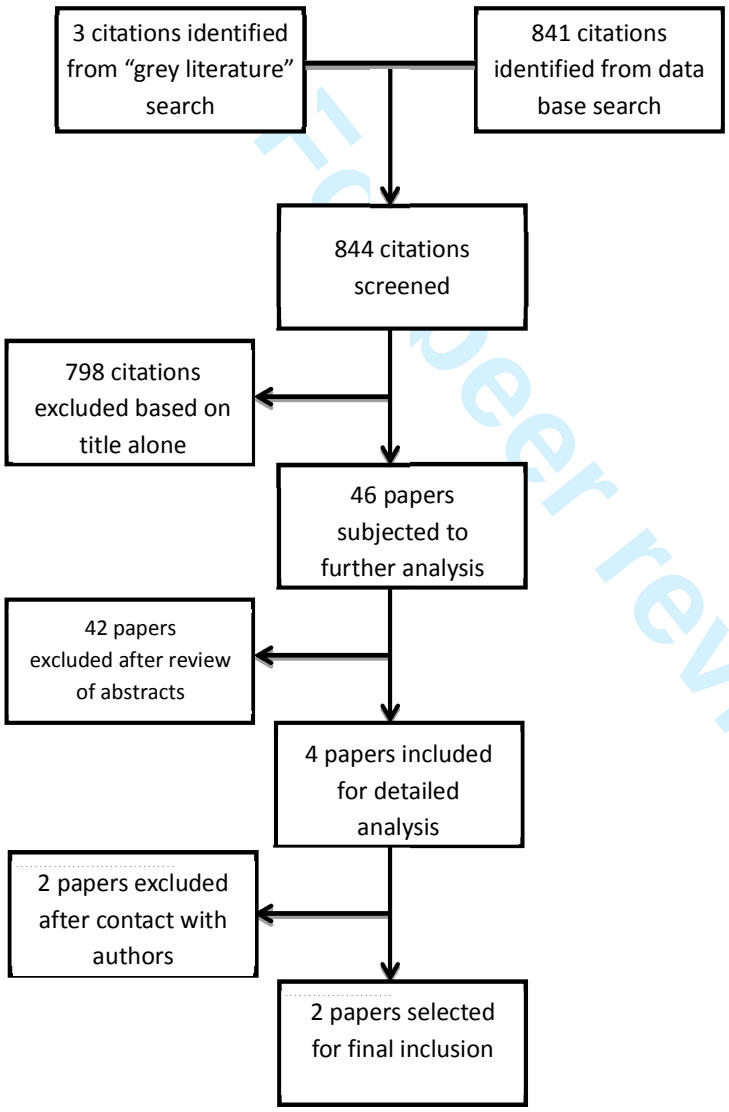

Table 1

Characteristics of included ~~studies~~reviews

Review	Weed et al[15]	McCartney et al[19]
Year	2009	2010
Question posed by review	Four questions were established for the review: i) What evidence exists that the Olympic Games, sports events or sports franchises can impact upon physical activity and sport participation and upon health-related behaviours? ii) By what processes have physical activity and sport participation and health-related behaviours been leveraged from the Olympic Games, sports events or sports franchises? iii) What processes that have been used to leverage, inter alia, volunteering, community engagement and tourism from the Olympic Games, sports events and sports franchises might inform leveraging strategies for physical activity, sport and health? iv) How has the leveraging of a range of opportunities from Olympic Games, sports events and sports franchises been evaluated?	To assess the effects of major multi-sport events on health and socioeconomic determinants of health in the population of the city hosting the event.
Search strategy	Published literature via SPORTS DISCUS ,CINAHL, PsychINFO, MEDLINE, • Web of Knowledge (General Science and Social Science Database) In addition several sources for "grey literature" were searched (see full paper for more details)	Papers published between 1978 and 2008. From Applied Social Science Index and Abstracts (ASSIA), British Humanities Index (BHI), Cochrane database of systematic reviews, Econlit database, Embase, Education Resources Information Center (ERIC)database, Health Management Information Consortium (HMIC) database, International Bibliography of the Social Sciences (IBSS), Medline ,PreMedline, PsycINFO, Sociological Abstracts, Sportdiscus , Web of

		Knowledge, Worldwide Political Science Abstracts In addition an 'extensive' search of the grey literature (between April & October 2008) was carried out (see individual review for full details).
No of included studies	24	54
Quality appraisal tool used to assess included studies	A rudimentary quality appraisal sheet was agreed by all authors and review panel as being relevant to the research question.[16]	Assessed using a modified version of the Hamilton quality assessment tool.
Overall comment on quality of included studies	Variable. With reference to our primary outcome, was assessed to be generally poor.	Study quality was 'poor'

Table 2

Quality assessment of included ~~studies~~reviews using the AMSTAR tool

1.	Question	Weed et al[15]	McCartney et al[6]
2.	Was an 'a priori' design provided?	Y	Y
3.	Was there duplicate study selection and data extraction?	Y	Y
4.	Was a comprehensive literature search performed?	Y	Y
5.	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Y	Y
6.	Was a list of studies (included and excluded) provided?	N-only included studies	N-only included studies
7.	Were the characteristics of the included studies provided?	Y	Y
8.	Was the scientific quality of the included studies assessed and documented?	Y	Y
9.	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Y	Y
10.	Were the methods used to combine the findings of studies appropriate?	Y	Y
11.	Was the likelihood of publication bias assessed	Y	N/A - authors state this not possible
12.	Was the conflict of interest stated?	U (although commissioned by Department of Health	Y
	Total	9	9

Key: Y=Yes, N=No, U=Unclear, N/A= Not Applicable

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Footnotes

Contributors

KRM, JP, SPS, MD, TB, CB, and BB are all members of Cohort 7 of The International Primary Care Research Leadership programme, part of The Brisbane Initiative to develop future leaders in primary care research. KRM had the initial idea for the review and drafted the first protocol. All authors commented and advised on this draft. KRM and NR devised the search strategy which was conducted by NR. KRM, JP and SPS screened the results of the searches and agreed on the final list of included ~~studies~~reviews. CB and BB assed the included ~~studies~~reviews for quality. TB and MD carried out the data extraction. KRM wrote the first draft of the final papers with contributions and edits from all remaining authors. All authors contributed to the final draft.

Acknowledgements

We are grateful to Professor Mike Clarke for his advice relating to the methodology section of this review. We also thank Dr Jeremy Howick for commenting on the original draft protocol and Meena Mahtani for proof reading the final draft.

Funding

No funding was sought to carry out this study.

Competing interests

None declared.

Appendix 1

Search strategies:

Medline (OvidSP) [1946 - , In process] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2255
2	(sport* adj (event* or mega-event*)).ti,ab.	505
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	15
4	((international or multination* or multi-nation*) adj games).ti,ab.	10
5	1 or 2 or 3 or 4	2730
6	(Medline or systematic review).tw. or meta-analysis.pt.	87371
7	5 and 6	20
8	meta-analysis.mp,pt. or review.pt. or search:.tw.	1884987
9	5 and 8	358

Embase (OvidSP) [1974 -] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2799
2	(sport* adj (event* or mega-event*)).ti,ab.	649
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	23
4	((international or multination* or multi-nation*) adj games).ti,ab.	17
5	1 or 2 or 3 or 4	3417
6	(meta-analysis or systematic review or MEDLINE).tw.	111218
7	5 and 6	19
8	meta-analy*:.mp. or search*.tw. or review.pt.	2102017
9	5 and 8	458

Cochrane Database of Systematic Reviews & Database of Abstracts of Reviews of Effectiveness (Cochrane Library, Wiley) – 8th August 2012

#1	(olympic* or paralympic* or special olympic*):ti,ab,kw	71
#2	(sport* near (event* or mega-event*)):ti,ab,kw	25
#3	(international or multination* or multi-nation*) near event* and sport*:ti,ab,kw	1
#4	((international or multination* or multi-nation*) near games):ti,ab,kw	1

SportDISCUS (EBSCOHost) [1980 -] – 9th August 2012

S9	S5 and S8	(485)
S8	TI (meta-analy* or review) OR AB (meta-analy* or search*)	(27026)
S7	S5 and S6	(7)
S6	TI (meta-analysis or systematic review or MEDLINE) OR AB (meta-analysis or systematic review or MEDLINE) OR KW (meta-analysis or systematic review or MEDLINE)	(4396)
S5	S1 or S2 or S3 or S4	(51244)
S4	TI (((international or multination* or multi-nation*) n2 games)) OR AB (((international or multination* or multi-nation*) n2 games))	(517)
S3	TI (((international or multination* or multi-nation*) n2 event*)) OR AB (((international or multination* or multi-nation*) n2 event*))	(1201)
S2	TI ((sport* n2 (event* or mega-event*))) OR AB ((sport* n2 (event* or mega-event*)))	(6927)
S1	TI (olympic* or paralympic*) OR AB (olympic* or paralympic*)	(44061)

Science Citation Index-EXPANDED, Social Science Citation Index [Web of Knowledge] (All years)

4 68 Topic=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
3 23 #2 OR #1
2 21 Title=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
1 3 Topic=(olympic* OR paralympic*) AND Title=(meta-analys* OR "systematic review" OR "evidence review")

Search filters used:

The validated search filters for Medline and Embase were taken from the following publications. The search of Cochrane Library is self-limiting as we included references within Cochrane Database of Systematic Reviews (CDSR) & Database of Abstracts of reviews of Effectiveness (DARE). There are no validated filters for SportsDISCUS or Web of Science – we applied keywords adapted from those used in the Medline & Embase searches for these 2 databases.

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EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.

J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.

Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team.

BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.

Search line 7 = Best specificity

(Medline or systematic review).tw. or meta-analysis.pt.

99.2 (99.1 to 99.3)

Search line 9 = Top strategy minimising the difference between sensitivity and specificity

meta-analysis.mp,pt. or review.pt or search:.tw.

Sensitivity reported as 98.0 (97.0 to 99.0)

~~**Limits applied:**~~

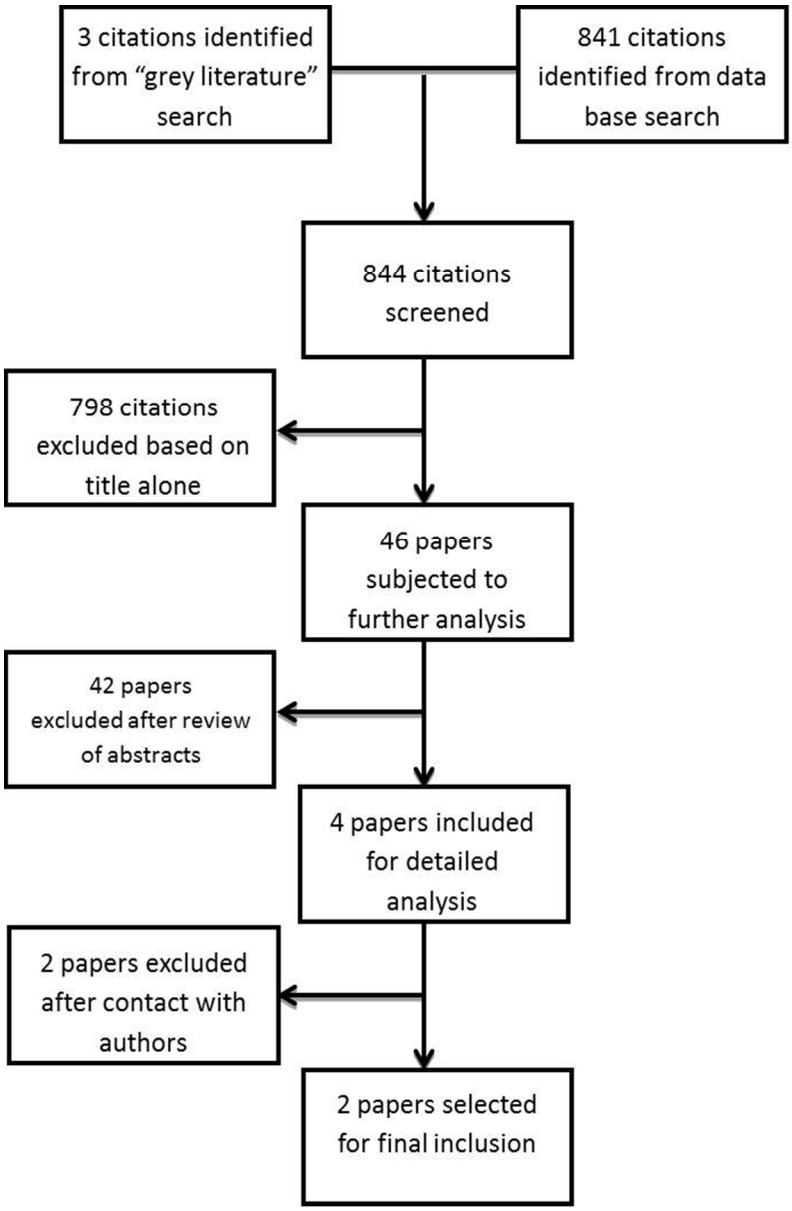
- ~~**Systematic review search filters taken from the following 2 articles**:~~

~~Highly specific(1) and balance between sensitivity & specificity(2).~~

~~Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team. BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.~~

~~EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.~~

- **Excluded papers prior to 1987**
- **Excluded animal studies**



117x178mm (150 x 150 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	n/a
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	10
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	17

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open - Decision on Manuscript ID bmjopen-2012-002058

Dr Kamal R. Mahtani, Dr Joanne Protheroe, Dr Sarah Patricia Slight, Dr Marcelo Marcos Piva Demarzo, Dr Thomas Blakeman, Dr Christopher A. Barton, Dr Bianca Brijnath, Ms Nia Roberts.

Authors reply

We have aimed to reply to each individual point raised by each reviewer. For clarity, the reviewer's comments are inserted in ***bold italic*** preceding our reply.

Reviewer 1: Hilary Thomson
Senior Investigator Scientist
MRC/CSO Social & Public Health Sciences Unit, Glasgow, UK.

I declare that I was an author on one of the systematic reviews included in this review of reviews. I am not aware of other competing interests.
We would like to thank Dr Thomson for taking the time to review our paper and for declaring her competing interest(s).

I can't see Appendix 1 to look at the search strategy and the reference the authors provide for search filters does not detail filters.
We are sorry to hear that Dr Thompson did not see Appendix 1. It is present within the word document on pages 19 – 20.

Our search filters are clearly included at the end of our search strategy. We have also added a statement to explain in more detail the filters that were used. We would like to point out that one of the authors (Nia Roberts) is an information specialist for the Cochrane Effective Practice and Organisation of Care Group. Her significant expertise was highly valued in devising and conducting an appropriately high standard search strategy.

There seems to be duplication between the secondary and primary outcomes which both include physical activity. Also were the primary outcomes used as a key screening criterion? That is if a review was identified that only addressed secondary outcomes would this have been excluded?
We have clarified our primary and secondary outcomes to avoid any risk of duplication. The primary outcome was an increased uptake of sporting activity. Secondary outcomes included "increases in other forms of physical activity". We applied the WHO definition of "physical activity", that is "any bodily movement produced by skeletal muscles that requires energy expenditure" as referenced in the text. This was deliberately chosen to ensure that other forms of physical (e.g. dancing) or sporting (since this also comes under the WHO definition) activities were included, thus making our search as comprehensive as possible. If a relevant review contained information relating to *only* a secondary outcome it was still included. However, we confirm that no such review met our inclusion criteria.

It is not clear what the authors used as a definition for a systematic review.
We used the definition quoted in the Cochrane Handbook for Systematic Reviews of Interventions. This line has now been added to the text and the handbook cited.

The methods of synthesis are not described. Given the nature of the data identified and the way the review has been presented this review has primarily provided a summary of the two reviews, and a limited narrative synthesis of reported data.
Within the methods section the approach to screening, appraisal and data extraction are described under synthesis- these items are not part of the synthesis. Also it is not entirely clear whether the screening, appraisal, and data extraction were conducted by more than one reviewer for each citation requiring this or whether the work was divided across the three reviewers.

With regards to the review synthesis process, we have taken Dr Thomson's point on board and rearranged our headings for increased clarity.

The "Methods" section is now divided into 1) Data sources and Search Strategy 2) Study selection 3) Outcomes 4) Quality assessment of included reviews 5) Data extraction and 6) Review synthesis. We have added a paragraph to this last section to help improve clarity. Within each section, we have made clear the role of each author. Each author carried out their role *independently* of each other. We also stated how any disagreements in the review process were resolved (e.g through discussion or referral to a third author).

What is meant by verifying "quality assessment"?

Unfortunately, we are unable to locate the term "verifying quality assessment" anywhere in the text.

I question the credibility or usefulness of this paper rather than the results themselves. It is unclear what the rationale or value of this review of reviews is, and what this paper contributes to the literature or adds to what the previous reviews and commentaries have made already presented relatively recently. Two systematic reviews addressing a broader range of events and outcomes have been published in the past 2-3 years. These were large scale reviews and in the course of their searching they would have identified existing systematic reviews, and other reviews for inclusion in their own review. In addition, there have been a number of editorial and commentary pieces published over the past year in the Lancet and the BMJ drawing attention to the nature and lack of available evidence. The authors (and many readers) would have known (even if not before but certainly after the searches) that there are very few systematic reviews addressing this topic, and what is available is relatively recent.

We would like to address Dr Thomson's comment on the credibility and usefulness of our manuscript in two parts (including the reply to the query below). In regard to the credibility of our review we would like to make several points. Firstly, all authors have a wealth of experience in both quantitative and qualitative research methods, including systematic reviews, which contributed to a systematic approach to our research question. We formulated and refined our question through numerous consensus discussions between all authors, chose a clear and appropriate search strategy, set clear inclusion/exclusion criteria, used (at a minimum) dual selection and extraction of included

reviews, assessed quality using the validated AMSTAR tool, compared and contrasted included reviews as a narrative, made an overall conclusion and highlighted the limitations of our own review. Secondly, and as mentioned earlier, one of the authors is also a registered information specialist with Cochrane UK and thus gave credibility to the provenance of our search strategy. Finally, the authors have a multinational mix of backgrounds e.g Brazil, Australia, USA and the UK. In keeping with the subject matter (i.e. a multi nation sporting event like the Olympics), the authors were able to offer unique insights into their own country's culture and sporting event history. We would argue that, if anything, these points strengthen the credibility of our review.

In addition to the paper presenting what appears to be an premature and unnecessary review of reviews the review itself has a fairly limited scope, further limiting the usefulness of the paper.

We believe our review is timely, necessary and useful for several reasons. First, our study is the first overview of systematic reviews. Therefore we have used a different methodology to the systematic reviews to which Dr Thomson is referring to. The purpose of our review was to compare and contrast existing systematic reviews on this topic. Through a combination of our "characteristics of included reviews" table, "Assessment of review quality using AMSTAR" and narrative we believe that this objective has been reached. Our review is also useful as, prior to its undertaking, it was unclear whether any additional reviews existed relevant to the research question. Dr Thomson highlighted two existing systematic reviews (both included in our overview). In fact, our review highlighted a third potentially relevant review which we chose to exclude after personal communication with the author. The fact that our methodology was both systematic and had a clear audit trail has meant that any reader (or policy maker) can be confident of these results presented to them. We would go further to say that our paper helps readers not only contrasts the results between reviews but helps summarise the evidence (e.g., the study by Weed et al. was 70 pages long) and point to a consistency in the direction of effect.

Our overview is also the most up-to-date study (as of August 2012) relevant to this research question. We would like to point out that the McCartney et al. review assessed studies up to 2008, and the Weed et. al. review was published in 2009. Taken together, this suggests a three to four year knowledge gap in the literature relevant to this topic, suggesting that our overview of reviews is neither premature nor unnecessary.

Finally, the fact we have produced a methodologically sound review in the same year as the London 2012 Olympic Games is very significant. No other previous games have placed a greater emphasis on an "Olympic legacy" than London 2012. Our review not only highlights to readers (and stake holders) that there is a paucity of overall evidence, but raises doubts over an automatic increase in uptake of sporting activity following a summer Olympic Games. Further, groups such as the London Organising Committee of the Olympic and Paralympic Games (LOCOG), may build on this finding to fill the gaps of evidence and put greater impetus to fulfil their desire for a lasting legacy.

The review only included reviews which had included data from summer Olympic and Paralympic games, and not other multi-sporting events or winter Olympic games, and was the primary outcomes were limited to sport and physical activity.

The fact and justification for limiting our research question to just the summer Olympic Games has been clearly pointed out in the opening paragraph of our "Limitations of this review" section within the discussion section.

More details on the specific strengths and weaknesses of the two included reviews would be helpful and an appendix with the AMSTAR data for both reviews would be useful.
The results with respect to reporting of the primary outcomes could benefit from further clarification. It is not always clear if the reported results relate to general conclusions of one of the two reviews or findings from studies on specific games, or whether the outcome being referred to is a specific sporting activity, general sporting activity, or physical activity.

An appendix with the result of our quality assessment using the AMSTAR tool is present in Table 2. We have researched other existing reviews of systematic reviews, and feel that the combination of our 1) "characteristics of included studies" table and 2) AMSTAR summary for each review is in keeping with other reviews of systematic reviews, although we welcome any further additional suggestions for improvement.

The rationale that if there had been an increase in activity following games that there would have been significantly more data identified does not make sense.
We thank Dr Thomson for pointing this out. We have removed this line from the discussion to avoid any confusion and feel the remaining paragraph makes our point clearly.

An issue arising throughout the paper is describing reviews as studies. The paper should be revised to ensure clarity when the authors are referring to a review, a review or reviews, a primary study, or a non-empirical paper.
We have taken Dr. Thomson's excellent point on board and have now clearly differentiated between reviews and studies.

Reviewer 2: Dr Simon Till
Consultant in Sport/Exercise Medicine & Rheumatology Sheffield Teaching Hospitals NHS Foundation Trust

I have no conflicts on interest.
I would approve publication without revision.

We are grateful to Dr Till for taking the time to review our manuscript and thank him for recommending our paper for publication.

My comment to the authors was that I was pleased they had raised awareness of what is a gap in knowledge at a time when it is imperative that LOCOG and the UK Government follow through on their commitments to ensure a health and physical activist legacy from what has been an their wise extremely successful Olympics and Paralympics.

We also thank him for pointing out that our paper has raised awareness of a current knowledge gap in the literature.

Reviewer 3: Dr Garry A. Tew
Senior Research Fellow
Centre for Sport and Exercise Science
Sheffield Hallam University
United Kingdom

This well-written review of reviews by Mahtani et al. focuses on the participation legacy of the Olympic and Paralympic games. Their conclusion is much the same as the two reviews that passed their study eligibility criteria: there's little evidence to support such a legacy at present.
We are grateful to Dr Tew for taking the time to review our manuscript. We also thank him for his helpful comments for improvements.

Minor comments:
Abstract - please rephrase the objective so that it begins "To..." rather than reading like a research question.
We have updated our objective as requested. It now reads: "To examine if there is there an increased participation in physical or sporting activities following an Olympic or Paralympic games."

Was the search limited to specific years?
We excluded citations prior to 1987 as we felt it was highly unlikely that a systematic review that met our inclusion criteria would exist prior to this date. Full details of our search strategy and filters can be found in appendix 1.

Intro - Ref #4 is an indirect reference - please cite the actual source to which you are referring to.
We have corrected reference 4 and now cite the original document from which the report was taken.

Secondary outcomes - "increases in other forms of physical activity" - I'm not sure what this means
By "increases in other forms of physical activity," we meant we wished to be as inclusive as possible in our secondary outcomes. For clarity, we have now added the lines "We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc."

The authors may want to highlight that London 2012 was the first games that specifically aimed at delivering a participation legacy. Olympic legacy is a relatively recent concept, and previous games have had a narrower focus, e.g. just develop transport infrastructure and sporting facilities within the host city. The authors may also wish to consider highlighting the difficulty presented by demonstrating a participation legacy, e.g. how can one be sure that an observed change in participation is attributed to the games? (Mike Weed has written an editorial in the BMJ about this.)
Thank you for highlighting the point regarding the emphasis placed on legacy for the London 2012 Olympic Games and the challenges in recording this data. We have now incorporated this reflection in to our discussion which now reads: "We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included

numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]"

BMJ open

Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-002058.R2
Article Type:	Research
Date Submitted by the Author:	03-Dec-2012
Complete List of Authors:	Mahtani, Kamal; University of Oxford, Department of Primary Health Care Sciences Protheroe, Joanne; Institute of Primary Care and Health Sciences, Keele University, UK, Arthritis Research UK Primary Care Centre Slight, Sarah; The University of Nottingham, Nottingham, UK, Division of Primary Care; Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA, Division of General Internal Medicine Demarzo, Marcelo; Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil, General Practice Unit Blakeman, Thomas; University of Manchester, School of Community Based Medicine Barton, Christopher; Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia, Social Health Sciences Brijnath, Bianca; Monash University, Melbourne, Australia, Department of General Practice Roberts, Nia; University of Oxford, UK, Knowledge Centre, Bodleian Health Care Libraries,
Primary Subject Heading:	Sports and exercise medicine
Secondary Subject Heading:	Evidence based practice, Public health, Sports and exercise medicine
Keywords:	SPORTS MEDICINE, PREVENTIVE MEDICINE, PUBLIC HEALTH, PRIMARY CARE

Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Kamal R. Mahtani[1,3] *NIHR Clinical Lecturer in General Practice*

Joanne Protheroe[1,4] *Senior Lecturer in General Practice*

Sarah Patricia Slight[1,5,6] *NIHR Postdoctoral Research Fellow*

Marcelo Marcos Piva Demarzo[1,7] *Assistant Professor in General Practice*

Thomas Blakeman[1,8] *NIHR Clinical Lecturer in General Practice*

Christopher A. Barton[1,9] *Lecturer in Quantitative Research Methods*

Bianca Brijnath[1,10] *NHMRC Early Career Public Health Fellow*

Nia Roberts[2] *Outreach librarian*

Corresponding author: kamal.mahtani@phc.ox.ac.uk

[1] Members of the Brisbane Initiative (Cohort 7), International Leadership Programme in Primary Care, Oxford, UK

[2] Knowledge Centre, Bodleian Health Care Libraries, University of Oxford, UK

Further affiliations

[3] Department of Primary Health Care Sciences, University of Oxford, UK
[4] Institute of Primary Care and Health Sciences, Arthritis Research UK Primary Care Centre, Keele University, UK
[5] Division of Primary Care, The University of Nottingham, Nottingham, UK
[6] Division of General Internal Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA
[7] General Practice Unit, Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil
[8] Primary Care Research, Health Sciences Research Group, School of Community Based Medicine, University of Manchester, UK
[9] Social Health Sciences, Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia
[10] Department of General Practice, Monash University, Melbourne, Australia

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Article summary

Article focus

- Increased levels of physical activity are linked with improved health and may play a key role in the prevention or treatment of most non-communicable diseases (NCD).
- The London 2012 Olympic and Paralympic Games aims to leave a long term legacy, which includes population level increases in physical and sporting activity.
- We conducted a systematic review of systematic reviews to establish whether hosting an Olympic games leads to increased participation in such activities.

Key messages

- There is little evidence that international elite sporting events such as the Olympics leads to increased participation in physical or sporting activities at the population health level. We found no evidence, in particular, relating to the Paralympic games.
- High quality, evidence based studies are needed to measure the true impact of the London 2012 games.

Strengths and limitations of this study

- Strengths: This is a systematic review of existing systematic reviews.
- Limitations: We restricted our search to those reviews published in English on previous Olympic and Paralympic Games.

Objective:

To examine if there is there an increased participation in physical or sporting activities following an Olympic or Paralympic games.

Design:

Overview of systematic reviews

Methods:

We searched the Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. In addition, we searched for "grey literature" in Google, Google scholar and on the International Olympic Committee websites. We restricted our search to those reviews published in English. We used the AMSTAR tool to assess the methodological quality of those systematic reviews included.

Primary and secondary outcome measures:

The primary outcome was evidence for an increased participation in physical or sporting activities. Secondary outcomes included public perceptions of sport during and after an Olympic Games, barriers to increased sports participation, and any other non-sporting health benefits.

Results:

Our systematic search revealed 844 citations, of which only two matched our inclusion criteria. The quality of these two reviews was assessed by three independent reviewers as 'good' using the AMSTAR tool for quality appraisal. Both reviews reported little evidence of an increased uptake of sporting activity following an Olympic Games event. Other effects on health, for example changes in hospital admissions, suicide rates and drug use, were cited although there was insufficient evidence to see an overall effect.

Conclusions:

There is a paucity of evidence to support the notion that hosting an Olympic games leads to an increased participation in physical or sporting activities for host countries. We also found little evidence to suggest other health benefits. We conclude that the true success of these and future games should be evaluated by high quality, evidence based studies that have been commissioned before, during and following the completion of the event. Only then can the true success and legacy of the games be established.

Introduction

The cost of hosting the 2012 Games of the XXX Olympiad in London has been estimated to be over £8 billion (UK) pounds.[1] Part of the justification for spending this amount and bidding to host the games, comes from the belief that the event will leave a legacy in the United Kingdom. The theme of the games, "Inspire a generation", reflected this desire to promote participation in sport in the run-up to, during and after the event.[2]

In 2010, the Department for Culture, Media and Sport outlined the UK Government's plans for this legacy, and included "harnessing the United Kingdom's passion for sport to increase grass roots participation, particularly by young people – and to encourage the whole population to be more physically active".[3] However, since the games were awarded to London in 2005, there has been an overall decline among 16-25 year olds in sport participation.[4] These findings are a cause for concern especially as a recent analysis of the burden of disease and life expectancy showed that physical inactivity has a major negative health effect worldwide linked to coronary heart disease, diabetes and cancer. It is also estimated that around 1.3 million deaths could be averted every year if physical inactivity decreased by 25%.[5]

A previous systematic review of literature published between 1978 and 2008 found insufficient evidence to support or refute any health or socioeconomic impacts from major multi-sport events.[6] We saw value in conducting an "overview of systematic reviews", thus allowing the findings of separate reviews to be compared and contrasted.[7] Secondly, we restricted our search to the impact of the Olympic and Paralympic games only, with our primary outcome of interest an increased participation in sport or recreational activities subsequent to hosting these games. Our aim was to highlight new areas that could possibly guide policy makers on decision making and planning of future games.

Methods

Data Sources and Search Strategy

Two authors (NR, KRM) devised the search strategy. One author (NR) searched Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. For each database, we applied two search filters for identifying systematic reviews.[8] We also performed searches on Google, Google Scholar and the International Olympic Committee websites. We restricted the inclusion of papers to those published in English. (Full details of the search strategy used are given in Appendix 1).

Study selection

Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Given the broad nature of non-systematic reviews, commentaries, and general opinion based articles, we restricted our search to only systematic reviews. We used the Cochrane Handbook for Systematic Reviews of Interventions for a definition of a systematic review, that is "a systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question" .[9] We included reviews which systematically appraised published literature within the remit of the review. No restriction was placed on age, gender or race. We included reviewsfrom all countries, and accepted reviews that presented their results quantitatively or as a narrative. We excluded reviews that *only* focused on other multi-sporting events (such as Winter Olympics, Commonwealth Games) as well as single sporting events (such as World cups, World Championships).

Outcomes

The primary outcome for this overview was an increased involvement in sporting activity following an Olympic Games. We define "increased uptake" as any means to demonstrate increased participation, and held no restriction on whether this was demonstrated qualitatively or quantitatively. We applied the term "sporting activity" to include any of the 36 Olympic sports (Archery, Athletics (including walking), Badminton, Basketball, Beach Volleyball, Boxing, Canoe Slalom, Canoe Sprint, Cycling – BMX, Cycling - Mountain Bike, Cycling – Road, Cycling – Track, Diving, Equestrian, Fencing, Football, Gymnastics – Artistic, Gymnastics – Rhythmic, Handball, Hockey, Judo, Modern Pentathlon, Rowing, Sailing, Shooting, Swimming, Synchronised Swimming, Table Tennis, Taekwondo, Tennis, Trampoline, Triathlon, Volleyball, Water Polo, Weightlifting and Wrestling) and 21 Paralympic sports (Archery, Athletics, Boccia, Cycling Road, Cycling Track, Football 5-a-side,

Football 7-a-side, Goalball, Equestrian, Judo, Powerlifting, Rowing, Sailing, Shooting, Swimming, Table Tennis, Sitting Volleyball, Wheelchair Basketball, Wheelchair Fencing, Wheelchair Rugby and Wheelchair Tennis).

Secondary outcomes included:

- Increases in other forms of physical activity;
- Public perceptions of sport during and after an Olympic games;
- Barriers to increased sports participation;
- Non-sporting (physical or mental) health benefits.

We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc.

Quality assessment of included reviews

We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.[11] Theassessment was carried out independently by two authors (CB, BB). Any disagreement between authors was referred to a third author(KRM) and a final decision was made.

Data extraction

Three authors (KRM, TB, MD) independently extracted data from included reviews using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

Review synthesis

All extracted data was tabulated according to study ID, year of publication, AMSTAR quality score, data relating to our primary outcome, data relating to secondary outcome. The sections relating to our primary outcome were further divided into the Olympic event to which they refer, the sporting activity and the overall impact. Quantitative synthesis was not possible and as a result it was agreed that all results be reported as a narrative.

Results

Results of search strategy

Figure 1 summarises the results of our search strategy. We initially identified 844 references after removal of duplicates. Of these, 798 references were excluded based on titles alone for a lack of relevance. Of the remaining 46 papers, a further 42 were dismissed after review of the abstracts. The majority of excluded citations were non-systematic reviews, commentaries and books. Where possible, relevant chapters of books were reviewed and included if they met our criteria. Four reviews were analysed in detail. Of these, two were subsequently excluded. Although one of these excluded reviews searched key databases, specialist bibliographic databases, and different types of evidence including grey literature, as well as contacted relevant individuals and organisations, we were unclear if its review process was carried out systematically.[12] We contacted the authors of this paper who confirmed that their study was *not* a systematic review and as a result it was excluded from our review.[13] The other excluded study[14] was an abbreviated version of one of our included reviews.[15] Personal communication with the lead author of both papers confirmed that the abbreviated version contained no additional information.[16] As a result we excluded it from our review. It was finally agreed that only two reviews were eligible for quality assessment and data extraction. The first of these was a systematic review of the evidence base for developing a physical activity and health legacy from the London 2012 Olympic and Paralympic games, commissioned by the UK Department of Health.[15] The second included study was a systematic review evaluating the health and socioeconomic impacts of major multi-sporting events between 1978 and 2008.[6] Table 1 summarises the main characteristics from the included reviews.

Quality assessment of included reviews

We only selected reviews where the objective of the study was clearly stated and fitted within the remit of this review. We used the AMSTAR methodological quality assessment tool to appraise our included reviews.[11] Overall, we found the quality of the included reviews to be good. Table 2 summarises the results of our quality appraisal using the AMSTAR tool.

Increased uptake of sporting or physical activity following an Olympic games

Both included reviews reported that the evidence to support an uptake of sport or physical activities after an Olympic games was generally weak and inconclusive. McCartney et al. reported no overall change in the recreational impact of hosting an Olympic Games.[6] They cited some evidence, however, of an upward trend in sports participation from the early 1980s until 1994, and in association with the 1992 Barcelona games in Spain. They graded the cited evidence as being of the lowest level according to their quality appraisal. Weed et. al. also referred to evidence for increased

participation following the 1992 Barcelona games.[15] The authors noted that the results were drawn from data taken 7 years prior and 3 years after the 1992 games, and highlighted a possible limitation in comparing data taken at different times and by different designs. The authors also concluded that the evidence was mixed for a "trickle down" effect on participation; it was possible that some short term benefits may have been seen but little evidence of a long term effect.

Public perceptions to sporting activity after an Olympic games

McCartney et al. did not cite any specific evidence of changes in the public's perception of sporting or physical activity following an Olympic games.[6] In contrast, Weed et al. made reference to a positive perception following elite sporting success.[15] However, they also cited evidence for a negative effect with the potential of elite sports deterring individual participation because of a perceived competence gap. The review also cited evidence for a lack of increased physical activity following the 2000 Sydney Olympics in Australia, despite the 'euphoria' that was documented as following the Games. Weed et al. also made reference to evidence from Sport England (UK) that found "more than a quarter of the population in England (26%) have been inspired by British medal-winning performances at the Olympic Games in Athens (2004)". However, they suggested that this was likely to be due to increased participation from people already partaking in sporting activity. They did however acknowledge the importance of an Olympic games in generating a "festival effect" with evidence that such a perception has the potential to increase the desire to participate in all aspects of the Games, including the increased uptake of physical activity.

Barriers to partaking in increased sporting activity

Weed et al. cite evidence that a negative perception to the Games could act as a barrier or negate completely the potential to use such an event for the development of physical activity or sport, or the promotion of health.[15] The authors also infer from their results, that the absence of planning supplemental activities to leverage and follow the main event, may also act as a barrier to further participation. Community and social empowerment were themes that were reported as being important facilitators in increasing sporting activity.

Other health benefits

The McCartney et al. study examined a number of other outcomes relating to health, wellbeing, quality of life, health service use, as well as recreation.[6] They found the quality of evidence to be mixed with no overall conclusion for a clear benefit. A moderate grade of evidence was ascribed to data relating to suicide rates which were found to be unchanged after the 1988 Seoul Olympics in South Korea. In contrast, lower levels of evidence were awarded to data showing an increase in paediatric health service demand, and a decrease in childhood asthma acute care events following

the 1996 Olympics in Atlanta, USA. A low level of evidence was given to data relating to an increase in hospital presentations related to illicit drugs following the 2000 Olympics in Sydney, Australia. Weed et al. also report no overall clear benefit on health after an Olympic Games event.[15] They cite smoking cessation data, following a campaign to reduce smoking around the Barcelona Olympics that were inconclusive in showing a positive link. They also referred to data from China in the build-up to the 2008 Beijing Olympics suggesting that general health and extended life expectancy improved using data gained from a 'national physique examination'. However, Weed et al. point out that such results should be interpreted with caution as it may not be possible to extrapolate them to other environments. A broader but similar point is discussed in the McCartney et al. review who point out that "both the commissioning of studies and their publication could well be biased towards positive results".

Discussion

Few systematic reviews have been published on the physical and sporting impact(s) that Olympic Games can have on the public. To the best of our knowledge, this is the first systematic review of systematic reviews to assess whether an Olympic event leads to an increased uptake in physical or sporting activities, in addition to other health benefits.

Overall we found little evidence to support a clear positive impact either on the uptake of activities or on other health benefits linked to hosting an Olympic games. Our review suggests that a number of factors are likely to have contributed to this. Firstly, it cannot be expected that such events will automatically increase activity simply by the event taking place. Instead, we found that a number of factors were likely to be needed, such as a "positive" perception in advance of the games, the idea that participation in physical activity need not be limited to elite sportsmen, and that there will be sufficient infrastructure to access and partake in activities within the community and schools setting after the games. As pointed out by Weed et al., the generation of a "festival" feel is likely to generate short-term positive perceptions and increased participation in a number of areas including sporting activity.[15] We also noted that both included reviews eluded that collecting data on increased physical activity after such an event may be challenging, poor or absent. As a result we recommend that evidence based strategies to record this data, locally and regionally, should already be in place following the 2012 London Games. We further recommend that such methods are executed in advance and following the 2016 Olympic Games in Rio, Brazil.

We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]

Limitations of our review

We were aware of several limitations to our review. We chose to only include data relating to the summer Olympic and Paralympic games, thus excluding the Winter Olympics as we felt that the

summer games would have a greater potential of encouraging events that could be transferable and available for mass participation worldwide. We also avoided including data from other multi-sporting events, such as the Commonwealth games, on the basis that no other single, multi-sporting, event had the same breadth of included sports or public interest as the Olympics. However, we note that data did exist, particularly following the 2002 Manchester Commonwealth games, but evidence of a definite link to increased activity was inconclusive. It was, therefore, unlikely to have changed the conclusions of our review.

We also limited our searching of "grey literature" to Google, Google scholar and the International Olympic Committee websites, as we felt that there would be a significant number of non-systematic reviews and commentaries on other sites that would not meet our inclusion criteria.

Overall conclusion

The evidence to support the notion that hosting an Olympic games leads to an automatic increase in mass sporting or physical activity is poor. Our review has found several areas of potential that could be capitalised on to test this hypothesis. Having existing routes into increased participation is likely to prove beneficial. An emphasis of involvement as well as targeting certain populations such as children and those contemplating activity, rather than just those already involved in it. The framing of an Olympic games in a broader sense, such as through a positive public perception and within a "festival" feeling, is also likely to reap benefits. The United Kingdom will host the 2014 Glasgow Commonwealth games and has a unique opportunity to build on the public interest generated from the London 2012 games.[19] We also suggest that in the interim, smaller events relating to increase sporting or physical activity, be put into place to keep the momentum generated from London 2012 going. Such events could then be capitalised on in the lead up to the 2016 Olympics in Brazil. The effects should be recorded using high quality, evidence based methods. Through such means the true success and legacy of the London 2012 games will be determined.

Figure 1

PRISMA flow diagram

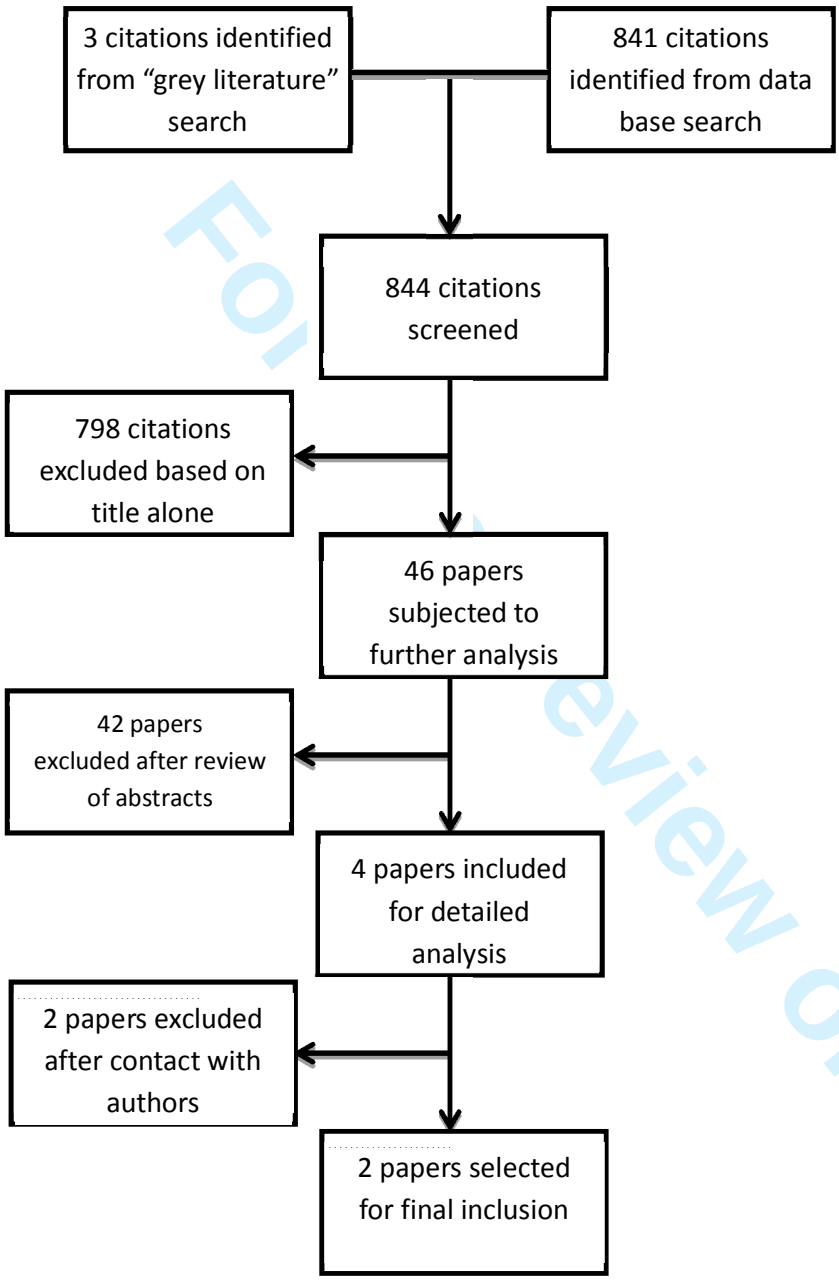

Table 1

Characteristics of included reviews

Review	Weed et al[15]	McCartney et al[19]
Year	2009	2010
Question posed by review	Four questions were established for the review: i) What evidence exists that the Olympic Games, sports events or sports franchises can impact upon physical activity and sport participation and upon health-related behaviours? ii) By what processes have physical activity and sport participation and health-related behaviours been leveraged from the Olympic Games, sports events or sports franchises? iii) What processes that have been used to leverage, inter alia, volunteering, community engagement and tourism from the Olympic Games, sports events and sports franchises might inform leveraging strategies for physical activity, sport and health? iv) How has the leveraging of a range of opportunities from Olympic Games, sports events and sports franchises been evaluated?	To assess the effects of major multi-sport events on health and socioeconomic determinants of health in the population of the city hosting the event.
Search strategy	Published literature via SPORTS DISCUS ,CINAHL, PsychINFO, MEDLINE, • Web of Knowledge (General Science and Social Science Database) In addition several sources for "grey literature" were searched (see full paper for more details)	Papers published between 1978 and 2008. From Applied Social Science Index and Abstracts (ASSIA), British Humanities Index (BHI), Cochrane database of systematic reviews, Econlit database, Embase, Education Resources Information Center (ERIC)database, Health Management Information Consortium (HMIC) database, International Bibliography of the Social Sciences (IBSS), Medline ,PreMedline, PsycINFO, Sociological Abstracts, Sportdiscus , Web of

		Knowledge, Worldwide Political Science Abstracts In addition an 'extensive' search of the grey literature (between April & October 2008) was carried out (see individual review for full details).
No of included studies	24	54
Quality appraisal tool used to assess included studies	A rudimentary quality appraisal sheet was agreed by all authors and review panel as being relevant to the research question.[16]	Assessed using a modified version of the Hamilton quality assessment tool.
Overall comment on quality of included studies	Variable. With reference to our primary outcome, was assessed to be generally poor.	Study quality was 'poor'

Table 2

Quality assessment of included reviews using the AMSTAR tool

1.	Question	Weed et al[15]	McCartney et al[6]
2.	Was an 'a priori' design provided?	Y	Y
3.	Was there duplicate study selection and data extraction?	Y	Y
4.	Was a comprehensive literature search performed?	Y	Y
5.	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Y	Y
6.	Was a list of studies (included and excluded) provided?	N-only included studies	N-only included studies
7.	Were the characteristics of the included studies provided?	Y	Y
8.	Was the scientific quality of the included studies assessed and documented?	Y	Y
9.	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Y	Y
10.	Were the methods used to combine the findings of studies appropriate?	Y	Y
11.	Was the likelihood of publication bias assessed	Y	N/A - authors state this not possible
12.	Was the conflict of interest stated?	U (although commissioned by Department of Health	Y
	Total	9	9

Key: Y=Yes, N=No, U=Unclear, N/A= Not Applicable

References

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Footnotes

Contributors

KRM, JP, SPS, MD, TB, CB, and BB are all members of Cohort 7 of The International Primary Care Research Leadership programme, part of The Brisbane Initiative to develop future leaders in primary care research. KRM had the initial idea for the review and drafted the first protocol. All authors commented and advised on this draft. KRM and NR devised the search strategy which was conducted by NR. KRM, JP and SPS screened the results of the searches and agreed on the final list of included reviews. CB and BB assed the included reviews for quality. TB and MD carried out the data extraction. KRM wrote the first draft of the final papers with contributions and edits from all remaining authors. All authors contributed to the final draft.

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No funding was sought to carry out this study.

Competing interests

None declared.

Appendix 1

Search strategies:

Medline (OvidSP) [1946 - , In process] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2255
2	(sport* adj (event* or mega-event*)).ti,ab.	505
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	15
4	((international or multination* or multi-nation*) adj games).ti,ab.	10
5	1 or 2 or 3 or 4	2730
6	(Medline or systematic review).tw. or meta-analysis.pt.	87371
7	5 and 6	20
8	meta-analysis.mp,pt. or review.pt. or search:.tw.	1884987
9	5 and 8	358

Embase (OvidSP) [1974 -] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2799
2	(sport* adj (event* or mega-event*)).ti,ab.	649
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	23
4	((international or multination* or multi-nation*) adj games).ti,ab.	17
5	1 or 2 or 3 or 4	3417
6	(meta-analysis or systematic review or MEDLINE).tw.	111218
7	5 and 6	19
8	meta-analy*:.mp. or search*.tw. or review.pt.	2102017
9	5 and 8	458

Cochrane Database of Systematic Reviews & Database of Abstracts of Reviews of Effectiveness (Cochrane Library, Wiley) – 8th August 2012

#1	(olympic* or paralympic* or special olympic*):ti,ab,kw	71
#2	(sport* near (event* or mega-event*)):ti,ab,kw	25
#3	(international or multination* or multi-nation*) near event* and sport*:ti,ab,kw	1
#4	((international or multination* or multi-nation*) near games):ti,ab,kw	1

SportDISCUS (EBSCOHost) [1980 -] – 9th August 2012

S9	S5 and S8	(485)
S8	TI (meta-analy* or review) OR AB (meta-analy* or search*)	(27026)
S7	S5 and S6	(7)
S6	TI (meta-analysis or systematic review or MEDLINE) OR AB (meta-analysis or systematic review or MEDLINE) OR KW (meta-analysis or systematic review or MEDLINE)	(4396)
S5	S1 or S2 or S3 or S4	(51244)
S4	TI (((international or multination* or multi-nation*) n2 games)) OR AB (((international or multination* or multi-nation*) n2 games))	(517)
S3	TI (((international or multination* or multi-nation*) n2 event*)) OR AB (((international or multination* or multi-nation*) n2 event*))	(1201)
S2	TI ((sport* n2 (event* or mega-event*))) OR AB ((sport* n2 (event* or mega-event*)))	(6927)
S1	TI (olympic* or paralympic*) OR AB (olympic* or paralympic*)	(44061)

Science Citation Index-EXPANDED, Social Science Citation Index [Web of Knowledge] (All years)

4 68 Topic=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
3 23 #2 OR #1
2 21 Title=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
1 3 Topic=(olympic* OR paralympic*) AND Title=(meta-analys* OR "systematic review" OR "evidence review")

Search filters used:

The validated search filters for Medline and Embase were taken from the following publications. The search of Cochrane Library is self-limiting as we included references within Cochrane Database of Systematic Reviews (CDSR) & Database of Abstracts of reviews of Effectiveness (DARE). There are no validated filters for SportsDISCUS or Web of Science – we applied keywords adapted from those used in the Medline & Embase searches for these 2 databases.

EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.

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Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team.

BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.

Search line 7 = Best specificity

(Medline or systematic review).tw. or meta-analysis.pt.

99.2 (99.1 to 99.3)

Search line 9 = Top strategy minimising the difference between sensitivity and specificity

meta-analysis.mp,pt. or review.pt or search:.tw.

Sensitivity reported as 98.0 (97.0 to 99.0)

- **Excluded papers prior to 1987**
- **Excluded animal studies**

Can the London 2012 Olympics "inspire a generation" to do more physical or sporting activities? An overview of systematic reviews

Kamal R. Mahtani[1,3] *NIHR Clinical Lecturer in General Practice*

Joanne Protheroe[1,4] *Senior Lecturer in General Practice*

Sarah Patricia Slight[1,5,6] *NIHR Postdoctoral Research Fellow*

Marcelo Marcos Piva Demarzo[1,7] *Assistant Professor in General Practice*

Thomas Blakeman[1,8] *NIHR Clinical Lecturer in General Practice*

Christopher A. Barton[1,9] *Lecturer in Quantitative Research Methods*

Bianca Brijnath[1,10] *NHMRC Early Career Public Health Fellow*

Nia Roberts[2] *Outreach librarian*

Corresponding author: kamal.mahtani@phc.ox.ac.uk

[1] Members of the Brisbane Initiative (Cohort 7), International Leadership Programme in Primary Care, Oxford, UK

[2] Knowledge Centre, Bodleian Health Care Libraries, University of Oxford, UK

Further affiliations

[3] Department of Primary Health Care Sciences, University of Oxford, UK
[4] Institute of Primary Care and Health Sciences, Arthritis Research UK Primary Care Centre, Keele University, UK
[5] Division of Primary Care, The University of Nottingham, Nottingham, UK
[6] Division of General Internal Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA
[7] General Practice Unit, Department of Preventive Medicine, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), Brazil
[8] Primary Care Research, Health Sciences Research Group, School of Community Based Medicine, University of Manchester, UK
[9] Social Health Sciences, Flinders Prevention Promotion and Primary Health Care Cluster, Flinders University, South Australia
[10] Department of General Practice, Monash University, Melbourne, Australia

Word count: 3500

Article summary

Article focus

- Increased levels of physical activity are linked with improved health and may play a key role in the prevention or treatment of most non-communicable diseases (NCD).
- The London 2012 Olympic and Paralympic Games aims to leave a long term legacy, which includes population level increases in physical and sporting activity.
- We conducted a systematic review of systematic reviews to establish whether hosting an Olympic games leads to increased participation in such activities.

Key messages

- There is little evidence that international elite sporting events such as the Olympics leads to increased participation in physical or sporting activities at the population health level. We found no evidence, in particular, relating to the Paralympic games.
- High quality, evidence based studies are needed to measure the true impact of the London 2012 games.

Strengths and limitations of this study

- Strengths: This is a systematic review of existing systematic reviews.
- Limitations: We restricted our search to those ~~studies~~reviews published in English on previous Olympic and Paralympic Games.

Objective:

To examine if there is there an increased participation in physical or sporting activities following an Olympic or Paralympic games.?

Design:

Overview of systematic reviews

Methods:

We searched the Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. In addition, we searched for "grey literature" in Google, Google scholar and on the International Olympic Committee websites. We restricted our search to those studiesreviews published in English. We used the AMSTAR tool to assess the methodological quality of those systematic reviews included.

Primary and secondary outcome measures:

The primary outcome was evidence for an increased participation in physical or sporting activities. Secondary outcomes included public perceptions of sport during and after an Olympic Games, barriers to increased sports participation, and any other non-sporting health benefits.

Results:

Our systematic search revealed 844 citations, of which only two matched our inclusion criteria. The quality of these two reviewsstudies was assessed by three independent reviewers as 'good' using the AMSTAR tool for quality appraisal. Both reviews reported little evidence of an increased uptake of sporting activity following an Olympic Games event. Other effects on health, for example changes in hospital admissions, suicide rates and drug use, were cited although there was insufficient evidence to see an overall effect.

Conclusions:

There is a paucity of evidence to support the notion that hosting an Olympic games leads to an increased participation in physical or sporting activities for host countries. We also found little evidence to suggest other health benefits. We conclude that the true success of these and future games should be evaluated by high quality, evidence based studies that have been commissioned before, during and following the completion of the event. Only then can the true success and legacy of the games be established.

Introduction

The cost of hosting the 2012 Games of the XXX Olympiad in London has been estimated to be over £8 billion (UK) pounds.[1] Part of the justification for spending this amount and bidding to host the games, comes from the belief that the event will leave a legacy in the United Kingdom. The theme of the games, "Inspire a generation", reflected this desire to promote participation in sport in the run-up to, during and after the event.[2]

In 2010, the Department for Culture, Media and Sport outlined the UK Government's plans for this legacy, and included "harnessing the United Kingdom's passion for sport to increase grass roots participation, particularly by young people – and to encourage the whole population to be more physically active".[3] However, since the games were awarded to London in 2005, there has been an overall decline among 16-25 year olds in sport participation.[4] These findings are a cause for concern especially as a recent analysis of the burden of disease and life expectancy showed that physical inactivity has a major negative health effect worldwide linked to coronary heart disease, diabetes and cancer. It is also estimated that around 1.3 million deaths could be averted every year if physical inactivity decreased by 25%.[5]

A previous systematic review of literature published between 1978 and 2008 found insufficient evidence to support or refute any health or socioeconomic impacts from major multi-sport events.[6] We saw value in conducting an "overview of systematic reviews", thus allowing the findings of separate reviews to be compared and contrasted.[7] Secondly, we restricted our search to the impact of the Olympic and Paralympic games only, with our primary outcome of interest an increased participation in sport or recreational activities subsequent to hosting these games. Our aim was to highlight new areas that could possibly guide policy makers on decision making and planning of future games.

Methods

Data Sources and Search Sstrategy

Two authors (NR, KRM) devised the search strategy. ~~We~~One author (NR) searched Medline, Embase, Cochrane, DARE, SportDISCUS and Web of Knowledge databases. For each database, we applied two search filters for identifying systematic reviews.[8] We also performed searches on Google, Google Scholar and the International Olympic Committee websites. We restricted the inclusion of papers to those published in English. (Full details of the search strategy used are given in Appendix 1).

~~Criteria for~~ Sstudy selection

Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Given the broad nature of non-systematic reviews, commentaries, and general opinion based articles, we restricted our search to only systematic reviews. We used the Cochrane Handbook for Systematic Reviews of Interventions for a definition of a systematic review, that is "a systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question".[9] We included reviews~~studies~~ which systematically appraised published literature within the remit of the review. No restriction was placed on age, gender or race. We included ~~studies~~ reviews from all countries, and accepted ~~studies~~ reviews that presented their results quantitatively or as a narrative. We excluded reviews that *only* focused on other multi-sporting events (such as Winter Olympics, Commonwealth Games) as well as single sporting events (such as World cups, World Championships).

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Outcomes

The primary outcome for this overview was an increased involvement in ~~physical or~~ sporting activity following an Olympic Games. We define "increased uptake" as any means to demonstrate increased participation, and held no restriction on whether this was demonstrated qualitatively or quantitatively. We applied the term "~~"~~sporting activity"~~'~~ to include any of the 36 Olympic sports (Archery, Athletics (including walking), Badminton, Basketball, Beach Volleyball, Boxing, Canoe Slalom, Canoe Sprint, Cycling – BMX, Cycling - Mountain Bike, Cycling – Road, Cycling – Track, Diving, Equestrian, Fencing, Football, Gymnastics – Artistic, Gymnastics – Rhythmic, Handball, Hockey, Judo, Modern Pentathlon, Rowing, Sailing, Shooting, Swimming, Synchronised Swimming, Table Tennis, Taekwondo, Tennis, Trampoline, Triathlon, Volleyball, Water Polo, Weightlifting and Wrestling) and 21 Paralympic sports (Archery, Athletics, Boccia, Cycling Road, Cycling Track, Football 5-a-side,

Football 7-a-side, Goalball, Equestrian, Judo, Powerlifting, Rowing, Sailing, Shooting, Swimming, Table Tennis, Sitting Volleyball, Wheelchair Basketball, Wheelchair Fencing, Wheelchair Rugby and Wheelchair Tennis). ~~We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.~~[10]

Secondary outcomes included:

- Increases in other forms of physical activity;
- Public perceptions of sport during and after an Olympic games;
- Barriers to increased sports participation;
- Non-sporting (physical or mental) health benefits.

We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc.

~~Critical appraisal~~Quality assessment of included reviews~~studies~~

We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.[11] The~~Quality~~ assessment ~~of included studies~~ was carried out independently by two authors (CB, BB). Any disagreement between authors was referred to a third author~~, verified by a third~~ (KRM) and a final decision was made. ~~We used the AMSTAR measurement tool to assess the quality of the included reviews. This 11-point assessment tool is, to the best of our knowledge, the only one validated tool for this purpose.~~[11]

Data extraction

Three authors (KRM, TB, MD) independently extracted data from included reviews using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included ~~studies~~studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.

Review synthesis

All extracted data was tabulated according to study ID, year of publication, AMSTAR quality score, data relating to our primary outcome, data relating to secondary outcome. The sections relating to

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our primary outcome were further divided into the Olympic event to which they refer, the sporting activity and the overall impact. Quantitative synthesis was not possible and as a result it was agreed that all results be reported as a narrative.

~~Review synthesis~~

~~Two authors (NR, KRM) devised the search strategy. Three authors (KRM, JP, SPS) independently screened the results of the searches, according to the inclusion criteria, which were agreed *a priori*. Any disagreement between these authors was resolved by discussion. Quality assessment of included studies was carried out by two authors (CB, BB), verified by a third (KRM), and assessed using the AMSTAR tool for the methodological quality of systematic reviews. Three authors independently extracted data from these reviews (KRM, TB, MD), using a predefined data extraction sheet. We included the title, author, year and funding source, study aim, search strategy, no. of included studies, inclusion and exclusion criteria, population(s) for which the studies have been set in, Olympic Games being referred to, overall conclusions, and implications for future practice. We avoided looking at the primary data unless we felt further relevant information was needed.~~

Results

Results of search strategy

Figure 1 summarises the results of our search strategy. We initially identified 844 references after removal of duplicates. Of these, 798 references were excluded based on titles alone ~~by three reviewers (KRM, JP, SPS)~~ for a lack of relevance. Of the remaining 46 papers, a further 42 were dismissed after review of the abstracts. The majority of excluded ~~studies~~citations were non-systematic reviews, commentaries and books. Where possible, relevant chapters of books were reviewed and included if they met our criteria. Four ~~studies~~reviews were ~~reviewed~~ analysed in detail. Of these, two were subsequently excluded. Although one of these excluded ~~studies~~reviews searched key databases, specialist bibliographic databases, and different types of evidence including grey literature, as well as contacted relevant individuals and organisations, we were unclear if its review process was carried out systematically.[12] We contacted the authors of this paper who confirmed that their study was *not* a systematic review and as a result it was excluded from our review.[13] The other excluded study[14] was an abbreviated version of one of our included ~~studies~~reviews.[15] Personal communication with the lead author of both papers confirmed that the abbreviated version contained no additional information.[16] As a result we excluded it from our review. It was finally agreed that only two ~~studies~~reviews were eligible for quality assessment and data extraction. The first of these was a systematic review of the evidence base for developing a physical activity and health legacy from the London 2012 Olympic and Paralympic games, commissioned by the UK Department of Health.[15] The second included study was a systematic review evaluating the health and socioeconomic impacts of major multi-sporting events between 1978 and 2008.[6] Table 1 summarises the main characteristics from the included ~~studies~~reviews.

Quality assessment of included reviews

We only selected reviews where the objective of the study was clearly stated and fitted within the remit of this review. We used the AMSTAR methodological quality assessment tool to appraise our included ~~studies~~reviews.[11] Overall, we found the quality of the included ~~studies~~reviews to be good. Table 2 summarises the results of our quality appraisal using the AMSTAR tool.

Increased uptake of sporting or physical activity following an Olympic games

Both included ~~studies~~reviews reported that the evidence to support an uptake of sport or physical activities after an Olympic games was generally weak and inconclusive. McCartney et al. reported no overall change in the recreational impact of hosting an Olympic Games.[6] They cited some evidence, however, of an upward trend in sports participation from the early 1980s until 1994, and in association with the 1992 Barcelona games in Spain. They graded the cited evidence as being of the

lowest level according to their quality appraisal. Weed et. al. also referred to evidence for increased participation following the 1992 Barcelona games.[15] The authors noted that the results were drawn from data taken 7 years prior and 3 years after the 1992 games, and highlighted a possible limitation in comparing data taken at different times and by different designs. The authors also concluded that the evidence was mixed for a "trickle down" effect on participation; it was possible that some short term benefits may have been seen but little evidence of a long term effect.

Public perceptions to sporting activity after an Olympic games

McCartney et al. did not cite any specific evidence of changes in the public's perception of sporting or physical activity following an Olympic games.[6] In contrast, Weed et al. made reference to a positive perception following elite sporting success.[15] However, they also cited evidence for a negative effect with the potential of elite sports deterring individual participation because of a perceived competence gap. The review also cited evidence for a lack of increased physical activity following the 2000 Sydney Olympics in Australia, despite the 'euphoria' that was documented as following the Games. Weed et al. also made reference to evidence from Sport England (UK) that found "more than a quarter of the population in England (26%) have been inspired by British medal-winning performances at the Olympic Games in Athens (2004)". However, they suggested that this was likely to be due to increased participation from people already partaking in sporting activity. They did however acknowledge the importance of an Olympic games in generating a "festival effect" with evidence that such a perception has the potential to increase the desire to participate in all aspects of the Games, including the increased uptake of physical activity.

Barriers to partaking in increased sporting activity

Weed et al. cite evidence that a negative perception to the Games could act as a barrier or negate completely the potential to use such an event for the development of physical activity or sport, or the promotion of health.[15] The authors also infer from their results, that the absence of planning supplemental activities to leverage and follow the main event, may also act as a barrier to further participation. Community and social empowerment were themes that were reported as being important facilitators in increasing sporting activity.

Other health benefits

The McCartney et al. study examined a number of other outcomes relating to health, wellbeing, quality of life, health service use, as well as recreation.[6] They found the quality of evidence to be mixed with no overall conclusion for a clear benefit. A moderate grade of evidence was ascribed to data relating to suicide rates which were found to be unchanged after the 1988 Seoul Olympics in South Korea. In contrast, lower levels of evidence were awarded to data showing an increase in

paediatric health service demand, and a decrease in childhood asthma acute care events following the 1996 Olympics in Atlanta, USA. A low level of evidence was given to data relating to an increase in hospital presentations related to illicit drugs following the 2000 Olympics in Sydney, Australia. Weed et al. also report no overall clear benefit on health after an Olympic Games event.[15] They cite smoking cessation data, following a campaign to reduce smoking around the Barcelona Olympics that were inconclusive in showing a positive link. They also referred to data from China in the build-up to the 2008 Beijing Olympics suggesting that general health and extended life expectancy improved using data gained from a 'national physique examination'. However, Weed et al. point out that such results should be interpreted with caution as it may not be possible to extrapolate them to other environments. A broader but similar point is discussed in the McCartney et al. review who point out that "both the commissioning of studies and their publication could well be biased towards positive results".

Discussion

Few systematic reviews have been published on the physical and sporting impact(s) that Olympic Games can have on the public. To the best of our knowledge, this is the first systematic review of systematic reviews to assess whether an Olympic event leads to an increased uptake in physical or sporting activities, in addition to other health benefits.

Overall we found little evidence to support a clear positive impact either on the uptake of activities or on other health benefits linked to hosting an Olympic games. Our review suggests that a number of factors are likely to have contributed to this. Firstly, it cannot be expected that such events will automatically increase activity simply by the event taking place. ~~If this was the case we would have expected significantly more data from our searches following previous games.~~ Instead, we found that a number of factors were likely to be needed, such as a "positive" perception in advance of the games, the idea that participation in physical activity need not be limited to elite sportsmen, and that there will be sufficient infrastructure to access and partake in activities within the community and schools setting after the games. As pointed out by Weed et al., the generation of a "festival" feel is likely to generate short-term positive perceptions and increased participation in a number of areas including sporting activity.[15] We also noted that both included ~~studies~~reviews eluded that collecting data on increased physical activity after such an event may be challenging, poor or absent. As a result we recommend that evidence based strategies to record this data, locally and regionally, should already be in place following the 2012 London Games. We further recommend that such methods are executed in advance and following the 2016 Olympic Games in Rio, Brazil.

We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]

Limitations of our review

We were aware of several limitations to our review. We chose to only include data relating to the summer Olympic and Paralympic games, thus excluding the Winter Olympics as we felt that the summer games would have a greater potential of encouraging events that could be transferable and available for mass participation worldwide. We also avoided including data from other multi-sporting events, such as the Commonwealth games, on the basis that no other single, multi-sporting, event had the same breadth of included sports or public interest as the Olympics. However, we noted that data did exist, particularly following the 2002 Manchester Commonwealth games, but evidence of a definite link to increased activity was inconclusive. It was, therefore, unlikely to have changed the conclusions of our review.

We also limited our searching of "grey literature" to Google, Google scholar and the International Olympic Committee websites, as we felt that there would be a significant number of non-systematic reviews and commentaries on other sites that would not meet our inclusion criteria.

Overall conclusion

The evidence to support the notion that hosting an Olympic games leads to an automatic increase in mass sporting or physical activity is poor. Our review has found several areas of potential that could be capitalised on to test this hypothesis. Having existing routes into increased participation is likely to prove beneficial. An emphasis of involvement as well as targeting certain populations such as children and those contemplating activity, rather than just those already involved in it. The framing of an Olympic games in a broader sense, such as through a positive public perception and within a "festival" feeling, is also likely to reap benefits. The United Kingdom will host the 2014 Glasgow Commonwealth games and has a unique opportunity to build on the public interest generated from the London 2012 games.[19] We also suggest that in the interim, smaller events relating to increase sporting or physical activity, be put into place to keep the momentum generated from London 2012 going. Such events could then be capitalised on in the lead up to the 2016 Olympics in Brazil. The effects should be recorded using high quality, evidence based methods. Through such means the true success and legacy of the London 2012 games will be determined.

Figure 1

PRISMA flow diagram

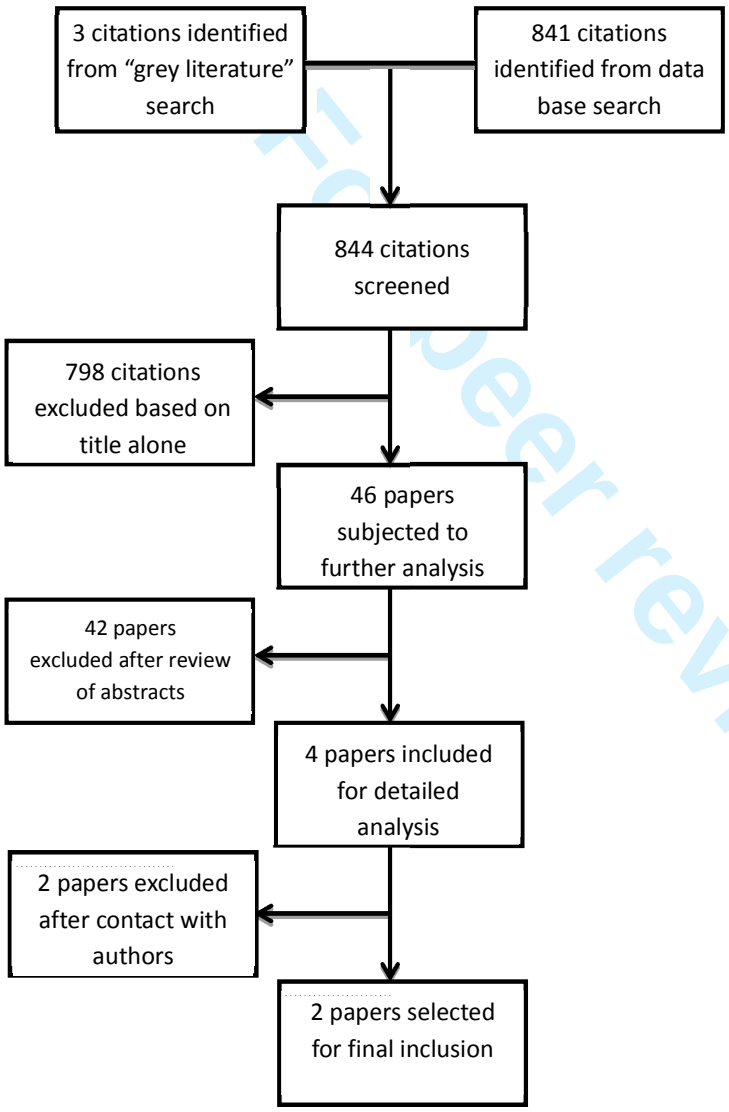

Table 1

Characteristics of included ~~studies~~reviews

Review	Weed et al[15]	McCartney et al[19]
Year	2009	2010
Question posed by review	Four questions were established for the review: i) What evidence exists that the Olympic Games, sports events or sports franchises can impact upon physical activity and sport participation and upon health-related behaviours? ii) By what processes have physical activity and sport participation and health-related behaviours been leveraged from the Olympic Games, sports events or sports franchises? iii) What processes that have been used to leverage, inter alia, volunteering, community engagement and tourism from the Olympic Games, sports events and sports franchises might inform leveraging strategies for physical activity, sport and health? iv) How has the leveraging of a range of opportunities from Olympic Games, sports events and sports franchises been evaluated?	To assess the effects of major multi-sport events on health and socioeconomic determinants of health in the population of the city hosting the event.
Search strategy	Published literature via SPORTS DISCUS ,CINAHL, PsychINFO, MEDLINE, • Web of Knowledge (General Science and Social Science Database) In addition several sources for "grey literature" were searched (see full paper for more details)	Papers published between 1978 and 2008. From Applied Social Science Index and Abstracts (ASSIA), British Humanities Index (BHI), Cochrane database of systematic reviews, Econlit database, Embase, Education Resources Information Center (ERIC)database, Health Management Information Consortium (HMIC) database, International Bibliography of the Social Sciences (IBSS), Medline ,PreMedline, PsycINFO, Sociological Abstracts, Sportdiscus , Web of

		Knowledge, Worldwide Political Science Abstracts In addition an 'extensive' search of the grey literature (between April & October 2008) was carried out (see individual review for full details).
No of included studies	24	54
Quality appraisal tool used to assess included studies	A rudimentary quality appraisal sheet was agreed by all authors and review panel as being relevant to the research question.[16]	Assessed using a modified version of the Hamilton quality assessment tool.
Overall comment on quality of included studies	Variable. With reference to our primary outcome, was assessed to be generally poor.	Study quality was 'poor'

Table 2

Quality assessment of included ~~studies~~reviews using the AMSTAR tool

1.	Question	Weed et al[15]	McCartney et al[6]
2.	Was an 'a priori' design provided?	Y	Y
3.	Was there duplicate study selection and data extraction?	Y	Y
4.	Was a comprehensive literature search performed?	Y	Y
5.	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Y	Y
6.	Was a list of studies (included and excluded) provided?	N-only included studies	N-only included studies
7.	Were the characteristics of the included studies provided?	Y	Y
8.	Was the scientific quality of the included studies assessed and documented?	Y	Y
9.	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Y	Y
10.	Were the methods used to combine the findings of studies appropriate?	Y	Y
11.	Was the likelihood of publication bias assessed	Y	N/A - authors state this not possible
12.	Was the conflict of interest stated?	U (although commissioned by Department of Health	Y
	Total	9	9

Key: Y=Yes, N=No, U=Unclear, N/A= Not Applicable

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Footnotes

Contributors

KRM, JP, SPS, MD, TB, CB, and BB are all members of Cohort 7 of The International Primary Care Research Leadership programme, part of The Brisbane Initiative to develop future leaders in primary care research. KRM had the initial idea for the review and drafted the first protocol. All authors commented and advised on this draft. KRM and NR devised the search strategy which was conducted by NR. KRM, JP and SPS screened the results of the searches and agreed on the final list of included ~~studies~~reviews. CB and BB assed the included ~~studies~~reviews for quality. TB and MD carried out the data extraction. KRM wrote the first draft of the final papers with contributions and edits from all remaining authors. All authors contributed to the final draft.

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No funding was sought to carry out this study.

Competing interests

None declared.

Appendix 1

Search strategies:

Medline (OvidSP) [1946 - , In process] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2255
2	(sport* adj (event* or mega-event*)).ti,ab.	505
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	15
4	((international or multination* or multi-nation*) adj games).ti,ab.	10
5	1 or 2 or 3 or 4	2730
6	(Medline or systematic review).tw. or meta-analysis.pt.	87371
7	5 and 6	20
8	meta-analysis.mp,pt. or review.pt. or search:.tw.	1884987
9	5 and 8	358

Embase (OvidSP) [1974 -] – 9th August 2012

1	(olympic* or paralympic*).ti,ab.	2799
2	(sport* adj (event* or mega-event*)).ti,ab.	649
3	((international or multination* or multi-nation*) adj event*).ti,ab. and sport*.mp.	23
4	((international or multination* or multi-nation*) adj games).ti,ab.	17
5	1 or 2 or 3 or 4	3417
6	(meta-analysis or systematic review or MEDLINE).tw.	111218
7	5 and 6	19
8	meta-analy*:.mp. or search*.tw. or review.pt.	2102017
9	5 and 8	458

Cochrane Database of Systematic Reviews & Database of Abstracts of Reviews of Effectiveness (Cochrane Library, Wiley) – 8th August 2012

#1	(olympic* or paralympic* or special olympic*):ti,ab,kw	71
#2	(sport* near (event* or mega-event*)):ti,ab,kw	25
#3	(international or multination* or multi-nation*) near event* and sport*:ti,ab,kw	1
#4	((international or multination* or multi-nation*) near games):ti,ab,kw	1

SportDISCUS (EBSCOHost) [1980 -] – 9th August 2012

S9	S5 and S8	(485)
S8	TI (meta-analy* or review) OR AB (meta-analy* or search*)	(27026)
S7	S5 and S6	(7)
S6	TI (meta-analysis or systematic review or MEDLINE) OR AB (meta-analysis or systematic review or MEDLINE) OR KW (meta-analysis or systematic review or MEDLINE)	(4396)
S5	S1 or S2 or S3 or S4	(51244)
S4	TI (((international or multination* or multi-nation*) n2 games)) OR AB (((international or multination* or multi-nation*) n2 games))	(517)
S3	TI (((international or multination* or multi-nation*) n2 event*)) OR AB (((international or multination* or multi-nation*) n2 event*))	(1201)
S2	TI ((sport* n2 (event* or mega-event*))) OR AB ((sport* n2 (event* or mega-event*)))	(6927)
S1	TI (olympic* or paralympic*) OR AB (olympic* or paralympic*)	(44061)

Science Citation Index-EXPANDED, Social Science Citation Index [Web of Knowledge] (All years)

4 68 Topic=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
3 23 #2 OR #1
2 21 Title=(olympic* OR paralympic*) AND Topic=(meta-analys* OR "systematic review" OR "evidence review" OR medline OR search*)
1 3 Topic=(olympic* OR paralympic*) AND Title=(meta-analys* OR "systematic review" OR "evidence review")

Search filters used:

The validated search filters for Medline and Embase were taken from the following publications. The search of Cochrane Library is self-limiting as we included references within Cochrane Database of Systematic Reviews (CDSR) & Database of Abstracts of reviews of Effectiveness (DARE). There are no validated filters for SportsDISCUS or Web of Science – we applied keywords adapted from those used in the Medline & Embase searches for these 2 databases.

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EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.

J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.

Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team.

BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.

Search line 7 = Best specificity

(Medline or systematic review).tw. or meta-analysis.pt.

99.2 (99.1 to 99.3)

Search line 9 = Top strategy minimising the difference between sensitivity and specificity

meta-analysis.mp,pt. or review.pt or search:.tw.

Sensitivity reported as 98.0 (97.0 to 99.0)

~~**Limits applied:**~~

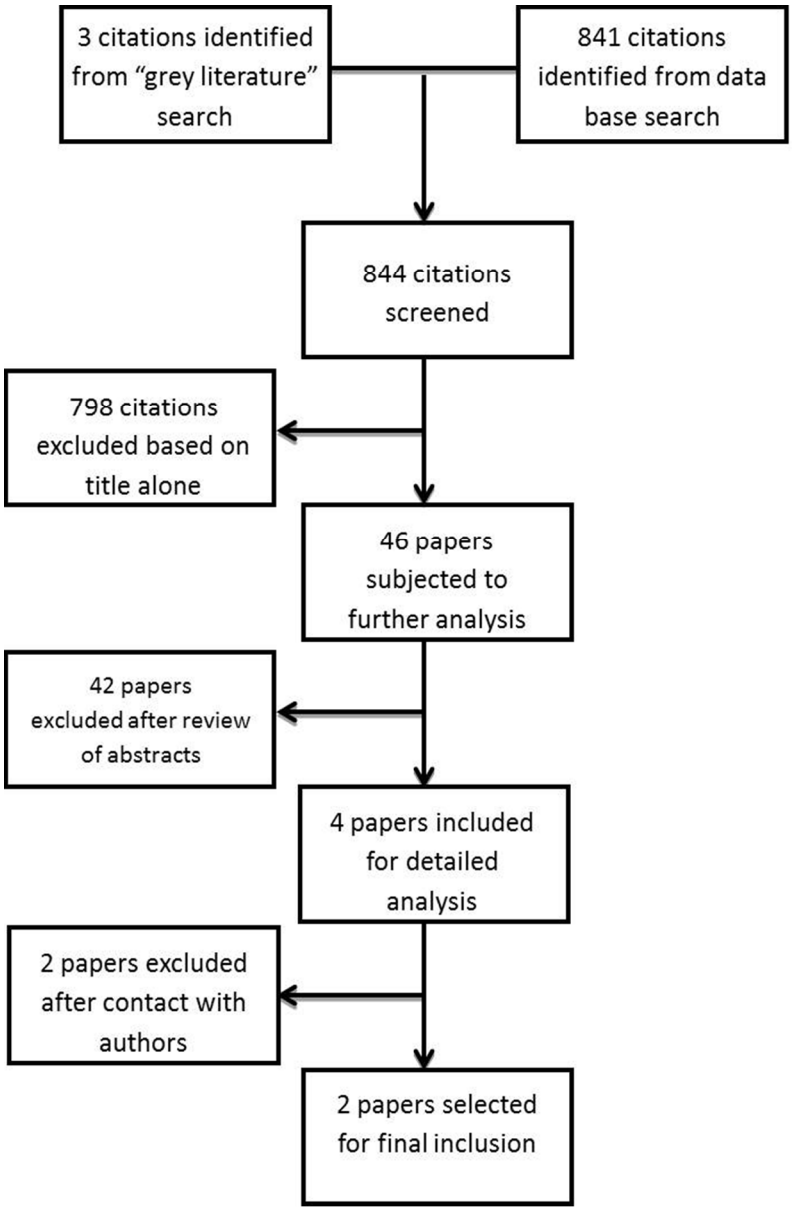
- ~~**Systematic review search filters taken from the following 2 articles**:~~

~~Highly specific(1) and balance between sensitivity & specificity(2).~~

~~Optimal search strategies for retrieving systematic reviews from Medline: analytical survey. Montori VM, Wilczynski NL, Morgan D, Haynes RB; Hedges Team. BMJ. 2005 Jan 8;330(7482):68. Epub 2004 Dec 24.~~

~~EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. Wilczynski NL, Haynes RB; Hedges Team.J Clin Epidemiol. 2007 Jan;60(1):29-33. Epub 2006 Jul 20.~~

- **Excluded papers prior to 1987**
- **Excluded animal studies**



117x178mm (150 x 150 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	n/a
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	10
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	17

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open - Decision on Manuscript ID bmjopen-2012-002058

Dr Kamal R. Mahtani, Dr Joanne Protheroe, Dr Sarah Patricia Slight, Dr Marcelo Marcos Piva Demarzo, Dr Thomas Blakeman, Dr Christopher A. Barton, Dr Bianca Brijnath, Ms Nia Roberts.

Authors reply

We have aimed to reply to each individual point raised by each reviewer. For clarity, the reviewer's comments are inserted in ***bold italic*** preceding our reply.

Reviewer 1: Hilary Thomson
Senior Investigator Scientist
MRC/CSO Social & Public Health Sciences Unit, Glasgow, UK.

I declare that I was an author on one of the systematic reviews included in this review of reviews. I am not aware of other competing interests.
We would like to thank Dr Thomson for taking the time to review our paper and for declaring her competing interest(s).

I can't see Appendix 1 to look at the search strategy and the reference the authors provide for search filters does not detail filters.
We are sorry to hear that Dr Thompson did not see Appendix 1. It is present within the word document on pages 19 – 20.

Our search filters are clearly included at the end of our search strategy. We have also added a statement to explain in more detail the filters that were used. We would like to point out that one of the authors (Nia Roberts) is an information specialist for the Cochrane Effective Practice and Organisation of Care Group. Her significant expertise was highly valued in devising and conducting an appropriately high standard search strategy.

There seems to be duplication between the secondary and primary outcomes which both include physical activity. Also were the primary outcomes used as a key screening criterion? That is if a review was identified that only addressed secondary outcomes would this have been excluded?
We have clarified our primary and secondary outcomes to avoid any risk of duplication. The primary outcome was an increased uptake of sporting activity. Secondary outcomes included "increases in other forms of physical activity". We applied the WHO definition of "physical activity", that is "any bodily movement produced by skeletal muscles that requires energy expenditure" as referenced in the text. This was deliberately chosen to ensure that other forms of physical (e.g. dancing) or sporting (since this also comes under the WHO definition) activities were included, thus making our search as comprehensive as possible. If a relevant review contained information relating to *only* a secondary outcome it was still included. However, we confirm that no such review met our inclusion criteria.

It is not clear what the authors used as a definition for a systematic review.
We used the definition quoted in the Cochrane Handbook for Systematic Reviews of Interventions. This line has now been added to the text and the handbook cited.

The methods of synthesis are not described. Given the nature of the data identified and the way the review has been presented this review has primarily provided a summary of the two reviews, and a limited narrative synthesis of reported data.
Within the methods section the approach to screening, appraisal and data extraction are described under synthesis- these items are not part of the synthesis. Also it is not entirely clear whether the screening, appraisal, and data extraction were conducted by more than one reviewer for each citation requiring this or whether the work was divided across the three reviewers.

With regards to the review synthesis process, we have taken Dr Thomson's point on board and rearranged our headings for increased clarity.

The "Methods" section is now divided into 1) Data sources and Search Strategy 2) Study selection 3) Outcomes 4) Quality assessment of included reviews 5) Data extraction and 6) Review synthesis. We have added a paragraph to this last section to help improve clarity. Within each section, we have made clear the role of each author. Each author carried out their role *independently* of each other. We also stated how any disagreements in the review process were resolved (e.g through discussion or referral to a third author).

What is meant by verifying "quality assessment"?

Unfortunately, we are unable to locate the term "verifying quality assessment" anywhere in the text.

I question the credibility or usefulness of this paper rather than the results themselves. It is unclear what the rationale or value of this review of reviews is, and what this paper contributes to the literature or adds to what the previous reviews and commentaries have made already presented relatively recently. Two systematic reviews addressing a broader range of events and outcomes have been published in the past 2-3 years. These were large scale reviews and in the course of their searching they would have identified existing systematic reviews, and other reviews for inclusion in their own review. In addition, there have been a number of editorial and commentary pieces published over the past year in the Lancet and the BMJ drawing attention to the nature and lack of available evidence. The authors (and many readers) would have known (even if not before but certainly after the searches) that there are very few systematic reviews addressing this topic, and what is available is relatively recent.

We would like to address Dr Thomson's comment on the credibility and usefulness of our manuscript in two parts (including the reply to the query below). In regard to the credibility of our review we would like to make several points. Firstly, all authors have a wealth of experience in both quantitative and qualitative research methods, including systematic reviews, which contributed to a systematic approach to our research question. We formulated and refined our question through numerous consensus discussions between all authors, chose a clear and appropriate search strategy, set clear inclusion/exclusion criteria, used (at a minimum) dual selection and extraction of included

reviews, assessed quality using the validated AMSTAR tool, compared and contrasted included reviews as a narrative, made an overall conclusion and highlighted the limitations of our own review. Secondly, and as mentioned earlier, one of the authors is also a registered information specialist with Cochrane UK and thus gave credibility to the provenance of our search strategy. Finally, the authors have a multinational mix of backgrounds e.g Brazil, Australia, USA and the UK. In keeping with the subject matter (i.e. a multi nation sporting event like the Olympics), the authors were able to offer unique insights into their own country's culture and sporting event history. We would argue that, if anything, these points strengthen the credibility of our review.

In addition to the paper presenting what appears to be an premature and unnecessary review of reviews the review itself has a fairly limited scope, further limiting the usefulness of the paper.

We believe our review is timely, necessary and useful for several reasons. First, our study is the first overview of systematic reviews. Therefore we have used a different methodology to the systematic reviews to which Dr Thomson is referring to. The purpose of our review was to compare and contrast existing systematic reviews on this topic. Through a combination of our "characteristics of included reviews" table, "Assessment of review quality using AMSTAR" and narrative we believe that this objective has been reached. Our review is also useful as, prior to its undertaking, it was unclear whether any additional reviews existed relevant to the research question. Dr Thomson highlighted two existing systematic reviews (both included in our overview). In fact, our review highlighted a third potentially relevant review which we chose to exclude after personal communication with the author. The fact that our methodology was both systematic and had a clear audit trail has meant that any reader (or policy maker) can be confident of these results presented to them. We would go further to say that our paper helps readers not only contrasts the results between reviews but helps summarise the evidence (e.g., the study by Weed et al. was 70 pages long) and point to a consistency in the direction of effect.

Our overview is also the most up-to-date study (as of August 2012) relevant to this research question. We would like to point out that the McCartney et al. review assessed studies up to 2008, and the Weed et. al. review was published in 2009. Taken together, this suggests a three to four year knowledge gap in the literature relevant to this topic, suggesting that our overview of reviews is neither premature nor unnecessary.

Finally, the fact we have produced a methodologically sound review in the same year as the London 2012 Olympic Games is very significant. No other previous games have placed a greater emphasis on an "Olympic legacy" than London 2012. Our review not only highlights to readers (and stake holders) that there is a paucity of overall evidence, but raises doubts over an automatic increase in uptake of sporting activity following a summer Olympic Games. Further, groups such as the London Organising Committee of the Olympic and Paralympic Games (LOCOG), may build on this finding to fill the gaps of evidence and put greater impetus to fulfil their desire for a lasting legacy.

The review only included reviews which had included data from summer Olympic and Paralympic games, and not other multi-sporting events or winter Olympic games, and was the primary outcomes were limited to sport and physical activity.

The fact and justification for limiting our research question to just the summer Olympic Games has been clearly pointed out in the opening paragraph of our "Limitations of this review" section within the discussion section.

More details on the specific strengths and weaknesses of the two included reviews would be helpful and an appendix with the AMSTAR data for both reviews would be useful.
The results with respect to reporting of the primary outcomes could benefit from further clarification. It is not always clear if the reported results relate to general conclusions of one of the two reviews or findings from studies on specific games, or whether the outcome being referred to is a specific sporting activity, general sporting activity, or physical activity.

An appendix with the result of our quality assessment using the AMSTAR tool is present in Table 2. We have researched other existing reviews of systematic reviews, and feel that the combination of our 1) "characteristics of included studies" table and 2) AMSTAR summary for each review is in keeping with other reviews of systematic reviews, although we welcome any further additional suggestions for improvement.

The rationale that if there had been an increase in activity following games that there would have been significantly more data identified does not make sense.
We thank Dr Thomson for pointing this out. We have removed this line from the discussion to avoid any confusion and feel the remaining paragraph makes our point clearly.

An issue arising throughout the paper is describing reviews as studies. The paper should be revised to ensure clarity when the authors are referring to a review, a review or reviews, a primary study, or a non-empirical paper.
We have taken Dr. Thomson's excellent point on board and have now clearly differentiated between reviews and studies.

Reviewer 2: Dr Simon Till
Consultant in Sport/Exercise Medicine & Rheumatology Sheffield Teaching Hospitals NHS Foundation Trust

I have no conflicts on interest.
I would approve publication without revision.

We are grateful to Dr Till for taking the time to review our manuscript and thank him for recommending our paper for publication.

My comment to the authors was that I was pleased they had raised awareness of what is a gap in knowledge at a time when it is imperative that LOCOG and the UK Government follow through on their commitments to ensure a health and physical activist legacy from what has been an their wise extremely successful Olympics and Paralympics.

We also thank him for pointing out that our paper has raised awareness of a current knowledge gap in the literature.

Reviewer 3: Dr Garry A. Tew
Senior Research Fellow
Centre for Sport and Exercise Science
Sheffield Hallam University
United Kingdom

This well-written review of reviews by Mahtani et al. focuses on the participation legacy of the Olympic and Paralympic games. Their conclusion is much the same as the two reviews that passed their study eligibility criteria: there's little evidence to support such a legacy at present.
We are grateful to Dr Tew for taking the time to review our manuscript. We also thank him for his helpful comments for improvements.

Minor comments:
Abstract - please rephrase the objective so that it begins "To..." rather than reading like a research question.
We have updated our objective as requested. It now reads: "To examine if there is there an increased participation in physical or sporting activities following an Olympic or Paralympic games."

Was the search limited to specific years?
We excluded citations prior to 1987 as we felt it was highly unlikely that a systematic review that met our inclusion criteria would exist prior to this date. Full details of our search strategy and filters can be found in appendix 1.

Intro - Ref #4 is an indirect reference - please cite the actual source to which you are referring to.
We have corrected reference 4 and now cite the original document from which the report was taken.

Secondary outcomes - "increases in other forms of physical activity" - I'm not sure what this means
By "increases in other forms of physical activity," we meant we wished to be as inclusive as possible in our secondary outcomes. For clarity, we have now added the lines "We followed the WHO definition of "physical activity", that is any bodily movement produced by skeletal muscles that requires energy expenditure.[10] This was to include other forms of physical activity to include those sports not mentioned above as well as non-Olympic physical activities such e.g. dance, skipping etc."

The authors may want to highlight that London 2012 was the first games that specifically aimed at delivering a participation legacy. Olympic legacy is a relatively recent concept, and previous games have had a narrower focus, e.g. just develop transport infrastructure and sporting facilities within the host city. The authors may also wish to consider highlighting the difficulty presented by demonstrating a participation legacy, e.g. how can one be sure that an observed change in participation is attributed to the games? (Mike Weed has written an editorial in the BMJ about this.)
Thank you for highlighting the point regarding the emphasis placed on legacy for the London 2012 Olympic Games and the challenges in recording this data. We have now incorporated this reflection in to our discussion which now reads: "We also noted that the London 2012 Olympic Games, more so than previous ones, have placed a greater emphasis on leaving a legacy. As a result pressure will mount on ensuring that this is achieved. We note that the 2010 Department for Culture Media and Sport document outlining the UK Governments plans for a legacy after the Olympic Games included

numerous proposals to improve mass participation in sport and increased activity. However the government proposals from 2010 contrast with recent reports, following the 2012 games, of a decline in sports diversity and coaching as a result of funding cuts.[17] Part of the problem may lie in the difficulty in measuring this impact. As pointed out in the 2010 editorial several confounders are likely to contribute to an apparent increase in sports participation.[18] For example a free swimming programme for under 16 and over 60 year olds may simply result in people who already swim, now swimming for free or more often. This then does not meet the remit of facilitating more people to participate.[18]"