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Original Research

Physical Therapy Service delivered in the Polyclinic During the Rio 2016 Paralympic Games

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ABSTRACT

Objective: To characterize the Physical Therapy Services delivered at the Polyclinic during the Rio 2016 Paralympic Games.
Design: Retrospective Cohort Study.
Setting: Physical Therapy Services (PTS) of the Polyclinic.
Participants: Athletes attended for Physical Therapy treatment at the Polyclinic during Rio 2016 Paralympic Games.
Main outcome measures: The number of athletes treated, their nationalities, their sports modality, the most frequently treated regions and the interventions applied.
Results: A total of 4504 interventions were delivered and 399 athletes were treated in the PTS. Athletes representing athletics and sitting volleyball were the most frequently attended for treatment. The main diagnoses were muscle tension and tendinopathy. Analgesia was the main purpose of treatment and myofascial release and electrotherapy was the most frequent interventions. Recovery service had a total of 1579 encounters and male athletes used cryo-immersion 3 times more when compared to female.
Conclusion: Athletes representing athletics and sitting volleyball were the most frequently attended for treatment and the thoracic/lumbar spine and pelvis/hip were the most commonly affected regions. Muscle strain and tendinopathy were the most frequent diagnoses and myofascial release and electrotherapy were the most frequent therapies used to achieve analgesia.

1. Introduction

The Paralympic Games demonstrates that being an athlete with an impairment does not preclude high-level sporting practice (Muther, Williamson, & Williamson, 2014). In the Rio 2016 Paralympic Games, 4328 athletes (2657 men and 1671 women) from 159 countries competed in 22 modalities, with 220 world records and 432 Paralympic records (www.paralympic.org/rio-2016). Athletes with different etiologies/sequels compete in Paralympic modalities and each athlete has a functional classification according to an activity limitation resulting from impairment (International Paralympic Committee medical code. *IPC Handbook;* Phillips, Squair, & Krassioukov, 2017). Rio 2016 Paralympic Games had an increment of 2 modalities (triathlon and canoe) and an increased number of athletes participating and records achieved comparing to London 2012 (www.paralympic.org/rio-2016). The increased level of competition and increment of new modalities requires a greater understanding of the most common sports injuries and the type of demand that physical therapist need to deal during the competition.

Knowledge about sports injuries and general health are considered the first step to promote prevention, immediate care and rehabilitation (Palmer-Green & Elliott, 2015). London

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Paralympic Games in 2012 had an overall injury rate of 12.7 injuries/1.000 days of training/competition (Willick et al., 2013). The modality that had the highest injury rate was five-a-side football (for athletes with visual disability) with 22.4 injuries/1.000 days. The regions with the highest injury incidence were the shoulder (17.7%), followed by wrist/hand (11.4%), elbow (8.8%), and knee (7.9%). Although previous studies have been carried out about injury epidemiology during the Paralympic Games, no reports on the Physical Therapy Service (PTS) characteristics, especially the Polyclinic according to our knowledge. Reynolds, Stirk, Thomas and Geary (1994) described the organization of medical and PTS of the English delegation during the Paralympic Games in Barcelona. Gawronski, Sobiecka, and Malesza (2013) described the characteristics of injuries and health conditions of Polish athletes during the Beijing and London Paralympic Games. Moreover, Derman et al. (2018) analyzed the medical data of the teams and described the incidence of injury in the pre-competition and competition periods of the Rio 2016 Paralympic Games. Information about injuries could guide the Organizing Committee on the acquisition of proper equipment and materials to treat the athletes and deliver a high-quality service during the Games.

The organization of the PTS during the Paralympic Games needs to offer the best interventions for prevention, rehabilitation and recovery. The proper care in the Polyclinic could influence athlete's performance and the competition level of the Paralympic Games (Grant et al., 2014). The knowledge about how previous games were organized and the type of demand delivered may help, together with evidence-based interventions, future services during major sports events. Therefore, the purpose of this study was to characterize the PTS delivered at the Polyclinic during the Rio 2016 Paralympic Games, specifically indicating the number of PTS encounters per day, distribution of athletes' nationalities, their sports modalities, regions treated, most frequent diagnoses, treatment purposes, most commonly applied interventions and recovery characteristics.

2. Materials and methods

2.1. Setting

This retrospective cohort study was developed using the database of the Paralympic Games Rio 2016, in Rio de Janeiro city, Brazil. The Local Organizing Committee of the Games (LOCOG) authorized our access to their database. All information was treated with strict confidence during the development of this study and the PTS database was anonymized at the end of the Paralympic Games. This study was approved by The University's Ethics in Research Committee (report number CAAE: 73365417.9.0000.5108).

PTS were available at the Polyclinic for 27 days: 1) from the opening of the Paralympic Village until the opening ceremony (from August 27th to September 6th), 2) during the Paralympic Games (September 7th to 18th), and 3) post-competition until September 22nd. Athletes could resort the PTS in the Polyclinic for injury assessment and treatment, for injury prevention and recovery and also for maintenance interventions (tertiary prevention).

2.2. Characteristics of the Physical Therapy Services (PTS)

On the busiest days (September 10th to 13th), approximately 10 physical therapists, 10 massage therapists, 2 Osteopaths, and 2 Chiropractors were required per shift. The working day counted on two shifts, from 7:00 a.m. to 3:30 p.m. and from 3:00 p.m. to 10:00 p.m. Therefore, the professionals had 30 min (from 3:00 p.m. until 3:30 p.m.) to exchange information about the earlier shift and improve the service flow for the next one.

The PTS in the Polyclinic was separated in seven rooms: three for assessments and individual procedures (physical therapy, osteopathy, and chiropractic), one electrotherapy room, one cryo-immersion room, one massage room, and one kinesiotherapy gymnasium. The Physical Therapy room (approximately 140 m^2) had 10 treatment tables with electrotherapy equipment including ultrasound, interferential, laser, superficial heat, cryo-compression and shockwave therapy. The kinesiotherapy gymnasium (approximately 140 m^2) had kinesiotherapy equipment and antigravity treadmills (AlterG). The cryo-immersion room (approximately 200 m^2) had 12 bathtubs coupled to filtering and temperature control machines. Finally, the massage room had 10 treatment tables and screens to allow athlete's privacy.

The referral system of the Polyclinic was the following: the doctor was the first contact in case of any injury/complain, then he/she referred the athlete to the physical therapist; in case of recovery (massotherapy and cryo-immersion), the physical therapist was the first contact. The athlete was assessed and the physical therapist registered the information related to their characterization (name, age, sex, country, modality) and the assessment performed (injury mechanism, region to be treated and intervention implemented). Some interventions followed a standardization procedure. For example, cryo-immersion was applied according to Machado et al. (2016) protocol of 11–15 min with a controlled temperature between 11 and 15° and massotherapy session was comprised by a relaxation massage for 30 min maximum.

2.3. Data collection

The LOCOG trained the physical therapists about how to register the information related to athlete's assessment and interventions delivered. To achieve a standardized registration, the LOCOG printed specific paper forms, prior to the games, for register the information of each athlete. The form included the following items: name, country, sex, sport modality, clinical diagnosis, description and localization of injury/complain, physical therapy assessment, treatment purposes, interventions performed on each session. At the end of each day, some members of the PTS transferred the information of each form into Excel® sheets, using codes to enhance data analysis. Since each session was signed by the physical therapist responsible for the treatment, a supervisor ensured that at the end of each session, the therapist fulfill all information about the treatment in the form. The supervisor checked all forms constantly and in case of missing data, he/she asked to the physical therapist responsible about the missing information.

All encounters were registered and divided into first visits or follow-up treatments for the same injury. New injuries were considered as first visits again. An injury was defined as any musculoskeletal complain that received physical therapy attention regardless absence from competition and training, including newly incurred, pre-existing, and not fully rehabilitated injuries (Junge et al., 2008). Overuse injuries were defined as those without a specific, identifiable event responsible for their occurrence (Clarsen, Myklebust, & Bahr, 2013). In addition, the results of cryo-immersion and massotherapy were analyzed as recovery methods.

Some definitions used in this present study were the following: “sport modality” being any type of Paralympic sport practiced during the Rio 2016; “encounter” meaning each session of physical therapy (which made “session” as a synonymous); “intervention” being any type of specific therapy (i.e. stretching, ultrasound, etc) provided by the PTS; “treatment” meaning the whole intervention program delivered for the athlete. Regarding the interventions applied, the data was organized as: 1) treatment purpose: analgesia, range of motion improvement and muscle relaxation; 2)

therapeutic resources: cryotherapy with compression, joint mobilization, myofascial release, kinesio taping, flexibility exercises, hot packs, interferential current, laser therapy and ultrasound.

2.4. Statistical analysis of the data

Descriptive analysis was performed to define the number of sessions carried out at the Polyclinic, the profile of the athletes (country, sex, sports modality), the absolute and relative frequencies of regions treated, diagnoses and interventions used.

All PTS primary treatments were transferred from the paper forms to an Excel file (Microsoft® Excel 2013). Data were sorted and the PTS encounters at the polyclinic were filtered out using SPSS V.20 (SPSS® Inc, Chicago, Illinois, USA). Data are presented as frequencies and proportions.

3. Results

Three-hundred and ninety-nine athletes from 74 countries were attended for treatment in the PTS of the Polyclinic during Rio 2016 Paralympic Games. Africa (41%, n = 308) and Asia (26%, n = 194) were the continents more attended for treatment in the Polyclinic, followed by America (17%, n = 127), Europe (15%, n = 115) and Oceania (1%, n = 3). Two-hundred and five athletes had physical impairment (71.4%), 96 had visual impairment (24%) and 18 had intellectual impairment (4.6%). Wheelchair was the exclusive type of locomotion for 72 athletes (18%). Ninety-eight athletes (24.5%) had poliomyelitis and/or congenital malformation as etiology and the most frequent sequelae were: paraplegia (n = 89, 22.3%), partial blindness (n = 71, 17.8%) and amputation (n = 64, 16%). The PTS delivered a total of 2667 encounters (747 of Physical Therapy, 172 of Osteopathic, 169 of Chiropractic, 962 of massotherapy and 617 water-immersion) during Rio 2016 Paralympic games. A total of 4504 interventions were performed and for each PTS encounter, a mean of 1.69 interventions were applied. Approximately a half of the interventions delivered in the PTS (57.4%; n = 2584) were specifically of Physical Therapy (i.e. electrothermophototherapy, strengthening, myofascial release, etc). The number of athletes per sports modalities attended for treatment at the Polyclinic and the number of encounters is indicated in Table 1. Athletes representing athletics, sitting volleyball and powerlifting were most frequently attended for treatment.

Table 1
Number of athletes per sports modality that were attended in the PTS and their frequency of Physical Therapy encounter.

Sports Modalities	Number of athletes (%)	Number of PT encounters (%)
Athletics	145 (36.3)	451 (60.4)
Wheelchair Basketball	8 (2.0)	11 (1.4)
Boccia	0 (0.0)	0 (0)
Cycling	16 (4.0)	17 (2.3)
Canoe	2 (0.5)	4 (0.6)
Wheelchair rugby	0 (0.0)	0 (0)
Football 5-a-side	5 (1.25)	6 (0.8)
Football 7-a-side	6 (1.5)	11 (1.5)
Shooting	2 (0.5)	3 (0.4)
Archery	2 (0.5)	3 (0.4)
Judo	13 (3.3)	22 (2.9)
Equestrian	2 (0.5)	2 (0.3)
Powerlifting	48 (12.0)	51 (6.8)
Goalball	16 (4.0)	21 (2.8)
Rowing	3 (0.8)	3 (0.4)
Sailing	2 (0.5)	2 (0.3)
Sitting volleyball	73 (18.3)	74 (9.9)
Table tennis	12 (3.0)	15 (2.0)
Triathlon	0 (0.0)	0 (0)
Wheelchair fencing	19 (4.8)	22 (2.9)
Wheelchair tennis	0 (0.0)	0 (0)
Swimming	25 (6.3)	29 (3.9)
Total	399 (100.0)	747 (100.0)

Abbreviations: PT = Physical Therapy.

3.1. Physical therapy encounters

The Rio 2016 Polyclinic had 747 Physical Therapy encounters (449 for males and 298 for females) during the period of 18 days (September 1st to September 18th). These encounters were related to rehabilitation and secondary prevention. The mean of interventions applied for each Physical Therapy encounter was 3.45. Fig. 1 shows the flow of Physical Therapy encounters during this period. Since three-hundred and ninety-nine athletes were treated in the Polyclinic, the mean number of encounters for each athlete was 1.87.

The regions treated by the PTS and most frequent diagnoses are indicated in Table 2. Joint injuries were related to sprain, ligament tear, and luxation. Moreover, table 2 shows the main objectives of the treatments and the most frequently applied interventions. The Polyclinic performed a total of 455 physical therapy assessments (first visit) to determine the interventions to be applied.

3.2. Osteopathic and chiropractic service

One-hundred and seventy-two encounters of osteopathy were performed, being 164 (95%) related to pain relief. Chiropractic performed 169 encounters, being 116 (68%) related to pain relief. The main sports modalities which sought this treatment were athletics (19%), sitting volleyball (8.5%) and powerlifting (7.5%), coincidentally, also the top 3 sports modalities attended for treatment by the PTS in the Polyclinic (see Table 1).

3.3. Recovery (massotherapy and water-immersion)

The recovery service had a total of 1579 encounters, being 962 of massotherapy. September 10th was the day with the highest demand in massotherapy room, with 107 sessions performed. The Polyclinic delivered 617 water-immersion sessions (407 encounters of cryo-immersion, 115 of contrast-immersion, and 95 of hot-immersion). The mean age of the athletes that used water-immersion was 28.66 (6.90) years. The youngest athlete was 15 years-old and the oldest was 54 years-old. Male athletes used water-immersion 3 times more compared to women. September 13th was the day with the highest demand in the water-immersion

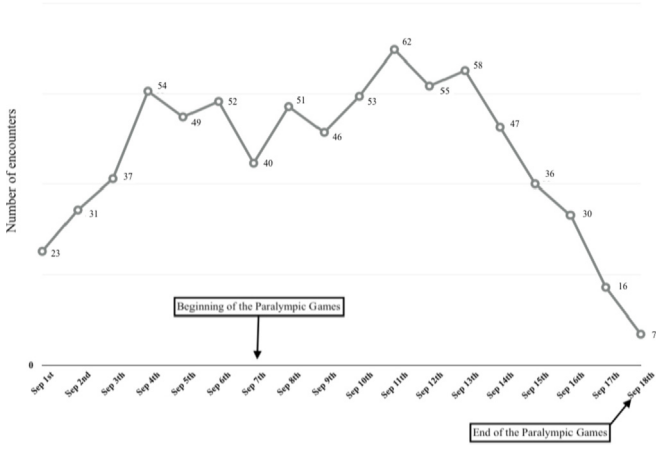

Fig. 1. Number of Physical Therapy encounters per day.

Table 2
Regions treated, most frequent diagnoses, treatment purposes and most frequently applied interventions.

Regions treated	Absolute frequency (n)	Relative frequency (%)
Thoracic/lumbar spine	172	37.3
Pelvis/hip	145	31.4
Shoulder	77	16.6
Neck/cervical spine	68	14.7
Total	462	100.0
Diagnoses	Absolute frequency (n)	Relative frequency (%)
Muscle strain	167	38.1
Tendinopathy	130	29.7
Shoulder/neck pain	61	13.9
Low Back pain	46	10.5
Joint injuries	34	7.8
Total	438	100.0
Treatment purposes	Absolute frequency (n)	Relative frequency (%)
Analgesia	622	81.4
Muscle relaxation	76	9.9
ROM improvement	66	8.7
Total	764	100.0
Interventions	Absolute frequency (n)	Relative frequency (%)
Myofascial release	343	20.4
Ultrasound	323	19.2
Laser therapy	284	16.9
Interferential current	270	16.1
Joint mobilization	154	9.2
Kinesio taping	119	7.1
Cryotherapy + compression	108	6.4
Flexibility exercises	43	2.8
Hot packs	33	1.9
Total	1677	100.0

Abbreviations: ROM = range of motion.

room. America (32%, n = 196) and Europe (26%, n = 159) were the continents more attended for treatment in the water-immersion room, followed by Africa (24%, n = 148) and Asia (18%, n = 114). Oceania did not used this facility.

4. Discussion

The International Paralympic Committee affirms the importance of programs to protect athletes' health, as well as to prevent and reduce diseases in this population (International Paralympic Committee medical code. *IPC Handbook;* www.paralympic.org/rio-2016). Especially considering the increased demand that Rio 2016 had (4328 athletes from 159 countries competing in 22 modalities (www.paralympic.org/rio-2016)). Therefore, knowledge about the organization of the PTS at the Rio 2016 Paralympic Games could be used as a reference to improve this service in future Paralympic events. This was the first study to specifically describe the characteristics of the PTS at the Polyclinic during the Paralympic Games. In the PTS, 399 athletes were attended for treatment, 2667 encounters were delivered and 2584 physical therapy interventions were performed during the 18-day operating period. The peak on September 4th could be related to the beginning of the Games and the peak around September 11th could be justified by the semi-finals and final phases. Fewer encounters were performed before and after the competition period. This pattern is common, as indicated by Grant et al. (2014), who showed a similar distribution of encounters during the London Olympic Games. Competitions increase the demand on athletes who could be predisposed to new injuries or exacerbation of previous ones. This highlights the necessity of proper training of the physical therapists to evaluate only relevant aspects of each injury and select effective interventions to allow the athlete to compete.

4.1. Continents attended for treatment by PTS in the polyclinic

During the Rio 2016 Olympic and Paralympic Games, the Polyclinic was also conceived as a welfare program, being assembled to offer support to all delegations, especially those countries that did not have multi-professional health teams (Athanasopoulos et al., 2007; Grant et al., 2014). This supports the fact that the majority of athletes attended for treatment in the PTS were from the African continent. Possibly, the PTS delivered in the Polyclinic it's a good opportunity for some athletes, which do not have regular access to professionals and some equipment, to treat their current and previous injuries.

4.2. Main sports modalities attended for treatment by PTS

The Rio 2016 Paralympic Games faced high demand from athletes searching for treatment and recovery services, therefore, PTS had to be organized to accomplish their mission. Athletes representing athletics, sitting volleyball, and powerlifting were most frequently attended for treatment in the Polyclinic during the Rio 2016 Paralympic Games. Derman et al. (2018) highlighted 5-a-side football, 7-a-side football, and wheelchair fencing as the most commonly sports modalities attended for treatment, which contradict our data. This difference probably occurred because athletics' injuries it's mainly by overuse and require physical therapeutic treatment but not urgent medical care (Weiler, Van Mechelen, Fuller, & Verhagen, 2016). Moreover, athletics is the sport with the highest number of athletes in the Paralympic games, including 3 types of deficiency - intellectual, visual, and physical - and it is also the sport with the highest number of functional classifications.

4.3. Regions treated

Thoracic/lumbar spine and pelvis/hip were the region most frequently treated in the PTS. These data are contradictory to the London Paralympic Games (Bethapudi, Campbell, Budgett, Willick, & Van de Vliet, 2015) and Derman et al. (2018) results that showed a high number of upper limb injuries. It's important to stress that Derman et al. (2018) also included encounters performed by physicians and sessions outside of the Polyclinic. Possibly, the regions most treated in the Polyclinic could be related to the sports modalities more attended, since both data were contradictory when our results were compared to London Paralympic Games and Derman et al. (2018).

4.4. Interventions applied in the PTS

The role of physical therapy in short-term but large-scale sporting events such as the Paralympic Games is to reduce or limit the increase of pain to allow athletes to perform within the limits of their injury (Grant et al., 2014). However, our results highlight the need of constant improvement in myofascial release techniques, ultrasound, and laser therapy, since they were the most frequently used interventions. It is important to consider the indication of these techniques for treat injuries such as muscular strain, tendinopathy and joint injuries (Aaron, Delgado-Diaz, & Kostek, 2017; Bailey, Thigpen, Hawkins, & Beattie, Shanley, 2017; Yu, Randhawa, Côté, & Optima Collaboration, 2016). Moreover, we need to indicate the importance of using manual therapy combined with exercises, which seems to provide better outcomes than exercise alone (Bennett, Macfarlane, & Vaughan, 2017). The authors would like to stress that these therapies have not strong evidence and this could reveal a mismatch between clinical practice in some sports event and evidence.

Osteopathic and chiropractic services were also offered to athletes in the Polyclinic of the Rio 2016 Paralympic Games. Cross-fiber massage, myofascial release, muscle energy technique, high-velocity low-amplitude technique and techniques to decrease tension were used to reduce pain (Laframboise, Vernon H & Srbely, 2016). This is the first report about the use of these techniques for Paralympic athletes and the number of encounters performed (n = 341) demonstrate athletes' demand.

4.5. Recovery usage

The benefits of recovery methods for delayed muscle pain, tissue inflammation, muscle relaxation and improved performance of Paralympic athletes are also not defined in the literature. Our study is the first to report about the use of these methods at the Paralympic Games. Our results revealed the demand for massotherapy (n = 962 encounters), cryo-immersion (n = 407 encounters), contrast baths (n = 115 encounters), and hot water baths (n = 95 encounters). Post-exercise massage improves performance because it increases the recovery rate of athletes (Kargarfard et al., 2016). Cryo-immersion reduces pain, muscle damage and inflammatory response after athlete's perform (Meline, Watier T & Sanchez, 2017). Hot and contrast baths contribute to muscle relaxation and reduced muscle soreness after practice (Bieuzen, Bleakley, & Costello, 2013). However, these references were established for Olympic athletes, therefore, the use of these interventions for Paralympic athletes remains controversial (Kellmann et al., 2018; Thompson & Vanlandewijck, 2013). The absence of evidence for Paralympic athletes highlights the need of future studies to establish parameters for this population.

4.6. Strengths and limitations of the study

This retrospective cohort study was the first one, to our knowledge, to describe the routine and demand of the PTS of the Polyclinic during Paralympic Games. This is a strong point of this study together with the quality of data registered. Specific information about the interventions used and the flow of sessions during a period of the Games were described. Therefore, the results of this study could contribute to the organization of the PTS delivered in Paralympic events and, consequently, guidance on adequate health care environment for the athletes. Another clinical perspective, could be related to the identification of equipment and materials needed to organize a PTS involved on attending during a Paralympic event. PTS is necessary during competitions, training and should give support to rehabilitation, prevention and recovery.

This study has some limitations. The data acquisition depended on proper registration in the forms performed by the physical therapists. To avoid bias, at the end of each shift we allocated a supervisor to charge the physical therapist to complete the form properly. Future studies could improve data registering using technology (i.e. application on tablets, smartphones) to avoid memory bias.

5. Conclusion

The results showed that the PTS performed 4504 interventions on athletes from 74 countries. Athletes representing athletics and sitting volleyball were the most frequently attended for treatment and the thoracic/lumbar spine and pelvis/hip were the most commonly affected regions. Muscle strain and tendinopathy were the most frequent diagnoses and myofascial release and electrotherapy were the most frequent therapies used to achieve analgesia. American athletes used recovery interventions more often than athletes from other continents. These data could provide some guidance for future Paralympic Games to achieve an adequate health care environment of PTS. The authors need to stress that evidence-based interventions should always be considered during the organization of a sport event.

Conflicts of interest

None declared.

Ethics approval

This work was not supported by grants. The Universidade Federal dos Vales do Jequitinhonha e Mucuri Ethics in Research Committee approved this study (report number CAAE: 73365417.9.0000.5108).

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