The role of sports physiotherapy at the London 2012 Olympic Games

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Accepted 3 November 2013

ABSTRACT

Background There is a lack of information on the utilisation of physiotherapy services at the Olympic Games.

Aim To better understand the athlete and non-athlete requirements of the physiotherapy services at the Olympic Village Polyclinic during the London 2012 Olympic Games.

Methods From 16 July to 14 August 2012, physiotherapy encounters for athletes and non-athletes (National Olympic Committee (NOC) team officials, coaches, team managers, workforce, Olympic family, technical officials and press) were recorded on the ATOS electronic medical records system at the polyclinic in the main Athletes' Village in Stratford.

Results Of the 1778 encounters, 1219 (69%) were administered to athletes and 559 (31%) to non-athletes. The anatomical areas most frequently recorded at the first visits for athletes were knee (15.4%), lumbar spine/lower back (15.2%) and upper leg (12.6%) and that for non-athletes were lumbar spine/lower back (19.8%), knee (15.8%) and neck/cervical spine. Muscle (33.3%) and joint injuries (24.8%) were the most common diagnoses in athletes and non-athletes (24.4% and 30.1%). The five most frequently used treatment modalities were therapeutic soft tissue techniques (23.3%), mobilisation techniques (21.8%), taping (8.9%), cryotherapy (6.9%) and exercise prescription (6.4%). The most common cause of athletes' injuries was overuse (43.6%).

Conclusions This study of the London 2012 Olympic Games workload highlights the physiotherapy needs of athletes as well as non-athletes and identifies the high numbers of pre-existing and overuse injuries in this setting, providing an insight into the reasons why the athletes seek physiotherapy support during the Olympic Games.

INTRODUCTION

The protection of the health of the Olympic athlete is the core objective of the International Olympic Committee (IOC) Medical Commission (MC).[1] Physiotherapy has become an essential part of the sports medicine team.[2] Physiotherapy service planning and preparation for competing athletes included servicing facilities for three polyclinics as well as athlete medical rooms at 24 Olympic competition venues and 28 training venues.

The combined group of National Olympic Committee (NOC) and London Organising Committee of the Olympic Games and Paralympic Games (LOCOG) physiotherapists formed the single largest professional group working at the Olympic Games. Traditionally, sports physiotherapists and sports massage practitioners have been appointed as part of the Organising Committee of the Olympic Games (OCOG) medical team.[3] The advances in sports medicine and science, particularly over the past decade, however, have opened a wider spectrum of treatment choices requiring a higher level of skill mix provided by a range of physical therapies disciplines.[2 3] The London 2012 Olympic Games were the first Summer Games where osteopaths and chiropractors were accredited to the main Olympic Polyclinic and practised in accordance with the IOCMC's policy on scope of practice.[1]

The essential role of the sports physiotherapist is to provide treatment and rehabilitation of injuries and also to provide support for performance through injury prevention, maintenance and recovery interventions. Until today, there has been only one study published evaluating the physiotherapy services carried out in an Olympic Village Polyclinic (Athens 2004 Olympic Games).[3]

The current study aims to provide an in-depth analysis of the physiotherapy services at the London 2012 Olympic Games in order to: (A) describe the level and pattern of physiotherapy activity at the main polyclinic at the Stratford Olympic Village, (B) characterise the athlete and non-athlete requirements of the polyclinic physiotherapy services in the Olympic Village and (C) describe the sports physiotherapy treatments used to manage the athletes and non-athletes who rely on the polyclinic services during the Olympic Games.

METHODS

Physiotherapy services were embedded in the polyclinics at the three Olympic Villages and were available for a total of 31 days; from the opening of the Olympic Village for the duration of the *precompetition period* to the opening ceremony (16–26 July), the *duration of Olympic competitions* (27–12 August) and for another 2 days of *postcompetition* until 14 August 2012. For this article, only the data from the main Olympic Polyclinic at Stratford were included, standing for the largest single facility of physiotherapy activity. Excluded from this report were physiotherapy encounters administered at the Rowing & Canoe Sprint Polyclinic, the Sailing Polyclinic, competition and training venues and the encounters administered by NOC as they had their own physiotherapy teams.

The polyclinic in the Stratford Athletes' Village was a purpose built 5000 m^2 building. Its design features were developed according to the building's use and function 'in legacy' after the Games; it was designed as a health and well-being centre for the local community. Physiotherapy was situated in two separate areas. The basement contained the hydrotherapy pool, ice baths and antigravity treadmills (AlterG). The first floor physiotherapy treatment area (approximately 300 m^2) had two treatment

To cite: Grant M-E, Steffen K, Glasgow P, *et al*. *Br J Sports Med* 2014;**48**:63–70.

rooms and approximately eight treatment bays incorporating a wide range of current electrotherapy modalities including ultrasound, interferential, laser and shockwave. There was a rehabilitation gym (approximately 140 m^2) and a wet area to provide cold therapy, which for safety reasons was separated from electrotherapy equipment. There was the availability of cold therapy, ice packs and cryotherapy compression pumps.

Availability, access and referral procedures

LOCOG made physiotherapy services available to all IOC accredited athletes and non-athletes, including NOC team officials, coaches, team managers, LOCOG workforce, Olympic family, technical officials and press.

Of the 10 586 athletes, their residencies were spread across the three Olympic Villages (Stratford, Rowing & Canoe Sprint, Sailing). Athletes could access the physiotherapy services in the respective polyclinics for assessment and treatment of an injury, and also for support with injury prevention, recovery and maintenance interventions. The non-athlete group, who were in excess of 15 000 personnel accredited to access the Olympic Village, also had the access to the physiotherapy services for assessment and treatment of injuries, which in general tended to have occurred during the Games or presented as a 'flare up' of a pre-existing injury. An injury was defined as any musculoskeletal complaint that received physiotherapy attention regardless of the consequences with respect to absence from competition and training, including newly incurred, pre-existing and not fully rehabilitated injuries.[4] Overuse injuries were defined as those without a specific, identifiable event responsible for their occurrence.[5]

Unlike previous Games where referral was required,[3] athletes and non-athletes could access the LOCOG physiotherapy services in confidence without the requirement of a referral or being accompanied. The scope of practice for chartered physiotherapists in the UK, as directed by their regulatory and professional bodies (Health and Care Professions Council and the Chartered Society of Physiotherapy), permits the physiotherapists to treat without a referral, provided professional standards are met, particularly with respect to safety and professional ethics. This allowed for implementation of direct access to physiotherapy services for the 2012 London Olympic Games. Following a physiotherapy assessment, athletes could be referred to other members of the multidisciplinary team, which comprised of a spectrum of medical, paramedical, dental and other physical therapies disciplines, such as osteopaths, chiropractors or sports massage.

Staff allocations and rostering of physiotherapy services

In view of the direct access policy for physiotherapy, it was necessary to recruit physiotherapists with appropriate physiotherapy education, skills and experience and preferably with an additional language (interpreters were readily available at all times). On every shift at least one team leader/senior physiotherapist was present who had a more advanced level of expertise in order to appropriately assess and evaluate injuries in particular when athletes accessed physiotherapy services without a referral. Staffing levels varied according to the demands on the service; on the busier days (23 July–11 August), approximately 10–12 physiotherapists were required per shift and at peak times up to 16 physiotherapists were required.

There were two shifts each day, from 6:30 to 15:15 and from 14:30 to 23:15 with a period of crossover to provide time for transfer of information. A further 10 physiotherapists were based at the polyclinic to supplement competition and training venue cover when needed, which required the staff to be flexible.

Medical records, encounter forms and data recording

Physiotherapy encounters were administered by LOCOG physiotherapists, in some cases in collaboration with the NOC accredited physiotherapists. Each physiotherapy encounter was recorded on a customised electronic medical record (EMR) system (ATOS IT Services Limited, London, UK). Codes and classifications for physiotherapy treatments were developed in advance of the Games. Treatment modalities, anatomical areas, diagnoses, onset and cause of injury were classified and assigned specific codes, which were developed specifically for use with the (ATOS) EMR system for the Olympic Games. Sports physiotherapists based their classification of overuse injuries on the athletes' subjective history and clinical evaluation.

The EMR system allowed only one treatment modality to be recorded per treatment session for statistical purposes; in many cases, more than one treatment modality was used during a treatment session; these were included in the free text sections. Therefore, the modality of treatment considered as the primary treatment was recorded in the EMR treatment record. The EMR system was also limited in the range of types of treatment modalities that could be classified with codes. Treatment encounters using modalities without a specific code were recorded using a generic code.

All encounters were divided into first visits or follow-up treatments for the same injury. As an example, an initial treatment for a hamstring injury would have been recorded as a first visit. In cases where an athlete returned for treatment of a different injury (eg, to the shoulder) this second attendance would have been recorded as a new first visit, while a treatment for the same hamstring injury from the previous attendance would have been recorded as a follow-up treatment. Physiotherapists were instructed to record each injury of a separate anatomical area as a separate encounter, except encounters aimed at more general effects such as cryotherapy baths, when the 'multiple body code' was used. All physiotherapy volunteers underwent 3 days of formal training with LOCOG, which included an instruction on classifications and physiotherapy treatment codes for use on the medical record system.

Confidentiality and ethical approval

The system and criteria for collecting and recording information were approved by the LOCOG Medical Advisory Group. In addition, the IOC Medical Code[1] on athlete confidentiality was strictly observed. All information was treated with strict confidence and the medical database was anonymised at the end of the Games.

Data analysis and statistics

All physiotherapy primary treatments as recorded in the EMR were transferred from the EMR system into an Excel file (Microsoft Excel 2013). Data were sorted and the physiotherapy encounters at the Stratford polyclinic were filtered out using SPSS V.20 (SPSS Inc, Chicago, Illinois, USA). Statistical analysis of the data was then carried out using R V.2.15.0 (2012).[6] Encounters were categorised by their accreditation status: athletes and non-athletes.

Data are presented as frequencies and proportions. For the analysis relating to anatomical area, diagnosis and cause of injury, only 'first visits' encounters were chosen in order to avoid the bias caused by the inclusion of the same individuals on multiple occasions. χ^2 Tests were used to test for association between nominal variables, and where relevant, post hoc tests (χ^2 tests, or equivalently, two-proportion Z tests) were used to identify

specific group differences. P values from post hoc tests were corrected for multiple testing error using a False Discovery Rate (FDR) approach,[7] and are reported as FDR-p. P values or FDR adjusted p values of less than 0.05 were considered to be statistically significant.

RESULTS

Distribution of encounters

The results shown in this section refer to those physiotherapy encounters administered at the Stratford Polyclinic only, as NOCs had their own physiotherapy teams. Of the 1866 encounters recorded, 95% (1778 encounters) recorded the accreditation category correctly (figure 1). A total of 1219 (69%) were administered to athletes and 559 (31%) to non-athletes. The non-athlete group comprised of NOC team officials (n=333, 18.7%), LOCOG workforce (n=160, 9.0%), Olympic family (n=34, 1.9%), technical officials and press (n=31, 1.7%). The distribution of the physiotherapy service across the continents was as follows: Africa (36.5%), Americas (32.5%), Asia (16.1%), Europe (10.7%) and Oceania (4.2%).

Over the 11 days leading up to the Games and the start of competition (16–26 July), there was a steep increase in the number of encounters recorded, peaking at 1 August with 126 encounters as the busiest day, followed by 31 July, with 116 encounters (figure 2) and a second peak occurred on 6 August with 98 encounters. The non-athlete group showed a more even distribution over time in the pattern of their requirements of the physiotherapy services.

First visits versus follow-up visits

There was a statistically significant difference between the proportions of the first visits and the follow-up visits for athletes and non-athletes (χ^2=35.95, p<0.01; figure 1). Of the total number of athlete physiotherapy encounters, 501 (41%) were first visits and 717 (59%) were follow-up visits, compared with 316 (57%) first visits and 243 (43%) follow-up visits in the non-athletes group.

Anatomical area relating to first visits only

In the athlete and non-athlete groups, the highest proportions of recorded first visits describing anatomical area were associated with the lower limb. The anatomical distribution of treatment areas is shown in table 1.

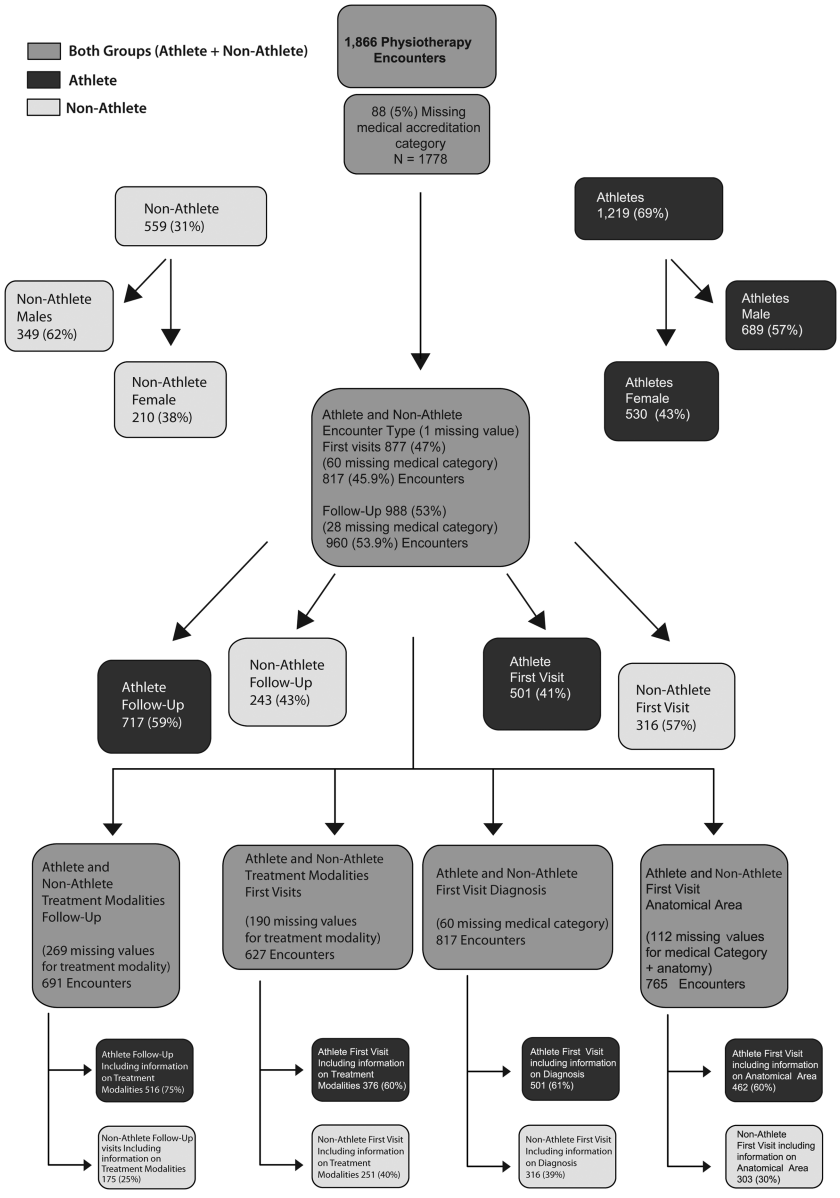

Figure 1 Flow chart displaying breakdown of physiotherapy encounters by athlete versus non-athletes and by first visit versus follow-up.

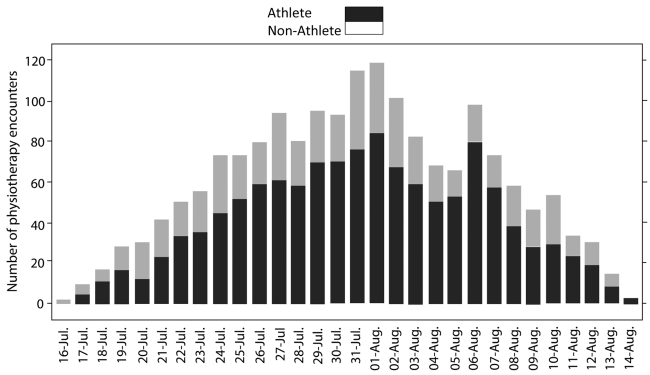

Figure 2 Bar graph displaying the distribution of physiotherapy encounters for athletes and non-athletes by date from 16 July to 14 August 2012.

The first 14 areas listed in table 1 comprised more than 95% of all first visit encounters, while other anatomical areas were reported more infrequently. The remaining categories were therefore regrouped together for statistical analysis, as 'other anatomical areas'. The overall distribution of injuries across these anatomical areas differed between athletes and non-athletes ($\chi^2=63.21$, $p<0.001$).

Diagnosis for athletes and non-athletes

Similar patterns of diagnosis were seen for athletes and non-athletes, with joint and muscle injuries being the most common.

Table 1 Frequencies and percentages of anatomical areas recorded for all first visit encounters and for first visit encounters with athletes and non-athletes separately

	All encounters n=765	Athletes n=462	Non-athletes n=303	FDR-p
Anatomical area				
Lumbar spine/lower back	130 (16.7)	70 (15.2)	60 (19.8)	0.456
Knee	119 (15.6)	71 (15.4)	48 (15.8)	0.977
Neck/cervical spine	70 (9.2)	24 (5.2)	46 (15.2)	<0.001
Upper leg	62 (8.1)	58 (12.6)	4 (1.3)	<0.001
Thoracic spine/upper back	58 (7.6)	30 (6.5)	28 (9.2)	0.539
Shoulder/clavicle	52 (6.8)	27 (5.8)	25 (8.3)	0.539
Lower leg	52 (6.8)	32 (6.9)	20 (6.6)	0.977
Ankle	35 (4.6)	22 (4.8)	13 (4.3)	0.977
Foot	34 (4.4)	19 (4.1)	15 (5.0)	0.969
Pelvis/sacrum/buttock	31 (4.1)	22 (4.8)	9 (3.0)	0.558
Hip	29 (3.8)	21 (4.5)	8 (2.6)	0.539
Achilles tendon	27 (3.5)	17 (3.7)	10 (3.3)	0.977
Multiple body locations	19 (2.5)	14 (3.0)	5 (1.7)	0.560
Other anatomical area				
Elbow	9 (1.2)	7 (1.5)	2 (0.7)	
Groin	8 (1.1)	7 (1.5)	1 (0.3)	
Abdomen	6 (0.8)	4 (0.9)	2 (0.7)	
Wrist	6 (0.8)	5 (1.1)	1 (0.3)	
Finger	4 (0.5)	3 (0.6)	1 (0.3)	
Upper arm	3 (0.4)	2 (0.4)	1 (0.3)	
Forearm	3 (0.4)	3 (0.6)	0 (0)	
Thumb	3 (0.4)	1 (0.2)	2 (0.7)	
Chest	2 (0.3)	2 (0.4)	0 (0)	
Hand	2 (0.3)	1 (0.2)	1 (0.3)	
Other medical	1 (0.1)	0 (0)	1 (0.3)	

FDR-p, FDR adjusted p values from post hoc χ^2 tests (athletes vs non-athletes).

The diagnosis 'other' for a physiotherapy encounter indicated that the athlete/non-athlete availed of the physiotherapy services for assessment only, injury prevention intervention (eg, stretching, strapping, etc), recovery (eg, massage, cryotherapy/ice baths) or general massage. For an athlete's first visit encounters, the most common types of diagnosis recorded were muscle injuries (33.3%), joint injuries (24.8%) and 'other' (16%). A somewhat similar pattern was seen for diagnoses in the first visits of non-athletes; the most common were joint (30.1%) and muscle (24.4%) injuries, with 20.6% reporting a diagnosis category of 'other' (table 2).

The first eight diagnosis categories in table 2 accounted for more than 93% of all diagnoses recorded for first visit encounters. The remaining diagnosis categories contain a limited data, and were therefore grouped together for statistical analysis. A χ^2 test revealed a statistically significant difference ($\chi^2=23.42$, $p<0.01$) in the percentages of diagnosis types for athlete and non-athlete first visit encounters.

Post hoc testing identified statistically significant differences in the percentages of first visit muscle injuries among athletes (33.3%) compared with non-athletes (24.4%; $\chi^2=7.02$, FDR-$p<0.05$), while non-athletes recorded a significantly higher percentage of 'arthritis or inflammatory disease/conditions' compared with the athlete-group ($\chi^2=8.60$, FDR-$p<0.05$).

Treatment modalities administered

A variety of different treatments were used (table 3). Based on 1399 encounters (first visits and follow-up treatments for athletes and non-athletes), the five most frequently used treatment modalities were treatment massage (23.3%), mobilisation techniques (21.8%), taping (8.9%), cryotherapy (6.9%) and exercise prescription (6.4%).

The types of treatment modalities administered to athletes varied depending on the diagnosis (table 4). For those diagnosed with a muscle injury, treatment massage (33.3%), mobilisation (10.6%), cryotherapy (10.6%) and acupuncture (8.3%) were utilised most often. Athletes diagnosed with a joint injury were most commonly treated with mobilisation (27.2%), joint manipulation (21.7%), massage (13%) and cryotherapy (8.7%). For athletes diagnosed with tendinopathy, the most common treatment types administered were treatment massage (28.6), ultrasound (12.2%), Alter G (10.2%) and mobilisation (10.2%).

Cause of injury and onset of symptoms related to 'diagnosis of injury'

Of the 501 first visits recorded, 374 visits reported the cause of injury. The most frequently reported causes of injury were overuse (43.6%), non-contact trauma (23.8%), no injury (ie, no specific cause of injury) (15.5%) and other causes of injury (7.8%). A less frequently reported causes of injury were falls (1.1%) and collisions (0.3%).

Pre-existing injuries accounted for almost half of the 436 first visit encounters (n=198, 45.4%) with information available on the onset of symptoms. While 162 (37.2%) encounters accounted for onset during the training, 60 encounters (13.7%) were related to the competition. A total of 16 encounters (3.7%) had to be classified as 'other onset' (table 5). For the most common injury type, muscle injuries, 32.2% arose prior to the Games. Joint injuries were the second most common injury seen; of these 46.4% were reported to have occurred prior to the Olympic Games.

Table 2 Frequencies and percentages of type of diagnosis made during first visits and follow-ups and calculated for athletes and non-athletes separately

	First visits			Follow-up visits	
	Athletes n=501	Non-athletes n=316	FDR-p	Athletes n=717	Non-athletes n=241
Muscle injury	167 (33.3)	77 (24.4)	0.036	228 (31.8)	74 (30.5)
Joint injury	124 (24.8)	95 (30.1)	0.204	196 (27.3)	54 (22.2)
Other	80 (16.0)	65 (20.6)	0.204	110 (15.3)	33 (13.6)
Tendinopathy	64 (12.8)	26 (8.2)	0.170	102 (14.2)	38 (15.6)
Arthritis inflammatory	5 (1.0)	14 (4.4)	0.030	1 (0.1)	12 (4.9)
Other bone injuries	11 (2.2)	7 (2.2)	0.970	11 (1.5)	7 (2.9)
Contusion/hematoma/bruise	10 (2.0)	7 (2.2)	0.970	7 (1.0)	1 (0.4)
Nerve root or spinal cord injury	7 (1.4)	3 (0.9)	0.970	18 (2.5)	8 (3.3)
Tenosynovitis	3 (0.6)	6 (1.9)	0.970	4 (0.6)	3 (1.2)
Other diagnosis categories					
Fasciitis	4 (0.8)	3 (0.9)		9 (1.3)	3 (1.2)
Bursitis	5 (1.0)	1 (0.3)		3 (0.4)	0
Fracture—stress	5 (1.0)	0		10 (1.4)	1 (0.4)
Fracture—closed	3 (0.6)	1 (0.3)		1 (0.1)	1 (0.4)
Laceration/abrasion	4 (0.8)	0		3 (0.4)	0
Muscle rupture	2 (0.4)	2 (0.6)		9 (1.3)	1 (0.4)
Dislocation/subluxation	1 (0.2)	2 (0.6)		0	1 (0.4)
Tendon—rupture	1 (0.2)	2 (0.6)		3 (0.4)	4 (1.6)
Abdominal pain	1 (0.2)	1 (0.3)		1 (0.1)	0
Peripheral nervous system	1 (0.2)	1 (0.3)		0	0
Allergy	0	1 (0.3)		0	0
Blister	0	1 (0.3)		0	0
Diabetes mellitus	0	1 (0.3)		0	0
Major trauma	1 (0.2)	0		0	0
Menstrual disorder	1 (0.2)	0		0	0
Muscle tone	1 (0.2)	0		0	0
Clotting, abnormal	0	0		0	1 (0.4)
Deep vein thrombosis	0	0		0	1 (0.4)
Infection	0	0		1 (0.1)	0

FDR-p, FDR adjusted p values from post hoc χ^2 tests for most common categories of diagnosis (athletes vs non-athletes) for first visit encounters. FDR, False Discovery Rate.

DISCUSSION

This study highlights the important role of physiotherapy in supporting the athletes and non-athletes during the Olympic Games. The analysis of all physiotherapy encounters demonstrated that as the largest single professional discipline within the multidisciplinary team, expertise and experience were important in the delivery of physiotherapy services.

The previous studies on larger sports events[8–10] have described the common perception of the role of physiotherapy in supporting athletes during competition/major Games as a provider of treatment interventions related to specific injuries, whereas this study has identified that a significant percentage of the physiotherapy encounters were related to supporting uninjured athletes. The present results also demonstrate that athletes attended for physiotherapy in the absence of injury. While no specific data were recorded regarding the reason for the consultation, it is reasonable to conclude that the physiotherapy encounters focused on maintaining physical function and enhancing recovery have a role to play in supporting athlete performance.

In the light of the fact that most NOCs had their own physiotherapists in London, this study represents only a portion of the total physiotherapy activity at the Games. However, we believe that the present findings reflect similar requirements that athletes have of their NOC physiotherapy teams. Also, there was a global reliance on physiotherapy support across a wide spectrum of countries and cultures during the 2012 Olympic Games. Every continent made use of the physiotherapy service with people of African and American affiliation being most represented.

Distribution of encounters among athletes and non-athletes

The pattern of physiotherapy activities mirrored the build-up and gradual reduction in physiotherapy activity over the period of competition, as was mentioned in the previously reported study on physiotherapy in Athens 2004[3] and the overall polyclinic activity during the 2012 Olympic Games.[11 12]

The major emphasis of the physiotherapy services in the polyclinic was orientated towards the needs of competing athletes, and the present findings reflect this support strategy, with 69% of treatments given to athletes and 31% to non-athletes. There was also a significantly higher proportion of follow-up visits recorded among athletes, indicating that this group, to a larger degree, tends to require more than one session of treatment for the same condition/injury. As was previously reported,[3 11 13–15] this study revealed that the muscle injuries were among the most common injuries in athletes (33%). Our findings also highlight the role of physiotherapists in supporting performance. These were non-injury-related encounters classified as 'other', which were 16% of the total number of physiotherapy encounters, which reflected the need for maintenance of the musculoskeletal system, injury prevention strategies and assistance with recovery.

Table 3 Frequencies and percentages of encounters during which each treatment modality was recommended, for first and follow-up visits of athletes and non-athletes separately and for all physiotherapy encounters

Treatment type	First visits		Follow-up visits		All visits
	Athletes n=376	Non-athletes n=251	Athletes n=516	Non-athletes n=175	n=1399
Soft tissue techniques	93 (24.7)	42 (16.7)	149 (28.9)	28 (16.0)	326 (23.3)
Mobilisation (active/passive)	62 (16.5)	71 (28.3)	94 (18.2)	51 (29.1)	305 (21.8)
Strapping/taping	28 (7.4)	25 (10.0)	51 (9.9)	16 (9.1)	125 (8.9)
Cryotherapy	40 (10.6)	14 (5.6)	31 (6.0)	12 (6.9)	97 (6.9)
Joint manipulation	32 (8.5)	27 (10.8)	17 (3.3)	10 (5.7)	89 (6.4)
Exercise	11 (2.9)	11 (4.4)	32 (6.2)	13 (7.4)	89 (6.4)
Ultrasound	19 (5.1)	10 (4.0)	45 (8.7)	8 (4.6)	86 (6.1)
Acupuncture	17 (4.5)	13 (5.2)	16 (3.1)	22 (12.6)	70 (5.0)
Muscle stretches	14 (3.7)	5 (2.0)	24 (4.7)	4 (2.3)	47 (3.4)
Advice/reassurance	8 (2.1)	14 (5.6)	10 (1.9)	3 (1.7)	37 (2.6)
General massage	15 (4.0)	4 (1.6)	8 (1.6)	3 (1.)	31 (2.2)
Alter G	11 (2.9)	4 (1.6)	11 (2.1)	0 (0)	26 (1.9)
Hydrotherapy	4 (1.1)	0 (0)	8 (1.6)	0 (0)	12 (0.9)
Laser	2 (0.5)	0 (0)	9 (1.7)	0 (0)	11 (0.8)
Verbal advice and guidance	4 (1.1)	4 (1.6)	1 (0.2)	0 (0)	10 (0.7)
Shockwave therapy	4 (1.1)	1 (0.4)	2 (0.4)	0 (0)	7 (0.5)
Heat	2 (0.5)	1 (0.4)	1 (0.2)	2 (1.1)	6 (0.4)
Gait re-education	2 (0.5)	2 (0.8)	1 (0.2)	0 (0)	5 (0.4)
Interferential	1 (0.3)	1 (0.4)	1 (0.2)	2 (1.1)	5 (0.4)
Longwave ultrasound	2 (0.5)	1 (0.4)	0 (0)	1 (0.6)	4 (0.3)
Pre-event massage	1 (0.3)	1 (0.4)	2 (0.4)	0 (0)	4 (0.3)
Fitness testing	0 (0)	0 (0)	2 (0.4)	0 (0)	2 (0.1)
LPUS-U/S bone-healing system	2 (0.5)	0 (0)	0 (0)	0 (0)	2 (0.1)
Combined U/S and I/F	0 (0)	0 (0)	1 (0.2)	0 (0)	1 (0.1)
Electromagnetic field unit	1 (0.3)	0 (0)	0 (0)	0 (0)	1 (0.1)
Basic wound care	1 (0.3)	0 (0)	0 (0)	0 (0)	1 (0.1)

Alter G, antigravity treadmills, I/F, interferential; LPUS, low-intensity pulsed ultrasound; U/S, ultrasound.

There was a significant difference in the frequency of cervical spine injuries occurring in the non-athletes compared with the athletes, which reflects the type of injury pattern of the workforce group. In many cases, these may have been age-related, degenerative conditions that pre-existed prior to the Games. Many of the cervical spine issues may also relate to the workforce staff spending long hours working intensely at computer work stations during the Games, resulting in neck strain, biomechanical and posture-related issues. The significant number of non-athlete encounters highlights the need for effective workforce planning for future Olympic Games in terms of the skill mix of physiotherapists.

Modalities of treatment administered

In view of the results identifying a high level of manual treatments and the relatively low level of exercise prescription found in this study, this reflects the type of work physiotherapists undertake during the Olympic Games. There is a greater requirement to concentrate on treating pain and symptoms and to facilitate recovery rather than to concentrate on training or rehabilitation.

The data demonstrate that not all athlete attendances were for treatment of an injury. Evaluation of those encounters identified a high number of interventions, coded as 'other' (16%), which typically denoted that the athlete did not have an injury, but attended for assistance with recovery, for example, cryotherapy (11%).[16] It should be noted that the use of cryotherapy baths was administered largely by the commercial supplier, and presented data may therefore not reflect the full extent of cryotherapy activity. However, these observations also reflect the changing focus of physiotherapy support at competition time from purely an injury management to the support of performance through the treatment and management of conditions which required maintenance and physiotherapy input to facilitate recovery.

Cause and onset of injury

This study highlights that 45% of encounters were related to ongoing management of pre-existing injuries, which reflects the significant level of persisting musculoskeletal problems among athletes entering major sport events. These findings reflect the challenges that physiotherapists face in supporting athletes which may not necessarily be captured in the traditional surveillance studies.[8 9 13 15] This also has implications for estimating the physiotherapy workforce requirements at the future Games and strongly suggests that further advances are needed for injury prevention[17] in light of the findings of this study that sports people at the Olympic level have a high prevalence of ongoing injury that requires at least a maintenance treatment.

We identified overuse injuries as the most common reason for physiotherapy attendance among athletes (44%).[5 18 19] The findings in this study suggest that further expansion of the present surveillance systems would be a positive advancement in order to more accurately account for injuries and symptoms associated with overuse problems that pre-exist and often manifest as 'injuries'.[5 18 19] This would also provide a greater level of understanding of the nature and extent of physiotherapy support required during the Olympic Games.

Table 4 Frequencies and percentages for treatment modalities for joint and muscle injuries, tendinopathy and 'other' (athlete first visits)

Treatment type	Joint injury n=92	Muscle injury n=132	Tendinopathy n=49	Other n=57
Acupuncture	4 (4.4)	11 (8.3)	0	1 (1.8)
Advice/assessment	2 (2.2)	1 (0.7)	3 (6.1)	1 (1.8)
Alter G	0	3 (2.3)	5 (10.2)	1 (1.8)
Basic wound care	0	0	0	0
Combined U/S and I/F	0	0	0	0
Cryotherapy	8 (8.7)	14 (10.6)	3 (6.1)	6 (10.5)
Electromagnetic field unit	1 (1.1)	0	0	0
Exercise	3 (3.3)	0	3 (6.1)	1 (1.8)
Fitness testing	0	0	0	0
Gait re-education	0	0	0	0
General massage	2 (2.2)	8 (6.6)	0	5 (8.8)
Heat	–	2 (1.5)	0	0
Hydrotherapy	1 (1.1)	2 (1.5)	0	0
Joint manipulation	20 (21.7)	1 (0.7)	1 (2.0)	4 (7.0)
Interferential	0	0	0	0
Laser	1 (1.1)	0	1 (2.0)	0
Longwave ultrasound	1 (1.1)	1 (0.7)	0	0
LPUS-U/S bone-healing sys	0	1 (0.7)	1 (2.0)	0
Mobilisation (active/passive)	25 (27.2)	14 (10.6)	5 (10.2)	11 (19.3)
Muscle stretches	3 (3.3)	7 (5.3)	0	3 (5.3)
Pre-event massage	1 (1.1)	0	0	0
Shockwave therapy	0	1 (0.7)	3 (6.1)	0
Strapping/taping	5 (5.4)	11 (8.3)	3 (6.1)	4 (7.0)
Treatment massage	12 (13.0)	44 (33.3)	14 (28.6)	17 (29.8)
Ultrasound	2 (2.2)	7 (5.3)	6 (12.2)	3 (5.3)
Verbal advice and guidance	1 (1.1)	0	1 (2.0)	0

Alter G, antigravity treadmills, I/F, interferential; LPUS, low-intensity pulsed ultrasound; U/S, ultrasound.

Methodological considerations

As outlined in figure 1, the main limitation of this study is related to the challenges associated with data recording during the Olympic Games. The medical encounter system (EMR) was not created for the primary purpose of carrying out this type of analysis, and there was a considerable amount of missing data

Table 5 Frequencies and percentages for encounters reporting 'onset of symptoms' for each diagnosis (athlete first visits)

Diagnosis	Pre-Games n=198	Training n=162	Competition n=60	Other n=16	Total n=436
Abdominal pain	1 (100.0)	0	0	0	1
Arthritis inflammatory	5 (100.0)	0	0	0	5
Bursitis	2 (40.0)	3 (60.0)	0	0	5
Contusion/haematoma/bruise	1 (11.1)	5 (55.6)	3 (33.3)	0	9
Dislocation/subluxation	0	1 (100.0)	0	0	1
Fasciitis	2 (50.0)	1 (25.0)	0	1 (25.0)	4
Fracture—closed	0	0	1 (100.0)	0	1
Fracture—stress	2 (66.7)	1 (33.3)	0	0	3
Joint injury	51 (46.4)	44 (40.0)	9 (8.2)	6 (5.5)	110
Laceration/abrasion	3 (75.0)	1 (25.0)	0	0	4
Major trauma	0	1 (100.0)	0	0	1
Menstrual disorder	0	0	0	1 (100.0)	1
Muscle injury	47 (32.2)	67 (45.9)	31 (21.2)	1 (0.7)	146
Muscle rupture	1 (50.0)	1 (50.0)	0	0	2
Muscle tone	1 (100.0)	0	0	0	1
Nerve root or spinal cord injury	5 (100.0)	0	0	0	5
Other	29 (47.5)	16 (26.2)	9 (14.7)	7 (11.5)	61
Other bone injuries	6 (60.0)	2 (20.0)	2 (20.0)	0	10
Peripheral nervous system	1 (100.0)	0	0	0	1
Tendinopathy	38 (62.3)	19 (31.2)	4 (6.6)	0	61
Tendon—rupture	1 (100.0)	0	0	0	1
Tenosynovitis	2 (66.7)	0	1 (33.3)	0	3

which were recorded on the system as a 'missing value' (figure 1). The missing data were, in some cases, due to the limited availability of codes and classifications. Where physiotherapists could not find an appropriate code, in some cases the data were not entered.

Treatment modality data were limited by the EMR system, which allowed the data to be collected only on the primary modality per encounter, which did not allow a complete presentation of activity. Therefore, the use of other modalities may be under-represented. In some cases, staff were either not sufficiently familiar with the EMR system, or did not record the data due to workload or limited access to computer terminals. Some practical challenges arose in entering contemporaneous information into the database system, because of difficulty accessing computer terminals during busy periods. Therefore, some of the information were entered into the system at a later convenient time but within 24 h.

This study has demonstrated that while the non-athlete group is smaller in comparison to the athlete group, nonetheless they form a considerable amount of the physiotherapy workload at the Polyclinic. For these reasons, the future Games organisers should put preparations in place to meet the needs of both groups. It is recommended that volunteer training for physiotherapy should be focused on athletes and also non-athletes, and could be modified in terms of further training on the appropriate use of codes and classifications.[20 21] Motivation and vigilance with compliance on accurate and complete record-keeping is also an essential aspect of the role of volunteers.[20] In addition to training, organisers also need to consider the availability and accessibility of computer terminals to facilitate the compliance of accurate and complete record-keeping.

To avoid any duplication and to ensure the accuracy, only the first visit encounters were used for some of the statistical analysis, for example when analysing diagnosis categories, cause of injury, etc. It was not possible using the current system to analyse the numbers of follow-up visits for a specific diagnosis. In future, it is recommended a system is developed that will allow for data collection that more accurately reflects the physiotherapy activity during the Olympic Games.

Implications for major events and workload planning

A high usage of physiotherapy services has been reported in the previous studies.[12 21] The introduction of direct access for physiotherapy (no referral required) for the LOCOG physiotherapy services was a significant new scope, and offered athletes a greater access to physiotherapy support. Although we did not formally evaluate the 'physiotherapy performance' using rigorous outcome measures, the subjective opinion of the IOC and LOCOG leadership was that the direct access to physiotherapy was safe and effective in this setting with a highly qualified and experienced physiotherapists. We contend that this provides another data point for policymakers considering this option.

In addition, the inclusion in the multidisciplinary team of sports massage practitioners, osteopaths and chiropractors, who practiced in accordance with the IOCMC's policy on scope of practice, created a new scope of physiotherapy practice for future Olympic organising committees (OCOGs) in terms of the skill mix available and the access to the different physical therapies for athletes during the Olympic Games.

This analysis has identified that the most frequently used treatment technique by physiotherapists was manual treatment, which is the mainstay of treatment in this setting (54%). The present findings reflect the ongoing need for monitoring and analysis of physiotherapy services during the Olympic Games and at other major sporting events to understand and further advance on prevention and treatment,[22] rehabilitation and support of performance for the high-performance athlete.

CONCLUSION

This study of the London 2012 Olympic Games workload highlights the physiotherapy needs of athletes and non-athletes, and identifies a high number of pre-existing and overuse injuries in this setting, providing an insight into the reasons why athletes seek physiotherapy support during the Olympic Games.

The study has also demonstrated the extensive role of the sports physiotherapist beyond the treatment of injury to a broader role by also providing assistance with maintenance and recovery. The expansion of the current injury surveillance systems and an appropriate EMR system are required to provide a more detailed classification system on diagnosis, grade of injury and the extent to which performance or training is impaired as a result of injury.

What are the new findings?

- Identifies the variation in physiotherapy activity between the athletes and non-athletes highlighting the different needs of each group.
- Further insight into the reasons why athletes seek the support of physiotherapy during the Olympic Games highlighting the role of physiotherapists in supporting athlete performance.
- Demonstrates the high incidence of pre-existing and overuse injuries.

How might this article impact on clinical practice in the near future?

- Future Organising Committee of the Olympic Games (OCOGs) needs to plan and provide physiotherapy services to meet the needs of athletes and non-athletes.
- Implementation of further injury prevention strategies to reduce the high incidence of athletes presenting with pre-existing and overuse injuries.
- Development of improved electronic medical record systems to accurately record the physiotherapy data.
- Provision of a multidisciplinary team of sports massage, osteopaths and chiropractors has created a new benchmark for future OCOGs in terms of the skill mix available and the access to physical therapies for athletes during the Olympic Games.

Acknowledgements The authors thank all members of the LOCOG Physical Therapy Services Workstream and volunteer (Games Maker) physiotherapists for the collection of the physiotherapy data.

Contributors MEG, PG and NP were responsible for the conception and design of the study. MEG, NP and LB coordinated the study and managed all aspects, including data collection. All authors had full access to all data. MEG, KS and MG initialised and conducted the analyses, which were planned and checked with the other co-authors. MEG wrote the first draft of the article and all authors provided substantive feedback on the article and contributed to the final manuscript. MEG and KS are the guarantors.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

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Br J Sports Med 2014 48: 63-70
doi: 10.1136/bjsports-2013-093169