TECHNICAL UNIVERSITY OF MADRID

Faculty of Physical Activity and Sport Sciences, INEF.

**Effects of a therapeutic exercise program for injuries prevention in
wheelchair basketball (WB) players**

**Efectividad de un programa de ejercicios terapéutico para la
prevención de lesiones de jugadores de baloncesto en
silla de ruedas (BSR)**

TESIS DOCTORAL CON MENCIÓN INTERNACIONAL

INTERNATIONAL DOCTORAL DISSERTATION

SALEKY GARCÍA GÓMEZ

Bachelor in Physical Therapy

Master in Physical Activity and Sport

Madrid, 2018

DEPARTMENT OF HEALTH AND HUMAN PERFORMANCE
FACULTY OF PHYSICAL ACTIVITY AND SPORT SCIENCES, INEF.

**Effects of a therapeutic exercise program for injuries prevention in
wheelchair basketball (WB) players**

**Efectividad de un programa de ejercicios terapéutico para la
prevención de lesiones de jugadores de baloncesto en
silla de ruedas (BSR)**

Saleky García Gómez

Bachelor in Physical Therapy

Master in Physical Activity and Sport

Supervisor

Javier Pérez Tejero, PhD

Universidad Politécnica de Madrid

Madrid, 2018

Tribunal designed by the Honourable Chancellor from the Technical University of
Madrid, on _____

Chairman: _____

Committee: _____

External Jury Member: _____

Secretary: _____

The lecture and defense of the PhD was made in _____

_____

Qualification: _____

CHAIRMAN

COMMITTEE

SECRETARY

In the infinity of life where I am, all is perfect, whole, and complete.

Louise Hay

ACKNOWLEDGES

To God because without you there is nothing.

To my dear family, My Everything, for been always by my side. To my parents, for supporting me in everything. Belkis, thanks for guiding me and never leave me alone. Ileana, thank you for being the most beautiful motivation anyone could have.

To the Ministry of Higher Education Science and Technology of the Dominican Republic and the Technical University of Madrid because through their collaboration agreement they opened the doors for what is unlikely possible and also for allow to fulfill one of my most desired goals.

To Javier Pérez-Tejero, as PhD director and project director: you did not limit my vision and was a fundamental part of this research in all its phases, your focus and commitment to your mission to generate inclusive spaces strengthens my commitment to continue working for the rights of people with disabilities.

To the Sanitas “Foundation Chair” on Inclusive Sports Studies and all the team (Ignacio, María José, Celia, Augusto, Carmen and Adriana) that motivated me to give the best of me. Thanks.

I am also grateful with the organizations involved in this project: Spanish Paralympic Committee and the Spanish Sport Federation for People with Physical Disabilities who made their facilities for the whole process of preparation and pre-selection for their participation of high-level competitions to achieve this project, and human resources (Raúl Elia, Frank, Oscar Trigo, Javilo, Miguel Vaquero, Miguel Ángel, Maria and Bea) available allowing us to be part of the training camp definitely without them this research would not be possible.

How not to thank the CD Ilunion team, made up of its directors, players, technical staff and families, the participation in training and different championships allowed me to know more about wheelchair basketball not only on a technical level but also on human

level.

To all the WB players who participate female, male and Sub-23 National selection, as well as the players of CD Ilunion, for been a fundamental part in this process, the kindness and the disposition of all made easier the work that took out. It was a pleasure to know great people.

To Dr. Ruben Barakat, because in a selfless way he put at our disposal his knowledge to enrich this project.

To the Hospital Paraplegics of Toledo, especially to all those who are part of the Biomechanics and Technical Aids Unit (Ana, Vicente, Miriam, Antonio and Enrique), to Dr. Angel Gil, from whom I learned that with discipline, ethics and effort you can achieve any goal you set for yourself.

Thanks to all the people that works in the Move Research Institute of the Vrije University of Amsterdam, to my partners of the room and especially to DirkJan Veeger and Marco Hoozemans you were a breeze of fresh air in the final phase of the project, knowing its facilities and the human warmth with which you welcomed me opened the doors to new experiences.

To Don Felipe, because with his advice, not only in this process, he shows me that it does not matter where you come from, it`s matter where you are go.

Thanks to the people who have left during the process, David, Papa Blanco and Don Fernando because in this process they have taught me that everyone comes to the world with a purpose.

Thanks to Lupe, César, Rosa and Alex, for treat me like a family during this journey in Spain.

Thanks to Onnis, Raquel, Juan, Karina, Rhina, Zaida, Jennifer, Jayden, Adrián and Mayte, people who be there for me when I need support during of this process and the funny moments.

To Elo, for be such a great person and be like a grandma here in Spain.

To Lili, for always being there and without noticing you teach me that with effort and focus everything is achieved.

Thanks to Pinilla, Artacho, Bartosz, Regina and Sonia Ruiz because at crucial times of this journey, without knowing it, you guys shared words that allowed me to see everything more clear and also reminded me that no matter what happens around us being strong and having clear goals are essential ingredients to achieve our dreams.

To all the staff of the Faculty, especially to Gádor, Toñi, Lupe, Juan, Pilar and all the staff of Academic Management for the willingness to help me always.

Thanks to Margarita, Doña María, Cristian, Lilian, Gina, Mercedes, Yaiza, Pedro and to each and every one of the people who, at different stages of this process, served as a motivating entity in the difficult moments, you gave me the necessary strength to continue towards the achievement of the goal.

Sometimes we go through life, without assuming that experiences are those that forge our character, taking risks and pursuing our dreams requires courage, but people who are on the road, without knowing it, are the ones that give you the pieces of the puzzle of your life. Thank you all, because by sharing this experience with you, I will be able to add value wherever I go.

AGRADECIMIENTOS

A Dios porque sin ti no hay nada.

A mi familia, mi todo, por siempre estar. A mis padres, por apoyarme en todo. Belkis, gracias por guiarme y nunca dejarme sola. Ileana, gracias por ser la motivación más linda que cualquiera podría tener.

Al Ministerio de Educación Superior Ciencia y Tecnología de la República Dominicana y a la Universidad Politécnica de Madrid porque mediante su acuerdo de colaboración abrieron las puertas para que algo poco probable fuera posible y dieran paso al cumplimiento de uno de mis más anhelados objetivos profesionales.

A Javier Pérez-Tejero, porque como director de esta tesis y del proyecto no limitó mi visión y fue parte fundamental de esta investigación en todas sus fases, porque su enfoque y entrega a su misión de generar espacios inclusivos potencia en mí el compromiso de continuar trabajando en pro de los derechos de las personas con discapacidad.

A la Cátedra “Fundación Sanitas” de Estudios sobre Deporte Inclusivo y todo el equipo de trabajo (Ignacio, María José, Celia, Augusto, Carmen y Adriana) quienes me motivaron a dar lo mejor de mí.

A las organizaciones que jugaron una parte esencial en este proyecto, el Comité Paralímpico Español y la Federación Española de Deportes para personas con Discapacidad Física, quienes pusieron a la disposición todo el proceso de preparación y preselección de cara a la participación de competiciones de alto nivel para la consecución de este proyecto y a todo el equipo humano (Raúl Elia, Frank, Oscar Trigo, Javilo, Miguel Vaquero, Miguel Ángel, María y Bea) que nos permitieron acudir a las concentraciones, espacios sin los cuales esta investigación no habría sido posible.

Como no agradecer al equipo CD Ilunion, conformado por sus directivos, jugadores, personal técnico y familias, quienes con la participación en los entrenamientos y diferentes campeonatos me permitieron conocer más a fondo el Baloncesto en Silla de Ruedas no sólo a nivel técnico sino también a nivel humano.

A los jugadores de baloncesto en silla de la selección nacional femenina, masculina y sub 23, así como los jugadores de CD Ilunion, han sido una parte fundamental en todo este proceso, la amabilidad y la disposición de todos hizo más fácil el trabajo que se llevó a cabo, fue un placer conocer a magníficas personas.

Al profesor Rubén Barakat porque de manera desinteresada puso a nuestra disposición sus conocimientos para enriquecer este proyecto.

Al Hospital Paraplégicos de Toledo, en especial a todos los que forman parte de la Unidad de Biomecánica y Ayudas Técnicas (Ana, Vicente, Miriam, Antonio y Enrique), al Dr. Ángel Gil, de quien aprendí que con disciplina, ética y esfuerzo se puede conseguir la meta que te propongas.

A todas las personas que forman parte del Move Instituto de Investigación de Ámsterdam de la Universidad Libre de Ámsterdam, a mis compañeros de sala y en especial a DirkJan Veeger y Marco Hoozemans, ustedes fueron una brisa de aire fresco en la fase final del proyecto, conocer sus instalaciones y la calidez humana con que me recibieron me abrió las puertas a nuevas experiencias y anhelos.

Gracias Don Felipe, porque con sus consejos, no solo en este proceso, me ha enseñado que no importa de dónde vienes sino hacia dónde vas.

Gracias a las personas que se han ido durante este proceso, David, Papa Blanco y Don Fernando porque en este proceso me han enseñado que a este mundo se viene con un propósito.

Gracias a Lupe, César, Rosa y Alex, por tratarme como una familia en esta aventura en España.

Gracias a Onnis, Raquel, Juan, Karina, Rhina, Zaida, Jennifer, Jayden, Adrián and Mayte, personas que estuvieron ahí cuando necesité un apoyo durante este proceso y por los momentos divertidos.

Gracias a Elo, por ser una gran persona y ser como mi abuela aquí en España.

Gracias Lili, por siempre estar ahí y sin darte cuenta enseñarme que con esfuerzo y enfoque todo se logra.

Gracias a Pinilla, Artacho, Bartosz, Regina y Sonia Ruiz, porque en momentos determinantes con una sola palabra permitieron que viera todo más claro y recordara que sin importar lo que suceda a nuestro alrededor ser fuerte y tener un objetivo claro es esencial para lograr nuestros sueños.

Al personal de la Facultad, es especial Gádor, Toñi, Lupe, Juan y todo el personal de Gestión Académica por la disposición en ayudarme siempre.

A Margarita, Doña María, Cristian, Gádor, Lilian, Gina, Mercedes, Yaiza, Pedro y a todos y cada una de las personas que en distintas etapas de este proceso fungieron como ente motivador en los momentos arduos me proporcionaron las fuerzas necesarias para continuar hacia el logro de la meta.

A veces vamos por la vida, sin asumir que las experiencias son las que forjan nuestro carácter, arriesgarse y perseguir nuestros sueños requiere coraje, pero las personas que te encuentras en el camino, sin saberlo, son las que te entregan las piezas del rompecabezas de tu vida. Gracias a todos, porque al compartir esta experiencia con ustedes podré en lo adelante agregar valor a donde vaya.

List of contents

List of tables.....	XIX
List of figures	XXI
List of Abbreviations.....	XXIII
Granted research projects and funding support	XXV
SUMMARY	XXVII
1. INTRODUCTION	1
1. Perspectives of disability.....	5
1.1 International Classification of Functioning, Disability and Health (ICF).....	5
1.2 Definition of “physical impairment”	6
2. Adapted Physical Activity and Adapted Sport.....	7
2.1 Context	7
3. Wheelchair basketball	8
3.1 History	8
3.2 Regulations and functional classification.....	10
3. 3 Wheelchairs: function and utility	12
4. Shoulder pain: Physiopathology, causes, clinical evaluation and treatment	12
4.1 Shoulder pain in wheelchair users.....	16
4.2 Shoulder pain and range of motion in WB players	18
5. Strategies to prevent shoulder pain in adapted sports	21
6. Exercise programs as a tool for treatment and prevention of shoulder injuries	24
6.1 Exercise program for shoulder pain prevention in WB players	30
7. Justification and contributions of the doctoral dissertation.....	31
2. HYPOTHESES AND OBJECTIVES	33
3. METHODS, RESULTS AND DISCUSSION	37
STUDY I.....	41
STUDY II.....	55
STUDY III	73
STUDY IV	85
STUDY V.....	105

4. SUMMARY, CONCLUSIONS AND FUTURE PERSPECTIVES	125
4.1 Summary of the findings and conclusions	127
4.2 Strengths, Limitations and Futures Perspectives.....	132
Strengths.....	132
Limitations	133
Futures Perspectives	133
4.3 Practical implications	134
4.4 Conclusions	135
5. REFERENCES.....	137
6. SUMMARIZED CV	157
7. APPENDIX.....	167

List of tables

Table 1. Exercise programs in wheelchair users.....	25
Table 2. General characteristics of the participants.....	47
Table 3. Relationship of ROM with shoulder pain.....	50
Table 4. Participant's characteristics.....	63
Table 5. SPI-WB Intraclass Correlation Coefficient per item.....	67
Table 6. Relationship of ROM with Shoulder Pain.....	68
Table 7. Spearman rank correlations between SPI-WB items and goniometric measurements of shoulder movement.....	69
Table 8. Demographic characteristics of the sample	80
Table 9. Comparison of gait, shoulder pain and type of shoulder pain by gender.....	81
Table 10. Statistical and practical significance according to gender.....	82
Table 11. Aspects related to the evaluation of the home-based exercise program...	97
Table 12. Qualitative aspects to improve per occupation profile related to Shoulder Prevention Exercise Program (SHEP) in contrast with literature.....	99
Table 13. Baseline demographic characteristics of SHEP program.....	116
Table 14. Pain and range of motion (ROM) scores at baseline and post intervention assessment.....	118

List of Figures

Figure 1. Literature review summary.....	3
Figure 2. International Classification of Functioning, Disability and Health (ICF).....	5
Figure 3. Example of WB in the Paralympics Games Rio 2016.....	8
Figure 4. Planes of movements (IWBF, 2014).....	10
Figure 5. Measures of the wheelchair in the BSR (IWBF, 2014).....	12
Figure 6. Anatomy of the shoulder (Norris, 2014).....	13
Figure 7. Most common shoulder problems (Gibson et al., 2004; Garb et al., 2010).....	14
Figure 8. Research design.....	62
Figure 9. Shoulder pain location.....	64
Figure 10. Relationship between shoulder pain, sport skills and game statistics.....	83
Figure 11. Experts occupation.....	90
Figure 12. Research Design: Expert Opinion research.....	91
Figure 13. Consort flow diagram for the Shoulder Home Exercise program (SHEP) for wheelchair basketball player's trial.....	115
Figure 14. Research Transfer.....	134

List of Abbreviations

CEDI: (in Spanish): “Sanitas Foundation” Chair on Inclusive Sports Studies.

FEDDF: (in Spanish): Spanish Sport Federation for People with Physical Disabilities.

ICF: International Classification of Functioning, Disability and Health.

IWBF: International Wheelchair Basketball Federation.

MIR: Magnetic resonance imaging.

ROM: Range of motion.

SCI: Spinal cord injury.

SHEP: Shoulder Home-Based Exercise Program.

SP: Shoulder pain.

UPM (in Spanish): Technical University of Madrid.

WB: Wheelchair basketball.

WHO: World Health Organization.

WUSPI: Wheelchair Users Shoulder Pain Index.

Granted research projects and funding support

In the present doctoral dissertation, the following institutions collaborated:

1. Sanitas Foundation Chair on Inclusive Sports Studies (CEDI) of the Technical University of Madrid (UPM), Spain. Director: Javier Pérez Tejero.
2. Spanish Sport Federation for People with Physical Disabilities (FEDDF), Madrid, Spain.

Saleky García Gómez was financially supported by a pre-doctoral grant of the Ministry of Higher Education Sciences and Technology (MESCYT) (2015-2018), Santo Domingo, Dominican Republic, and a pre-doctoral grant from CEDI-UPM (December 2016-July 2018).

Implication of the PhD candidate: Saleky García Gómez collaborated in the daily activities of the CEDI and carried out two short-term internships in Paraplegic Hospital of Toledo and Vrije University in Netherlands, also conducted a data collection and has been working on transcriptions, the data analysis and writing papers related to the doctoral dissertation topic. On other hand, collaborate in the training sessions and activities of the CD Ilunion Wheelchair Basketball Team (Season 2015-2016 and 2016-2017), also had participation in the process of the preparation and training of the players with the Male, Female and Sub-23 Spanish Selection of Wheelchair Basketball (2015-2017).

SUMMARY

The present doctoral dissertation aims to analyse the effects of an exercise program for injuries prevention in wheelchair basketball (WB) players, as part of a preventive project for shoulder health in these players. In this regard, five studies aimed to determine several aspects of shoulder health condition. The first study was a **shoulder pain (SP) assessment in a sample of elite WB players**, evaluating SP, clinical test and range of motion (ROM) in seventeen male WB players, between 16 and 43 years of age; this sample were evaluated during their preparation for a major competition. In this line, SP presented high incidence in the sample studied, and there was a clear inverse relationship between SP and ROM. The second study analysed the **validity and reliability of the “Shoulder Pain Index (SPI-WB) in WB players”**, adapted from Wheelchair User Shoulder Pain Index (WUSPI) in order to develop an instrument to characterize SP in this specific population. A convenience sample of WB players (N=17) belonging to the Spanish preselection male national team, with an age range between 16 to 43 years, was studied. This index showed a reliable and valid instrument to assess pain according to activities of daily living (ADLs) and sport skills (SS) in this population, so it can be a use as a complementary tool for athletes’ clinical screening. The third study developed was about how **SP influence wheelchair basketball sport skills** (such as shooting, rebounding, one long hand passes and other situations) in preparation process for an international competition. Fifty-one WB players aged from 15 to 45 years (21 females, 23, 86 ± 1 , 38 years and 30 males, 23, 90 ± 1 , 46 years) were evaluated with SPI-WB questionnaire. This study showed that SP could affect WB situations being this more frequent in females than males during shoots, a reason to develop protocols to promote shoulder health.

In line with the central objective of the project, the fourth study assessed the **expert's opinion of a home-based exercise program for SP prevention (SHEP) in WB players**; to address this information an ad hoc questionnaire was administered to a convenience sample of nine experts (one rehabilitation physician, one sport physician, four physiotherapists and three coaches) that fulfilled the defined inclusion criteria. This program was perceived as an adequate and validate tool to prevent SP in WB player's population. The fourth study was focus in the application of the **SHEP in a sample of WB players along their preselection and preparation to major competition**. Thirty-six male and female WB players from the Spanish pre-selection national teams were assigned to either an exercise or a control group to develop the non-randomized clinical trial. The program appeared to be useful to prevent injury and maintain the condition of the shoulder. After SHEP development, SP was reduced, but not significantly in the sample after intervention, neither for ROM there were not significant changes. The functionality and health of the shoulder were preserved along the exigent training and preparation for an international competition such as Rio de Janeiro –Brazil- 2016 Paralympic Games for males, obtaining the silver medal; and Atri –Italy- European Championships B for females, obtaining the gold medal. SHEP application and the general sport performance achieved, it seems clear that preventive programs for shoulder griddle should be always incorporate along sport training in WB players.

RESUMEN

El presente trabajo tiene como objetivo analizar el efecto de un programa de ejercicios terapéuticos para la prevención de lesiones en jugadores de baloncesto en silla de ruedas (BSR). En este sentido, en el marco de cinco estudios se determinaron diferentes aspectos de la condición de salud del hombro. El primer estudio sobre la **evaluación de dolor de hombro (DH) en jugadores de élite de BSR** se centra en evaluar el DH mediante cuestionario, pruebas clínicas y rango de movimiento (ROM) en diecisiete jugadores de BSR, con edades comprendidas entre 16 y 43 años; la evaluación fue realizada durante una concentración de cara a una competición internacional. En los hallazgos se encontró alta incidencia de DH en la muestra estudiada, a su vez se identificó hubo una clara relación entre DH y el ROM. El segundo estudio analiza la **validez y fiabilidad del cuestionario de dolor en el hombro en jugadores de BSR (CDH-BSR)**, este es una adaptación del Wheelchair User Shoulder Pain Index (WUSPI) para diseñar un instrumento que permita identificar el DH en esta población. La muestra está formada por jugadores de BSR (N=17) pertenecientes a la pre-selection nacional española con edades entre 16 y 43 años, fue estudiada. Siendo CDH-BSR, un instrumento válido para evaluar el dolor en las actividades de la vida diaria (AVD) y gestos deportivos (GD). Continuando con lo anteriormente planteado, el tercer estudio analiza cómo el **DH puede afectar a los gestos deportivos propios del BSR**. En este estudio, 51 jugadores de BSR con edades entre 15 y 45 años de los cuales 21 mujeres (23.86 ± 1) y 30 son hombres (23.90 ± 1) fueron evaluados con el cuestionario CDH-BSR. Esta investigación muestra que el DH puede afectar a gestos deportivos como hacer canastas, realizar rebotes, pases largos y otras situaciones propias del juego, a la luz de los resultados se presenta más frecuente más DH en mujeres que en hombres al realizar canastas siendo este un motivo para desarrollar protocolos para promover la salud del hombro.

En línea con el objetivo central del programa, el tercer estudio analizó la **opinión de expertos acerca de un programa de ejercicios en el hogar para la prevención del DH en jugadores de BSR**; se diseñó un cuestionario *ad hoc* que fue administrado a nueve expertos (un médico rehabilitador, un médico del deporte, cuatro fisioterapeutas y tres entrenadores) quienes cumplían con los criterios de inclusión. Los resultados obtenidos de la evaluación del programa concluyen que es una herramienta adecuada y válida para prevenir el DH en jugadores de BSR. Por último, el cuarto estudio estuvo enfocado en determinar la **efectividad de un programa de ejercicios del hombro en el hogar a los fines de prevenir lesiones de hombro en jugadores BSR**. Para desarrollar un ensayo clínico no aleatorizado, 36 jugadores y jugadoras de BSR pertenecientes a la preselección nacional española de BSR fueron asignados a un grupo de intervención o un grupo control. Este protocolo podría ser una herramienta útil para prevenir lesiones y mantener la condición óptima del hombro en jugadores de élite. Después de la intervención, el DH se redujo en esta muestra; sin embargo no hubo diferencias significativas para el DH y el ROM. La funcionalidad y salud de hombro se mantuvo a lo largo de un exigente proceso de entrenamiento y preparación para una competición internacional como son los Juegos Paralímpicos Rio de Janeiro –Brasil- 2016 Juegos Paralímpicos para la selección masculina, quienes obtuvieron la medalla de Plata; y Atri –Italia- Campeonato de Europa B para la selección femenina, quienes obtuvieron medalla de Oro. Con la aplicación de SHEP y el rendimiento deportivo general alcanzado, parece claro que los programas para prevenir el DH deberían de incorporarse en el marco del entrenamiento deportivo en los jugadores de BSR.

1. INTRODUCTION

Health intervention in adapted sport has been a critical issue in order to decrease musculoskeletal injuries. Research in sport injuries is increasing all over the years; however, it is necessary to develop studies to characterize shoulder injuries in wheelchair athletes, moreover to design and implement protocols to treat and prevent injuries in wheelchair sports.

In this regard, the aim of the present study was to design, develop and implement a SHEP in order to determine the effects of a home-based exercise program in WB players to establish a work line to prevent injuries in the context of concentration and preparation of WB player for a major competition.

Develop and implement of the SHEP describe in this doctoral dissertation will follow this structure:

- The first chapter includes a brief review of the framework of the study, with seven sections. Figure 1 represents the introduction structure.

Figure 1. Introduction structure

- In the second chapter, hypotheses and objectives of the present doctoral dissertation are presented.
- The third chapter is related to the results, method and discussion. It also has four sections related to different articles:

- First study: Pérez-Tejero, J. & García-Gómez, S. (*Summited*). Shoulder pain assessment in elite wheelchair basketball players. *Andalusian Journal of Sports Medicine*, ISSN: 1888-7546.
- Second study: García-Gómez, S., Pérez-Tejero, J., García, B., Barakat, R. (*Accepted*) Validity and reliability of the shoulder pain index for wheelchair basketball players. *Journal of Sport Psychology*. ISSN: 1132-239X
- Third study: García-Gómez, S., & Pérez-Tejero, J. (2017). Wheelchair basketball: influence of shoulder pain in sport skills. *Journal of Sport Psychology*, 26(3), 45-49. ISSN: 1132-239X.
- Fourth study; García-Gómez, S., Pérez-Tejero, J., Ocete, C., Barakat, R. (2017) Expert's opinion of a home-based exercise program for shoulder pain prevention: application in wheelchair basketball players. *Psychology, Society & Education*. 9(3), 433-445. ISSN: 2171-2085.
- Fifth study: García-Gómez, S., Pérez-Tejero, J., Hoozemans, M., Barakat, R. (2018) A home exercise program as preventive tool for shoulder function in wheelchair basketball players when preparing major competition. (In press).
- Last chapter is presenting a summary with conclusions, practical implications, limitations and future directions of the study.

INTRODUCTION

1. Perspectives of disability

1.1 International Classification of Functioning, Disability and Health (ICF)

The International Classification of Functioning, Disability and Health (ICF, WHO 2001) consist in two fundamental aspects related to the health conditions and contextual factors, as a framework to describe and organize information about function and disability. It provides a standard language and a conceptual basis for the definition and measurement of health and disability. The ICF integrates the major models of disability (Figure 2); it recognizes the role of environmental factors in the creation of disability, as well as the relevance of associated health conditions and their effects (WHO, 2002).

Figure 2. *International Classification of Functioning, Disability and Health (ICF, WHO, 2001).*

Disability is an umbrella term, covering impairments, activity limitations, and participation restrictions (WHO, 2001). Consequently, there are health, personal conditions and environmental factors as a crucial aspect to define disability. However, the notion of disability varies across the world and the definition internationally is a

people with disabilities represent a heterogeneous group of people, despite the stereotypical view of disability that emphasizes wheelchair users.

Researches in physical disability and wheelchair (sport) propulsion/dynamics (Vanlandewijck, 2001; Van der Woude, Janssen, & Dirk, 2005) used this theoretical framework for those activities related to spinal cord injury (SCI), to develop restoration of (wheeled) mobility in SCI rehabilitation but also, performance in wheeled sports, as WB.

1.2 Definition of “physical impairment”

Physical impairment is a global definition for the conditions that can limit the body functionability on alterations in body structure (WHO, 2011); for example, when a part of a person's body is not working properly. Thus, a physical impairment means any physiological disorder or condition, cosmetic disfigurement, or anatomical loss affecting one or more of the following body systems: neurological, musculoskeletal, special sense organs, respiratory, cardiovascular, reproductive, digestive, genito-urinary, skin and endocrine (Jacob, Decker, & Lugg, 2016).

In this regard, the main focus of our approach is people with physical impairment such as amputation and spinal cord injury (SCI) because they are the impairment eligible for WB practice. For example, people with SCI results in impairment or loss of sensitive and motor function and decrease of the stability in the trunk or limb (or both) caused by damage to the neural elements within the spinal canal (Figoni, 2009)

2. Adapted Physical Activity and Adapted Sport

2.1 Context

The adapted physical activity is defined as a cross-disciplinary theory-practice that attempts to identify and solve motor problems through the lifespan; develop and implement theories that support access to sport and active lifestyle; develop cooperative home-school-community service delivery, also empowerment system (DePauw & Sherrill, 1994; Sherrill & DePauw, 1997). There are several social benefits for the people who practice physical activity such as improve feelings of wellbeing and life satisfaction (Frontera, Slovik, & Dawson, 2006).

Sport is an important tool for social change as well as rehabilitation; with influence in the perception of the people with disabilities of themselves and the way society perceives them (Frontera et al., 2006). The term “adapted sport” is used to refer to a sport that has been designed for specifically practice by athletes with a disability (DePauw & Gavron, 2005). In this context, adapted sport encompasses many sport opportunities and competitions for athletes with physical, sensory, and intellectual impairments (Seaman, 2007). On the other hand, Paralympic sport arises as a complementary tool from physical, social and psychological rehabilitation for people with paraplegia (Guttmann, 1976; Pérez, Sanz, & Reina, 2012); this kind of sport requires selective classification systems in order to stablish equality in competitive performance (Tweedy & Vanlandewijck, 2011). For example, in basketball, some aspects like the use of wheelchair, changes of the regulations are adaptations to be practiced by people with disability (Pérez, 2012), and it is one of the most popular adapted sport in the context of Paralympics Games (Figure 3).

Figure 3. WB at the 2016 Paralympics Games in Rio de Janeiro

3. Wheelchair basketball

3.1 History

WB emerged out of the Second World War (1939-1945), because of this global conflict, many veterans returned to the society with physical disabilities. Sir Ludwig Guttmann and his colleagues organized the first Stoke Mandeville Wheelchair Games in 1948, a competition in which was featured wheelchair sports, including wheelchair netball, similar to WB. Four years later, in 1952, the games developed into the First International Wheelchair Sport Competition for people with physical disabilities. The annual event became known as the International Stoke Mandeville Games, and then in 1960 in Rome took place the First International Games for Disabled in conjunction with the Olympics Games named “Paralympics Games”. The Paralympic Games are the main event for world-class athletes with physical disability and one of the biggest multi-sport competitions in the world.

In Spain, related to Male National WB team, the sport takes higher standards of player preparation in 1992, moreover they achieved fourth place in Atlanta 1996 (Pérez,

2012) and fifth place in the 2012 London Paralympic Games. In 2011 and 2013 in the European Championship, the men's team BSR obtains bronze in both competitions. In smaller categories, good results have been obtained, achieving first 2006 Junior World Position and a Second Place in the Sub-Championship in 2009. Actually, at national level, three competitions stand out, as well as clubs and associations responsible for aspect related to the level of training, WB is governed by the Organization of Wheelchair Basketball in Spain, depends on the FEDDF. This federation structures the championships of league, national cups and aspects related to the national team.

Currently, there are three levels of competition: Honor Division that counts with 10 teams, with 9 teams and the first division with 13 teams divided into two groups. At the same time, it is celebrated once a year the *King's Cup* (Copa del Rey). Nowadays, there is no female WB league at national level; however, the competition is mixed, and females had a reduction of 1.5 points. There is an active participation of Spanish clubs at the European competitions.

At the National Selections level, European Championship held for males, females and sub-23 every two years, this is essential for later qualify for the World Championships. In relation to international competition, every four years the Paralympics Games are celebrated. In international championships a separation is made between genders. In this regard, the Spanish National Team and the Paralympics Games received fourth place in Atlanta, fifth place in London 2012 and 2th place in Rio de Janeiro 2016. In 2011 and 2013, the team received bronze in both European Championships competitions. On other hand, Spanish Female WB team played 12 European women's championships: 12 of them European Championships A, and a Championship of Europe B. In 2016, they won the European B, also in 2017 achieves the world classification for Hamburg 2018, taking fifth place in the competition.

3.2 Regulations and functional classification

WB is probably the most popular adapted sport practice worldwide (Crespo-Ruiz, Del Ama-Espinosa, & Gil-Agudo, 2011) it is practiced in over 75 countries. WB is regulated by a functional classification system according to the IWBF, which is a requirement to establish an equitable competition. This classification value is the player's "playing points" on the court. At any given time in a game, the total points assigned to a team of five players on court must not exceed 14– they may be below 14 (IWBF, 2014).

In the classification system, the main functions determine a player's classes are trunk, lower limb and upper limb function. The key element is the *volume of action described as the limit to which a player can move voluntarily in any direction, and with control return to the upright-seated position, without holding the wheelchair for support or using the upper extremities to aid the movement* (IWBF, 2014). The volume of action includes all directions, and describes the position of the ball as if the player were holding it with both hands in frontal, sagittal and transverse plane of movements (IWBF, 2014) (Figure 4).

Figure 4. Planes of movements (IWBF, 2014).

WB players must have a physical to compete, such as SCI, congenital deformities, post-polio syndrome, lower limb amputation and orthopedics deformities that can be demonstrated by Magnetic Resonance Imaging (MIR) and X-ray, which usually requires the use of a wheelchair. For WB competition, the wheelchair must comply certain standards determined by the IWBF regulations (see 3.3.).

In WB, players are assigned a classification between 1.0 and 4.5 in half point increments when player does not seem to fit exactly into one class, exhibiting characteristics more than one more classes (IWBF, 2014). According to the volume of action, the characteristics of each classification, it is as follow (IWBF, 2014):

- Class 1.0: The player does not have active trunk movement in the vertical plane, has little or no controlled trunk movement in the forward plane and not controlled trunk movement in the sideways plane.
- Class 2.0: The player does not active upper trunk rotation; partially controlled trunk movement in the forward plane and does not controlled trunk movements in the sideways plane.
- Class 3.0: The player does not complete trunk movement in the vertical plane, has complete trunk movement in the forward plane and does not have a total control of the movement in the sideways plane.
- Class 4.0: The player does not complete trunk movement in the vertical plane; however, has complete trunk movement in the forward plane. In one side can complete trunk movement, but usually due to limited function in the contralateral side has difficulty with controlled trunk movement opposite side.
- Class 4.5: The player does complete trunk movement in the vertical forward and sideways plane.

It is essential to clarify that not all players who participate in WB use a wheelchair for activities of daily living (ADLs) (Pérez-Tejero, 2007). For WB players, the use of a wheelchair for ADLs and competition is a risk factor to develop skeletal muscle disorders by overloading joints when performing specific shoulder movements (Pérez-Tejero & Castellanos, 2009).

3. 3 Wheelchairs: function and utility

The wheelchair is a support instrument that with, proper use, allows the users development in activities of daily living (ADLs) and sports activities. An adequate wheelchair skills performance it is associated with age, paraplegia and higher self-efficacy perceptions (Fliess-Douer, Vanlandewijck, Post, Van Der Woude, & De Groot, 2013). In the context of sport, the wheelchair it is considered part of the player (IWBF 2014). Thus, improving mobility enhances efficiency and provides security to the user. It is used according to the anthropometric measures and level of functionality of the user, as well as the demands of the sport to be practiced (Vanlandewijck, 2001; Pérez-Tejero, 2007).

Some requirements must be known about the wheelchair sport specific for WB, these measures are determined by the game rules (Figure 5). Contravention of the rules will result in the WB player being banned from the game (IWBF, 2014).

Figure 5. Measures of the wheelchair in the BSR (IWBF, 2014).

Degenerative conditions of the shoulder remain a significant source of pain and impairment in general population (Killian, Cavinatto, Galatz, & Thomopoulos, 2012). In this regard, SP is no considered as a diagnosis but as a symptom that may be caused by various pathologies (Murphy & Carr, 2010). It is the third most common musculoskeletal reason of healthcare consultation after neck and back pain (Garg, Prince, & Cole, 2010).

For the complex anatomy of the shoulder (Figure 6) and the spectrum of disorders affecting this joint, it could be difficult to diagnose and consequently create a specific treatment (Garg et al., 2010; Walker, 2014).

Figure 6. Anatomy of the shoulder (Norris, 2014).

Shoulder disorders exhibit similar clinical features, such as decreased range of motion (Garg et al., 2010). This situation and the lack of consensus in clinical assessment difficult preventive and treatment choices (Norris, 2014). The pathogenesis of rotator cuff tears is considered as a result of a common pathway involving both, intrinsic and extrinsic causes. Intrinsic causes include age-related, metabolic and vascular changes leading to degenerative tearing and differential shear stress within the

tendon causing intratendinous tears. However, the extrinsic causes included biomechanical aspects, glenohumeral instability, acute trauma event and repetitive microtrauma (Garg et al., 2010). Most shoulder problems fall into three categories: soft tissue disorders, arthritis and instability or muscles tears that affect soft tissue. (Garg et al., 2010) (Figure 7).

Figure 7. Most common shoulder problems (Gibson et al., 2004; Garb et al., 2010).

Commonly the shoulder is affected by pathogenesis of the rotator cuff disease and tendinopathy (Garg et al., 2004) caused by repeated shoulder movements such as subacromial impingement. As well as, subacromial bursitis is caused by repetitive damage to the bursa, overuse and repetitive movements. Subacromial impingement is defined as SP resulting from the catching of the rotator cuff under the coracoacromial arch of the shoulder; this can lead to a tear in the tendon of rotator cuff muscles which can be either partial or complete (Garg et al., 2010). Impingement and tears of the rotator cuff are the cause of SP in over 75% of patients who not use wheelchairs (Lewis, 2009). On other hand, capsulitis adhesive (frozen shoulder) is associated with SP, synovitis and contracture. The cause of capsulitis adhesive is still unclear; however, it is being related to prolonged immobility or systemic illness (Walker, 2014).

Degenerative conditions as osteoarthritis and rheumatoid arthritis could result in joint damage and loss of function. On other hand, stability problems associated with dislocation of the glenohumeral joint include tearing of the rotator cuff and damage to the nerves (Clark & Adkison 2004).

Clinical evaluation of the shoulder establishes the cause of SP, specially related to rotator cuff impingement. A painful ROM from 70° to 120° of forward flexion is commonplace, with pain in anterior-superior region of the shoulder, often radiating down the lateral upper arm into the deltoid insertion; shoulder ROM is usually not restricted, except due to pain (Garg et al., 2010).

The aim of physical evaluation is to identify subacromial impingement and any weakness in the cuff muscles. Specifically, to assess active and passive ROM, clinical test such as *Neer* (Neer, 1983), *Hawkins-Kennedy* (Hawkins & Kennedy, 1980), *Jobe* (Jobe & Moynes, 1982) and *Patte test* (Beaudreuil et al., 2009); moreover, strength testing and bilateral evaluation is important for comparison and examination.

- *Neer test* (Neer, 1983): It is frequently used to identify possible subacromial impingement (Hegedus et., al 2008, Hegedus et al., 2012). The examiner should stabilize the patient's scapula with one hand, while passively flexing the arm while it is internally rotated. If the patient reports pain in this position, then the result of the test is considered to be positive.
- *Hawkins-Kennedy test* (Hawkins & Kennedy, 1980): It is frequently used to identify possible subacromial impingement. The examiner places the patient's arm shoulder in 90 degrees of shoulder flexion with the elbow flexed to 90 degrees and then internally rotates the arm. The test is considered to be positive if the patient experiences pain with internal rotation.

- *Jobe test* (Jobe & Moynes, 1982): This test is used to diagnose rotator cuff tears. To perform the test the examiner passively elevates the patient's shoulder to 90 degrees of abduction with internal rotation. Then applies a downward pressure against the arm. A positive test is the provocation of pain or abnormal weakness.
- *Patte test* (Beaudreuil et al., 2009): This test is used to explore the integrity of infraspinatus or teres minor muscle. The therapist elevates the patient's arm to 90 degrees in the scapular plane. The therapist then flexes the elbow to 90 degrees, and the patient is asked to laterally rotate the shoulder. A positive test occurs with weakness and/or pain.

Neer (1972) established three stages to develop the treatment plan in rotator cuff disorders physical evaluation, as follows:

1. Reversible o edema and inflammation (subacromial impingement).
2. Tendon fibrosis and chronic inflammation (subacromial impingement with or without partial tear).
3. Complete fiber failure with a full thickness tear.

The long-term objective of the treatment for shoulder injuries is relieve pain; restore movement and function of the shoulder (Garg et al, 2010; Norris, 2014). Depending of the stages of the rotator cuff disorders the treatment includes non-steroidal anti-inflammatory drugs, subacromial corticosteroid injections and physiotherapy.

4.1 Shoulder pain in wheelchair users

The architecture of the shoulder, because of its limited stability and small supporting musculature is not well designed for the tasks required of manual wheelchair users (Van Straaten, Cloud, Morrow, Ludewig, & Zhao, 2014). For that reason, wheelchair users may report SP as a common problem in this population, showing a

range from 14% up to 85% of SP in different studies (Curtis & Black, 1999; Ballinger, Rintala & Hart, 2000; Fullerton, Borckardt, & Alfano, 2003; Pérez-Tejero, Martínez-Sinovas, & Rossignoli, 2006; Samuelsson, Tropp, & Gerdle, 2004; Wessels, Brown, Ebersole, & Sosnoff, 2013). Previous studies have reported shoulder injuries as a common problem in WB (Nyland, Robinson, Caborn, Knapp, & Brosky, 1997; Curtis & Black, 1999; Pérez-Tejero et al., 2006), and these are mainly from the increased load at this joint and repetitive stress of ADLs and sport activities (Fullerton et al., 2003). Different aspects of the propulsion technique and muscle imbalance have been shown to affect the pathogenesis of the SP in wheelchair athletes (Burnham et al., 1993; Curtis & Black, 1999; Kulig et al., 2001).

According to some authors (Riddle, Rothstein, & Lamb, 1987; Mullaney, McHugh, Johnson, & Tyler, 2010), ROM provides relevant information related to the specific movement because of the presence or absence of injury in the segment studied, which is the shoulder in this case. In this regard, clinical tests could evaluate SP related to a specific shoulder injury through performing orthopedic tests that determine the integrity of the muscle and tendon (Hawkins & Kennedy, 1980; Jobe & Moynes, 1982; Neer, 1983).

There is a clear relationship between daily wheelchair use and the onset of SP (Samuelsson et al., 2004), affecting sedentary populations, athletes, and people with quadriplegia and paraplegia (Mullroy, Gronley, Newsam, & Perry, 1996). However, some studies have stated that SP could affect sports activities (Burnham et al., 1993; García-Gómez & Pérez-Tejero, 2016).

In this perspective, SP initially does not limit a player's ability to independently perform activities; however, it may involve functional costs in wheelchair users by influencing the speed, efficiency of movement, fatigue, and cardiac and neuromuscular

disorders (Pérez-Tejero, 2009). Therefore, it is important to describe the degree of pain and ROM and how they affect the ADLs and sports activities of wheelchair users.

4.2 Shoulder pain and range of motion in WB players

SP is one of the most common symptoms of physical dysfunction, mainly as a consequence of the increased load at this joint and repetitive stress of daily and sport activities (Curtis, 1997; Nyland et al., 1997; Fullerton et al., 2003). A previous study reported that wheelchair athletes are at particular risk of overuse injuries of the shoulder complex due to repetitive use of the upper extremities for biomechanical aspects (Dec et al., 2000; Heyward, Vegter, De Groot, & Van Der Woude, 2017). Furthermore, sports practice would increase injury and repetitive trauma risk because of the nature of the adapted sports. (Aytar et al., 2014). In that sense, wheelchair athletes sustain injuries that are related to the demands of their specific sports (Curtis, 1997).

In some wheelchair sports such as table tennis and archery, a high percentage of subscapularis and supraspinatus tendinopathy cases for the non-playing arm of table-tennis wheelchair athletes had been reported, and also a high percentage of biceps long head tendinopathy for the draw arm arch wheelchair athletes (You et al., 2016). On the other hand, wheelchair sports such as wheelchair rugby may reduce risk of SP and overuse injury due to intermittent activity rather than continuous pushing (Barfield et al., 2016).

Some studies concluded that sport activities could be affected by the physical condition of the player, specifically SP (Burnham et al., 1993; Fullerton et al., 2003; García-Gómez & Pérez-Tejero, 2016). The amounts of training hours and active competition have been associated with incidence of injuries in wheelchair users (Curtis

et al., 1999). In contrast with other study, in WB, SP could be influenced by the time of hours training per week (García-Gómez & Pérez-Tejero, 2017).

Shoulder injuries such as sprains, strains, tendinitis, bursitis, impingement syndromes and avascular necrosis are a common problem in WB players (Nyland et al., 1997; Curtis & Black, 1999). Previous studies have been found that about the 72% - 85% of WB players had current SP because of ADLs or sport activities (Curtis & Black, 1999; Pérez-Tejero et al., 2006).

WB implicate high-intensity activity for wheelchair propulsion, maneuvering and specific movements as well as braking, pushing, wheelchair management (Vanlandewijck, Theisen, & Daly, 2001, de Witte, Berger, Hoozemans, Veeger, & van der Woude, 2017) and overhead movements for shooting, rebounding and long passes can promote SP (García-Gómez & Pérez-Tejero, 2017), also training for many hours over a long period of time (Curtis & Dillon, 1985; Curtis et al., 1995). In this regard, other studies indicated that SP affects more ADLs than sport activities in WB players related to age and years of wheelchair use (García-Gómez & Pérez-Tejero, 2016), taking into consideration the sample of this study were elite WB players. Different aspects of the propulsion technique, as fast propulsion to create greater forces and increasing the number of push cycles per minute, put a high demand through the shoulder gird (Kulig et al., 2001). In addition, muscle imbalance has been shown to be a factor that can be implicated in the pathogenesis of the SP in wheelchair athletes (Burnham et al., 1993; Curtis & Black, 1999; Kulig et al., 2001).

In this regard, ROM could be influenced by propulsion technique, therefore it can be inferred that it is necessary to develop shoulder strategies to initiation ROM with adequate muscle balanced (control) and power (Starrs, Chohan, Fewtrell, Richards, &

Selfe, 2012). Wheelchair users with no SP had greater ROM than those who had SP (Wessels, Brown, Ebersole, & Sosnoff, 2013).

According to previous studies (García-Gómez & Pérez-Tejero, 2016; Wessels et al., 2013), the correlation between SP and joint mobility could affect WB skills performance. These can be affected by the health condition, shoulder injury, functional class and wheelchair propulsion, among others. For instance, according to Wang, Chen, Limroongreungrat and Change, (2005) in average rebounds per game male and female players showed significant influence by the sitting height on. On the other hand, recovering the ball, steals, blocked shots or opponent's and turnovers are the more important variables in both genders in imbalanced WB games in major competitions (Gómez et al., 2014). Some authors (Goosey-Tolfrey, Morriss, & Butterworth, 2002; Malone, Gervais, & Steadward, 2002; Pérez-Tejero, Duarte, Muelas, Prieto, & Navarro, 2016) explained how functional class can influence shooting performance in WB. In this regard, it seems relevant to explore the possible consequences shoulder pain injuries on WB sport skills, this information is important for the physiotherapist and the coach to consider the health assessment and screening of the player along the sport season, and to develop specific preventive training programs considering the shoulder joint.

Both, novice and elite WB players experience soft tissue injuries to the upper limb specifically in WB (Curtis et al., 1995; Curtis, 1997). In contrast, other study specifies that older males have a higher risk of SP (Tsunoda, Mutsuzaki, Hotta, Tachibana, Shimizu, et al., 2016). However, WB players with age between 15 and 20 years already evidenced SP (García-Gómez, De la Rosa, Pérez-Tejero, 2014; García-Gómez & Pérez-Tejero, 2017). Also, while performing specific sport activities related to WB, players presented more SP during rebounding/one-handed long passes in players who use the wheelchair in daily activities (García-Gómez & Pérez-Tejero, 2017).

SP could affect the specific activities of WB according to gender, especially during shooting in female players, so ways to promote shoulder health must be developed (García-Gómez & Pérez-Tejero, 2016). In this line, Tsunoda et al. (2016) established a gender difference; considered male WB players have a higher risk of SP than female players, so daily shoulder care and periodic medical check-ups are needed for male WB players.

5. Strategies to prevent shoulder pain in adapted sports

Sport injury prevention studies have been developed over the years in order to improve the interventions, being the exercise one of the most used strategy implemented in the clinical practice to prevent injuries (Cools, Johansson, Borms, & Maenhout, 2015); however, educational programs related to ergonomic aspects is well known as an aspect to develop in prevention, treatment and health promotion.

In general, regular exercise could boost positively in a wide range of areas, such as improved blood circulation, decrease the risk of a hip or vertebral fracture and help control weight, improved blood cholesterol levels, boost in energy levels, managing stress, and releasing tension (WHO, 2001). However, there are many benefits of the exercise in people with disabilities such as (Frontera et al., 2006; Figoni, 2009):

- Increased muscular strength and endurance of the arm musculatures.
- Increased cardiac and pulmonary function.
- Increased maximal stroke volume or cardiac output.
- Improved ability to perform activities of daily living.
- Protection against development of chronic diseases.
- Decreased anxiety and depression.
- Enhanced feeling of well-being.
- Weight control.

- Lowered cholesterol and blood pressure.

A recent systematic review identifies limited evidence in shoulder injury in overhead sports, also limited information related to the effect of shoulder injury prevention measures (Asker, Brooke, Waldén, Tranaeus, Skillgate, & Holm, 2018). In this regard, current research explains that home-based programs in wheelchair users have been found to be effective in reducing pain levels by nearly 50%, to improve functional condition; this kind of strategies need to be implemented early and coordinate with an upper extremity evaluation and screening to prevent and treat issues (Silvestri, 2018). On other hand, improving shoulder ROM could decrease SP in upper-extremity dominant sports (Wilroy & Hibberd, 2017).

Shoulder injury is one of the common conditions in elite wheelchair athletes (Fairbairn & Huxel, 2018). Furthermore, musculoskeletal injury in adapted sport is similar to able-bodied related to type of illness such as strain and sprain. The upper extremity, including shoulder, elbow and hand, is the most frequently injured area in all Paralympic athletes (Tuakli-Wosornu, Mashkovskiy, Ottesen, Gentry, Jensen, & Webborn, 2018). In this regard, 52% of the WB players develop SP during the process of preparation for a championship (García-Gómez & Pérez-Tejero, 2017).

In rehabilitation, the most used strategies to maintain the health of the Paralympic athletes at the highest level are: injury prevention, functional training, functional recovery focused on specific goals of the athlete (Mantilla, 2018). It is well known in physiotherapy, that there are many protocols to treat and prevent injuries to promote health; however, exercise is the most common strategy that clinicians use to prevent shoulder injuries in adapted sport and able-bodied sports. Exercise training in people with disabilities had benefits such as exercise improve upper extremity strength; power and endurance reduce upper extremity pain (Frontera et al., 2006).

Cools et al. (2015) explain some aspect to be clear to develop a strategy to prevent recurrent injuries in overhead sports:

- It is necessary to define the risk factors for injury and re-injury in the specific sport.
- Determine which risk factors may be used as criteria to reincorporate to the training sessions and competition.
- Measure with a reliable, valid assessment tools and protocols the variables could influence the player's conditions.
- Finally, preventive exercise programs for shoulder injuries prevention in sports that include overhead movements need to be design and implemented to prevent re-injury of the shoulder.

Some studies suggest that exercise is a useful tool as an element to prevent and to treat SP as a result of injuries (Nawoczinski, Ritter-Soronen, Wilson, Howe, & Ludewig, 2006; Van Straaten, Cloud, Morrow, Ludewig, & Zhao, 2014) in wheelchair users; even high-intensity interval training appears feasible and safe to prevent SP (Gauthier, Brosseau, Hicks, & Gagnon, 2018). There are many researches about shoulder interventions depending of the type of injury and the condition of the athlete for the physiotherapist to determine which protocol and the appropriate exercise. In this population, only one study (Wilroy & Hibberd, 2017) is developed to evaluate how exercise program prevent shoulder injuries in a collegiate WB has been found; however, this study is focus in prevent SP during a process of high levels of training in an elite WB population.

6. Exercise programs as a tool for treatment and prevention of shoulder injuries

A literature review was done in order to know the different researches about exercise program for shoulder condition in wheelchair users. Previous studies documented the influence of home-based exercise programs on shoulder injuries in wheelchair users (Table 2), assessing the effect of exercise on shoulder pain and how affects function. Furthermore, it has been shown that the results of these programs suggest that provide shoulder stability and mobility of the shoulder are fundamental training contents in these programs, to prevent postural changes related with muscular imbalance.

Table 1.

Exercise programs in wheelchair users.

Authors	Sample	Time	Exercise	Dosage	Study design	Measure
Curtis et al., 1999	42 wheelchair users randomly assigned (21/21).	6 months.	3 Strengthening (scapular retraction, shoulder external rotation and shoulder adduction) 2 Stretching (pectoral stretch, biceps stretch)	7 days per week. Strengthening: 3 set of 15 repetitions, stretching: 5 repetitions, holding for 20 to 30 seconds each time.	Comparative (with and without treatment). Follow up 2 and 4 months.	Wheelchair Users Shoulder Pin Index (WUSPI).
Nawoczinski et al., 2006	41 wheelchair users assigned according to clinical diagnostic test (21/20).	8 weeks.	3 Strengthening (middle and lower trapezius muscles, serratus and shoulder external rotation) 4 Stretching (upper trapezius muscle, pectoral stretch, long head biceps muscle).	Every day. Strengthening: Lower band resistance: 3 sets of 10 repetitions Higher band resistance: 3 sets of 20 repetitions.	Comparative (with and without shoulder impingement symptoms). Follow-up at 4 and 8 weeks.	Wheelchair Users Shoulder Pin Index (WUSPI), Shoulder Ranting Questionnaire (SRQ).
Nash et al., 2007	7 wheelchair users.	16 weeks.	Strength: Overhead press, horizontal row, horizontal butterfly, biceps curl, latissimus pull-down and triceps press. Circuit Resistance training: military press, horizontal rows, preacher curls, wipe grip latissimus dorsi.	Strength: 8 repetitions lasting 6 seconds (3s concentric, 3s eccentric). Follow at 4 weeks. Circuit Resistance training: 3 days per week.	Repeated measures design. Not intervention. Follow baseline and 16 weeks.	Wheelchair Users Shoulder Pin Index (WUSPI), Wingate Anaerobic test, Helms Equalizer 1000 multistation and Equalizer 700 multistation.

Mulroy et al., 2011	80 wheelchair users assigned according to clinical diagnostic test (40/40).	12 weeks.	Stretching anterior shoulder structure, posterior shoulder structure, and upper trapezius muscles. Active movements: thumb up, arm rotation, shoulder squeeze and arm diagonals. 4 Strengthening: thumb up, shoulder external rotation, shoulder squeeze and pull down.	3 time per day. Stretching 3 to 5 repetitions, holding 15 seconds. Active movements: 3 to 5 repetitions. Strengthening 3 sets of 15 repetitions. Rest 60-90 seconds.	Comparative (with and without intervention) Follow-up at 4, 8, 12 weeks and 4 weeks after intervention.	Wheelchair Users Shoulder Pin Index (WUSPI), Shoulder torques, Short-form Heath Survey questionnaire and QOL.
Norrbrink et al., 2012	5 wheelchair users.	10 weeks.	Double-poling ergometer.	Session of 50 minutes, 3 days per week.	Repeated measures design. Follow up baseline and 10 weeks.	Wheelchair Users Shoulder Pin Index (WUSPI).
Froehlich-Grobe et al., 2012	135 wheelchair users.	1 year.	Moderate-intensity aerobic exercise and strength training.	-	Comparative (Staff-supported vs self-guide group). Baseline, 3 month, 6 month, 12 month.	Reports of weekly exercise, physiological, disability-related and psychosocial outcomes.
Middaugh et al., 2013	15 wheelchair users with SCI randomly assigned. (7/8).	8 weeks.	3 Stretching cervical rotation, lateral head tilt biceps and pectoral. 4 Strengthening scapular retractors, external rotation, adduction and extension. EMG: upper and lower trapezius, anterior deltoid and infraspinatus.	5 days per week: Stretching and strengthening: 1 set of 5 repetitions. EMG: 3 to 6 pushes (as trained above) with a 2- to 3-second cruise.	Comparative (home-based exercise program vs same exercise program plus EMG biofeedback. Follow up baseline and 10 weeks.	Wheelchair Users Shoulder Pin Index (WUSPI).

Van Straaten et al., 2014	16 wheelchair users, convenience sample.	12 weeks	Strengthening serratus anterior, scapular retractors and depressors and external rotation. Isometrics exercise anterior chest and posterior shoulder structures.	3 days per week. 3 sets of 30 repetitions with 30 seconds rest between sets.	Repeated measures design. Baseline follows up 12 weeks and 24 weeks.	Wheelchair Users Shoulder Pin Index (WUSPI), Disabilities of arm, shoulder, and hand (DASH) index, Shoulder Ranting Questionnaire (SRQ) and isometrics strength test.
Froehlich-Grobe et al., 2014	128 wheelchair users randomly assigned.	12 months.	Both groups received (1) disability-specific educational information (health benefits of exercise, aerobic and strength training distinctions, accessible exercises and locations); (2) resistance bands; (3) instruction/encouragement for self-monitoring; (4) 15 regularly scheduled calls; and (5) handwritten cards.	-	Comparative (Staff-supported vs self-guide group).	Accelerometer data, Self-reported perceptions, anthropometric data and physiological outcomes.

Troy et al., 2014	27 wheelchair users randomly assigned.	12 weeks	Each strength exercise session subjects were instructed to warm up for 5 min, exercise for 30 min and cool down for 5 min.	3 days per week, 30 min per day, for 12 weeks.	Comparative (control group, arm cycle ergometer ACE protocol and upper body rowing ergometer UBRE protocol): Familiarization test, pre-test, 12-week intervention period and post-test.	Wheelchair User is Shoulder Pain Index (WUSPI), Shoulder Pain and Disability Index (SPADI) and a simple visual-analog scale (VAS) and GXT for VO2peak.
Mulroy et al., 2017	301 (100/201) wheelchair users.	3 years	Stretching anterior shoulder structure, posterior shoulder structure, and upper trapezius muscles. Active movements: thumb up, arm rotation, shoulder squeeze and arm diagonals. 4 Strengthening: thumb up, shoulder external rotation, shoulder squeeze and pull down. Recommendations to improve mobility techniques.	4 weeks series of 2 hours classes with physical therapist.	Comparative study with a follow up assessments at 18 months and 3 years.	Shoulder Pain Onset (SPO).

Satyavanshi et al., 2017	30 wheelchair users (15 subjects each group)	5 weeks	Shoulder external rotation for supraspinatus, infraspinatus, protraction for serratus anterior, elbow flexion for biceps brachialis, horizontal abduction for posterior deltoid, shoulder internal rotation for subscapularis, elbow extension for triceps, horizontal adduction for pectoralis major, shoulder extension for latissimus dorsi were performed.	Total duration of treatment was 5 days per week for 5 weeks.	Pre-post-test experimental study design	Wheelchair propulsion Speed test (50 meters).
Gauthier et al., 2018	11 wheelchair users (6 HIT group/5 MICT group)	6 weeks	High-Intensity Interval Training (HIT): alternated between 30 s high-intensity intervals and 60 s low-intensity intervals. Moderate intensity continuous training (MICT): maintained a constant moderate intensity	Six-week programs consisted of three 40-minute propulsion-training sessions per week.	Comparative study	Cardiorespiratory fitness testing, upper limb muscle strength, and shoulder pain (WUSPI questionnaire)

6.1 Exercise program for shoulder pain prevention in WB players

The proposed Shoulder Home-Based Exercise Program (SHEP) had focus in prevent chronic soft tissue injuries in WB players with a dosage of three days per week for ten weeks; included warm-up phase, resistive shoulder exercise and a stretching phase (Appendix I). Exercise program should have different elements such as exercise that strength the muscles and stabilize the shoulder blade, balance the strength of muscles used for pulling and pushing. The intensity of the exercise depends of the type of the exercise, for example, in case of warm-up phase should be light, in resistive shoulder exercise 80% 1RM and in the stretching maintained below discomfort point (Figoni, 2009). Some studies demonstrated that strengthening with elastic bands has showed effective results in improve upper limb strength in wheelchair users (Nawoczenski et al., 2006; Mulroy et al, 2011; Satyavanshi, Pattnaik, & Mohanty, 2017). An exercise program should include special attention to front chest musculature and back of the shoulder joint, which is often tight when the patient has limited inward rotation of the shoulder (Van Straaten et al., 2016). On other hand, a study conducted by García-Gómez, Pérez -Tejero, Ocete and Barakat (2017) provides evidence for adequate structure and content validity of the SHEP as a valid tool and could be an option to prevent SP in WB players according to the expert's opinion.

7. Justification and contributions of the doctoral dissertation

After the introduction, it seems clear that shoulder health prevention program in WB players need special attention along training process. Also, training and competition appears as a source of possible source of injury, SP and decrease of ROM a shoulder level, affecting health and, consequently, sport performance. The present dissertation provides a profile of the elite WB players under preparation and preselection for major competition, and it is clear that it is necessary to investigate how shoulder conditions could affect WB player's development, considering clinical evaluation. In addition, the interaction of health multidisciplinary team focuses to develop a home-based exercise program, as an ideal first step to develop intervention programs about prevention and treatment of SP focus in the physical condition of the WB player.

Therefore, we provide scientific evidence about the use of a home-based exercise program in order to prevent shoulder injuries, in the context of the preselection and preparation for international competition in a specific sample of male and female Spanish selection WB players (Rio de Janeiro –Brazil- 2016 Paralympic Games for males, obtaining the silver medal; and Atri –Italy- European Championships B for females, obtaining the gold medal). Also, provide a questionnaire to rate the perception of SP in WB associated with ADLs and SS.

2. HYPOTHESES AND OBJECTIVES

HYPOTHESES AND OBJECTIVES

As presented, SP is a common musculoskeletal problem in wheelchair users, specifically WB players. Development of the player can be influenced by the health conditions of the shoulder, for that reason we considered to design and to implement a home-based exercise program as a tool that could prevent and reduce this symptom. In general, the aim of this doctoral dissertation was to determine the effectiveness of a home-based therapeutic exercise program for injuries prevention in WB players. This project was structured in five sequential researches representing the chapters of this doctoral dissertation.

Hypothesis and objectives of Study I

Objective: To evaluate SP in a sample of elite WB players during their preparation for a major competition.

Hypothesis and objective of Study II

Hypothesis: A Shoulder Pain Index for Wheelchair Basketball (SPI-WB) could provide information about SP in ADLs and specific activities the game in WB players.

Objective: To determine the validity and reliability of the Shoulder Pain Index for Wheelchair Basketball (SPI-WB) players.

Hypothesis and objective of Study III

Hypothesis: Shoulder pain could affect WB sport skills development.

Objective: To assess the influence of SP in those WB sport skills.

Hypothesis and objective of Study IV

Hypothesis: A newly designed SHEP had the adequate structure and content validity to prevent SP in WB players.

Objective: To assess the structure and content validity of a SHEP, as an instrument to prevent of SP in WB.

Hypothesis and objective of Study V

Hypothesis: SHEP could maintain shoulder health related to SP and ROM in WB players in their preparation for major competition.

Objective: To analyse the preventive effect of a 10-week SHEP on SP and ROM in elite WB players along a training period before major competition.

3. METHODS, RESULTS AND DISCUSSION

METHODS, RESULTS AND DISCUSSION

As mentioned above, the main objective the present doctoral dissertation was to determine the effectiveness of a home-based exercise protocol in WB players to prevent and reduce SP in elite WB players in the context of preselection and preparation for an international competition. The data will be presented in the differences studies referred previously.

Sections “Methods”, “Results” and “Discussion” are presented below in five sequential contributions of this doctoral dissertation

---

SHOULDER PAIN ASSESSMENT IN ELITE WHEELCHAIR BASKETBALL PLAYERS

Javier Pérez-Tejero¹, Saleky García-Gómez¹

¹Sanitas Foundation Chair for Inclusive Sport Studies, Faculty of Physical Activity and Sports Sciences, Technical University of Madrid, Madrid, Spain.

Target Journal: **Andalusian Journal of Sports Medicine**

Impact Factor (SJR): 0.381

Date Submission: April, 2018

Abstract

Objective: The aim of this study was to evaluate shoulder pain (SP) in a sample of elite WB players during their preparation for a major competition. *Method:* Seventeen male WB players, between 16 and 43 years of age, were studied during their athletic preparation for a WB championship. The SP questionnaire, impingement tests and shoulder range of motion (ROM) were evaluated during a training camp. Spearman's rank correlation coefficient was used to analyse the relationship between SP and ROM, indicating the value of the effect size. *Results:* SP was evident in 52.9% of the sample and was significant and negatively correlated with ROM, while 35.3% related to impingement tests player has reported pain. The correlation was moderate to high. *Conclusions:* SP presented high incidence in the sample studied, and also there was a clear relationship between SP and ROM. In this regard, the use of SPI-WB, goniometric measurements and clinical test could be a useful approach for monitoring the health condition of WB players. Further research it's needed to determine the influence of biomechanical aspects in SP development related to specific situations of WB. *Keywords:* physical disability, adapted sport, joint range, impingement test, questionnaire.

Introduction

Wheelchair basketball (WB) is probably the most popular adapted sport and is currently practiced in over 75 countries. Its practice and competition are regulated by International Wheelchair Basketball Federation, establishing a functional classification system for every player, according to it being a requirement to establish equitable competition (IWBF, 2014). The Spanish National Team and the Paralympics Games received fourth place in Atlanta, fifth place in London 2012 and second place in Rio de Janeiro 2016. In 2011 and 2013, the men's team received bronze in both European Championships competitions. Today, three national competitions as well as clubs and associations handle related aspects of the education.

WB players must have a physical disability to compete, such as spinal cord injury (SCI), congenital deformities, post-polio syndrome, lower limb amputation and orthopaedic deformities that can be demonstrated by MIR and X-ray, which usually require the use of a wheelchair. For WB, the wheelchair must compliment certain standards determined by the IWBF regulations. In WB, it is essential to clarify that not all players who participate in WB use a wheelchair for activities of daily living (ADLs) (Pérez & Castellanos, 2009). For WB players, the use of a wheelchair for ADLs and competition is a risk factor developing skeletal muscle disorders by overloading joints when performing specific shoulder movements (Pérez & Castellanos, 2009).

The architecture of the shoulder, because of its limited stability and small supporting musculature, is not well designed for the tasks required of manual wheelchair users (Van Straaten et al., 2014). For that reason, wheelchair users may report shoulder pain SP (Ballinger et al., 2000; Samuelsson et al., 2004). Previous studies have reported shoulder injuries as a common problem in WB (Curtis & Black, 1999; Nyland et al., 1997; Pérez-Tejero et al., 2006), and these are mainly from the

increased load at this joint and repetitive stress of ADLs and sport activities (Fullerton et al., 2003). Different aspects of the propulsion technique and muscle imbalance have been shown to affect the pathogenesis of the SP in wheelchair athletes (Burnham et al., 1993; Curtis & Black, 1999; Kulig et al., 2001).

According to some authors (Riddle et al., 1987; Mullaney et al., 2010), ROM provides relevant information related to the specific movement because of the presence or absence of injury in the segment studied, which is the shoulder in this case. In this regard, clinical tests could evaluate SP related to a specific shoulder injury through performing orthopaedic tests that determine the integrity of the muscle and tendon (Hawkins & Kennedy, 1980; Jobe & Moynes, 1982; Neer, 1983). A few studies suggest the association of age and SP (Curtis et al., 1995a; Fullerton et al., 2003; Alm, Saraste, & Norrbrink, 2008). According to the literature, SP in ADLs could be influenced by the age. SP has been reported to be increased with age, suggesting that subjects over 50 years were over four times as high as the average score of subjects between the ages 21-30 years (Alm et al., 2008). However, studies with WB players with less than 20 years showed high index scores for SP (Curtis et al., 1995b).

There is a clear relationship between daily wheelchair use and the onset of SP (Samuelsson et al., 2004), affecting sedentary populations, athletes, and people with quadriplegia and paraplegia (Curtis et al., 1995b). However, some studies have stated that sports activities could be affected by SP (Mullroy et al., 1996; García-Gómez & Pérez-Tejero, 2016).

In this regard, SP initially does not limit a player's ability to independently perform activities; however, it may involve functional costs in wheelchair users by influencing the speed, efficiency of movement, fatigue, and cardiac and neuromuscular

disorders (Pérez-Tejero & Castellanos, 2009). Therefore, it is important to describe the degree of pain and range of motion and how they affect the ADLs and sports activities of wheelchair users. This study is original as the study participants were WB players under preparation for major competition, being necessary to investigate how shoulder conditions could affect WB player's development. For all of the above mentioned, the aim of this study was to characterize SP in WB players in the context of preselection and preparation of the Wheelchair Basketball World Championships in South Korea, 2014.

Methods

The present study was an observational cross-sectional study. The protocol for this study was approved by an ethical committee. Table 2 reflects the general characteristics of the studied sample. The data collection procedure was performed according to the Declaration of Helsinki (World Medical Association, 2000).

Participants

Seventeen WB players voluntarily participated in the study with an age range between 16 to 43 years. To participate in the study, the following three inclusion criteria were determined: (1) selected as member of preselection male national team, (2) use a manual wheelchair for at least 3 hours a day and at least one year before the study for players who use a wheelchair for ADLs and (3) use wheelchair at least one year before the study for players who use a wheelchair for sports only. All participants provided written informed consent; the rights of the subjects were protected.

Table 2.
General characteristics of the participants

Player	Functional class	Years since injury	Wheelchair users ADLs	Years using wheelchair in ADLs	Years Sports	Type of Disability
1	1	11	Yes	11	11	SCI
2	1,5	32	Yes	32	21	SCI
3	2	18	Yes	18	17	SCI
4	3	29	Yes	14	12	SCI/SB
5	3	18	Yes	18	22	SCI
6	3	27	Yes	6	15	SCI/SB
7	3	27	Yes	7	15	SCI/SB
8	4	19	No	-	12	Lower limb Injury
9	4	16	No	-	11	AMP
10	3	18	Yes	21	5	SCI
11	1	16	Yes	16	16	SCI
12	1,5	16	Yes	16	3	SCI
13	3	13	Yes	10	3	SCI
14	4,5	2	No	-	6	Knee Injury
15	1	14	Yes	10	7	SCI
16	2	21	Yes	20	1	SCI
17	1	7	Yes	7	-	SCI

ADLs activity of daily living; SCI Spinal Cord Injury; SB Spine Bifida; AMP Amputation.

Measures

A Shoulder Pain Index in Wheelchair Basketball players (SPI-WB) was used to measure SP. Scientific evidence support (Pérez-Tejero et al., 2006), based on the WUSPI (Curtis et al., 1995a; Curtis et al., 1995b), a mechanism to analyse the incidence of SP in this sport and how it could affect the development of WB players. According to previous study, SPI-WB had adequate α Cronbach scores ($\alpha = 0.899$), and significant ICC ($r = 0.976$, $p < 0.05$). It consisted of the following three main components: a) demographic data identifying factors relevant to the athlete's lifestyle, including shoulder dysfunction (15 items), and six items, including the years of experience in WB

practice, actual pain at the right/left shoulder, time since SP onset, SP location, numbness or cramps at the shoulder and pain in other body parts; b) pain related ADLs (15 items), distinguishing between wheelchair users (5 specific items) and all participants (10 items) and c) 4 items related to SP perception when performing specific WB skills, including shooting, pushing, rebounding or one-handed long pass, and other game situations (Pérez-Tejero et al., 2006). Clinical tests were used in the evaluation of orthopaedic shoulder injury, including the Neer's and Hawkins-Kennedy tests to determine subacromial impingement (Hawkins & Kennedy, 1980; Neer, 1983), these two clinical diagnostic test there are commonly performed by primary practioners dealing with shoulder subacromial impingement (Hughes, 2011). The Jobe test was used to evaluate the integrity of the supraspinatus muscle and tendon (Jobe & Moynes, 1982); being a simple technique which can improve the clinical diagnosis of the rotator cuff tears (Gillooly, Chidambaram, & Mok, 2010).

A goniometer was selected to explore the shoulder ROM (Riddle, Rothstein, & Lamb, 1987; Mulroy et al., 1996) and the notation system was on a scale of 0° of 180 °. A single experienced clinician stabilized the range of motion of the shoulder; for standardized goniometric measurements intra-and inter-rater reliability were used prior to the study. To determine the presence of injury, the Parameters Standard Grade Mobility according to the American Academy of Orthopedic Surgery (AAOS) were used.

Procedures

Clinical evaluation was conducted during a 5-day training camp while the player was in a seated position. For every player, SPI-WB was applied first; second, a general assessment of ROM was performed using a goniometer measuring the flexion,

extension, internal rotation, external rotation and abduction of both shoulders; then, we evaluated possible injuries of the shoulders with the Neer, Hawkins-Kennedy and Jobe clinical tests.

Statistical Analysis

For statistical analysis, all demographic data were analysed using descriptive statistics. The Spearman correlation coefficient was used to establish correlations between SP and ROM. A post hoc power analysis was performed based on an effect-size approach and revealed with 17 participants, there was 80% power to detect the correlation, $\alpha=0.05$, effect size 0.547 based in coefficient of determination $p^2=0.30$. The interpretation of the effect size was made considering values <0.20 as very low; between 0.20 to 0.39 as low; 0.40 to 0.59 as moderate; 0.60 to 0.79 as high; and 0.80 to 1 as very high (Morrow, Jackson, Disch, & Mood, 2005). The software used for data processing and analysis were Excel (Microsoft Office 2007) and SPSS V18.0 program. The significance level was set at $\alpha \leq 0.05$.

Results

Table 3 reflects the general characteristics of the sample. In this study, 82.4% of the WB players used a wheelchair for ADLs and sport practice, while 17.6% used it for sport practice alone. Most of the subjects reported SCI (70.6%); nine had dorsal injury and three had low back injuries. SP was evident in 52.9% of the WB players according to the SPI-WB. However, 35.3% had SP according to the clinical test; 41.1% of those had pain in their right shoulders, and 11.8% of the participants had bilateral SP.

To analyze the data, the test was divided into activities related to transfers exclusively for users of wheelchair (items 1, 2, 3, 4 and 5), common items related to ADLs (items 6 to 15) and SS (items 16 to 19). A table was made with the sum of the

data obtained from each player considering the above statements. According to age, four groups were established, which were those under 20, between 20 and 30, between 30 and 40 and older than 40 years of age for identify which group have more SP as a descriptive information. Shoulder pain related to ADLs and SS was more frequent in players with an age between 20-30 years. Regarding the functional class, it is important to note that only higher classes (4-4.5) have less pain. On other hand, those with spinal cord injury (SCI) have a disability that is associated with more pain; however, they represented a large proportion of the study sample size. Regarding the active ROM, the mean was below the data AAOS, indicating a decrease in ROM, although the participants had functional mobility (Table 3).

Table 3.
Relationship of ROM with SP

Shoulder Movement	AAOS	Media	SE	Min.	Max.
Right flexion	180	172,35	12,39	150	190
Left flexion	180	167,06	24,69	110	190
Right extension	60	65,00	11,46	35	80
Left extension	60	65,29	12,81	40	80
Right abduction	180	167,94	16,30	130	185
Left abduction	180	167,06	24,24	100	185
Right internal rotation	70	65,88	19,70	20	100
Left internal rotation	70	69,12	16,89	30	100
Right external rotation	90	87,06	11,05	60	110
Left external rotation	90	80,00	12,75	40	90

AAOS American Academy of Orthopedic Surgeos; SE Standard Error.

According SP, there was a significant negative correlation between the SPI-WB scores and ROM, showing that subjects with less shoulder ROM reported more pain during both ADLs (>10-min duration, ramp/uneven, washing back and sleeping) and SS (shooting, rebounding, one long passes and other sports situations). The practical significance was moderate to high. These correlations indicate that reducing ROM may

be related to the degree of pain because lower amplitude corresponds to greater articular shoulder pain.

Statistical analysis indicates that there is a negative correlation between SP according to the impingement test and ROM. There was a greater relationship between the Neer test and right abduction ($r = -0.56$; $p \leq 0.05$), right internal rotation ($r = -0.496$; $p \leq 0.05$) and left extension ($r = -0.56$; $p \leq 0.05$). For the Hawkins-Kennedy test, there was a significant negative correlation with right bending ($r = -0.60$; $p \leq 0.05$) and internal rotation ($r = -0.52$; $p \leq 0.05$), and there was no correlation with the test Jobe regarding ROM. Being the practical significance moderate. According to ROM and SP-WUSPI, the correlation was moderate to high. However, the relationship to the impingement test was moderate.

Discussion

In this study, 52.9% of the sample studied reported SP, which is consistent with previous studies (Curtis & Black, 1999; Ballinger et al., 2000; Fullerton et al., 2003; Samuelson et al., 2004; García-Gómez & Pérez-Tejero, 2016). To the best of our knowledge, the percentage of players who reported SP is troubling, especially in the selection and preparation process and specifically for a WB championship.

Eight of the nine subjects with SP (41.2 %) reported pain at the right shoulder and 11.8% reported bilateral pain. Considering that 94.1% of the participants have right shoulder as dominant side, these results could explain the appearance of chronic SP in this population with greater effects on the dominant side (right shoulder). According to the statistical analysis, the functional class did not influence SP. However, subjects with a lower functional class had SP during ADLs. In contrast, Fullerton et al. (2003) reported that SP in athletes who use a wheelchair (1-3.5, functional class) is

lower compared to those who participate in sports. One study reported that players without trunk control had more SP than those with trunk control (Yildirim et al., 2010). Subjects with ages between 20 and 30 years had more SP than others. However, subjects who were more than 31 years of age had more SP (Curtis & Black, 1999). Other author explains that SP it is no necessary a consequence of age (Wessels et al., 2013).

According to the results, there is a relationship between the type of disability during ADLs, such as sleep, and specific sport skills. On other hand, wheelchair use was related to SP when players participate in a specific sport skill. In this regard, SP could be related to repetitive activities. Some authors have reported that SP may result from lifting, especially with abduction and internal rotation, (Burnham et al., 1993; Curtis et al., 1995; Wang, 2005; Park et al., 2010). It is relevant to evaluate the deficit of flexion and abduction of the shoulder during training, as well as to think about how internal rotation could influence rebounds, considering that internal rotation a very important factor to performance (Wang, 2005).

In wheelchair users, factors like overuse and impingement positioning could cause pain (Burnham et al, 1993; Nyland et al., 1997; Fullerton et al., 2003), and these conditions could influence the shoulder ROM. ROM could be affected by the SP (SP-WB), showing a significant negative correlation with ROM in contrast to other studies (Arroyo-Aljaro & González-Viejo, 2009; Curtis et al., 1995; Park et al., 2005). However, players can perform ADLs and SS related to WB without a problem. The obtained averages were according to data from the AAOS (Table 2). On other hand, according to clinical data, there is a relationship between SP and ROM. There is a greater association with the subacromial impingement tests, and subacromial

impingement is a common lesion in athletes (Hawkins and Kennedy, 1980), including WB players.

In this regard, it is relevant to characterize SP in WB players because it can provide useful information for the physiotherapist and coach. It would be appropriate to keep track of these conditions and implement strategies that could prevent shoulder injuries in WB (Vanlandewijck et al., 2001) as well as to develop a multidisciplinary, clinical approach during their preparation. As well take in consideration functional class in the strategies development because could influence players performance; however functional class reflects to a limited extent the actual differences in performance (Cavedon, Zancanaro, & Milanese, 2015) As a study limitation, these results cannot be generalizable to other adapted sports nor other categories of physical disability.

Conclusions

The most affected ADLs in WB players were sleeping and pushing a wheelchair up ramps/inclines. According to SS, the most affected activities were shooting and other game actions. The functional class might influence the development of SP, and lower functional classes have more pain. In this regard, the type of disability was related to SP in SS. The use of SPI-WB, goniometric measurements and clinical tests could be a useful approach for monitoring the health condition of WB players.

VALIDITY AND RELIABILITY OF THE SHOULDER PAIN INDEX FOR WHEELCHAIR BASKETBALL PLAYERS

Saleky García-Gómez^{1, 2}, Javier Pérez-Tejero^{1, 2}, Beatriz García³, Rubén Barakat^{1, 2}

¹Faculty of Physical Activity and Sports Sciences, Technical University of Madrid,
Madrid, Spain.

²AFIPE research group

³Spanish Federation of Sports for Persons with Physical Disability (FEDDF).

Article accepted for publication in the

Journal of Sport Psychology

Impact Factor (JCR): 0.789

Date: June, 18th, 2018

Abstract

Wheelchair basketball is one of the adapted sports with higher significance worldwide, being the shoulder pain a common problem. The purpose of this study was to determine the validity and reliability of the Shoulder Pain Index for Wheelchair Basketball (SPI-WB) players. A convenience sample of WB players (N=17) belonging to the Spanish preselection male national team, with an age range between 16 to 43 years, was studied. Data were gathered during a training camp, where shoulder pain (SP) and range of motion (ROM) were evaluated. After descriptive analysis, Spearman correlation coefficient was used to establish correlations of shoulder pain according to ROM per player, while Cronbach's Alpha coefficient and intraclass correlation (ICC) were used to assess test-retest reliability. The level of significance was set at $p \leq 0.05$. SP was evident in 52.9% of the sample studied, with pain in activities of daily living (ADLs, as washing back and sleeping) and selected sport skills (SS, as shooting and rebounding). The designed questionnaire presented adequate validity, with significant inverse correlation between SP and ROM. For reliability, adequate α Cronbach scores were found SPI-WB ($\alpha = 0.98$), while ICC was significant ($r = 0.98$, $p < 0.05$). The SPI-WB appears as a reliable and valid instrument to assess pain in this population, so it can be used as a complementary tool for athletes' clinical screening.

Keyword: Shoulder, athletic training, basketball; psychometric validation.

Introduction

Wheelchair basketball (WB) is one of the disability sports with higher significance worldwide (Crespo-Ruíz et al., 2011). It is regulated by a functional classification system from the International Wheelchair Basketball Federation (IWBF) (IWBF, 2014). Under this system; players are evaluated on their functional mobility to play, not on their impairment. In this regard, degree of pain in game situation is not considered (IWBF, 2014). WB players must present a physical disability to compete, mainly from congenital deformities, post-polio syndrome, spinal cord injury, lower limb amputation and orthopedics deformities (Nyland et al., 1997). Muscles imbalance around the shoulder may contribute to the development of shoulders disorders in manual wheelchair users (Burnham et al., 1993; Fullerton et al., 2003). Furthermore, Moon et al., (2013) reported how wheelchair propulsion could influence upper limb pain. Thus, the onset of shoulder injuries could have a relationship with the wheelchair propulsion technique in both athlete and sedentary population (Pérez-Tejero & Castellanos, 2009; Samuelsson et al., 2004).

Some studies focused on the shoulder as the common place of pain reported by the wheelchair user population (Curtis et al., 1999; Finley & Rodgers, 2004; Samuelsson et al., 2004; Yildirim et al., 2010). Many factors such as age, gender, wheelchair use and time since injury are correlated with shoulder pain (Wessels et al., 2013; García-Gómez & Pérez Tejero, 2017; Kentar et al., 2018; Finley, Ebaugh, & Trojian, 2018). Although shoulder pain (SP) initially can limit the capacity of the individual to perform activities independently, it may involve functional costs for the wheelchair user (Mulroy et al., 1996). Physical activity and sport are much recommended in this population, due to their benefits as part of a healthy lifestyle (Frontera et al., 2006). Some studies have demonstrated that those wheelchair users who are engage in sport activities have two times less chances to present SP than those not engaged, with a later onset of SP (Pérez-

Tejero, 2007; Gil-Agudo, Del Ama-Espinosa, & Crespo-Ruíz, 2010; Pérez-Tejero, 2012). However, other studies argued that sport practice does not increase or decrease the risk of SP in the wheelchair user population (Finley & Rogers, 2004). Few studies (Curtis & Black, 1999; Pérez-Tejero et al., 2006; Yildirim et al., 2010) showed a high prevalence of shoulder injuries in wheelchair users, being sprains, strain, tendinitis and bursitis commonly reported (Burnham et al., 1993; Nyland et al., 1997; Fullerton et al., 2003).

On other hand, some authors explain that the upper limb movement dynamics in WB can cause physical dysfunction of the shoulder (Mulroy et al., 1996; Burnham et., 2013). According to Pérez-Tejero et al. (2006), 85% of the WB players have experienced some kind of SP along the competitive season. Even more, shoulder injuries are also common among the non-athlete population (Nyland et al., 1997). Other studies explained that SP in WB is attributed to the overloading by the sitting position of the player and how he/she controls the trunk, causing chronic degenerative changes at shoulder level and difference between genders (Curtis et al., 1999; Mulroy et el., 1996; Yildirim et al., 2010; García-Gómez & Pérez Tejero, 2017).

Related to the literature, it has been demonstrated that SP could influence ADLs in wheelchair users, but it is still unknown how SP could influence specific WB skills. Thus, there is an urgent need to investigate and validate an instrument to determine the players' perception of SP and how it could affect their health and sport performance. In this regard, it seems relevant to explore the possible consequences of performing repetitive movements in the sport context, being this information important for the physiotherapist and coach, in order to develop specific training programs for players' shoulder health assessment and screening.

Also, knowing that many WB players (mainly those classified from 3 up to 4,5 functional classification points, IWBF, 2014) do not use the wheelchair in their daily locomotion (presenting biped gait in ADL when using crutches, lower limb prothesis sticks, etc. or no technical aid), but sitting in the sport wheelchair for WB practice (training and competition), it appears pertinent to design a new tool for SP assessment in WB from those developed for wheelchair users (Vanlandewijck et al., 2001; IWBF, 2014). In this regard, there are multiple established SP scales that are appropriate for general wheelchair users like Shoulder Pain and Disability Index (SPADI) by Roach, Budiman-Mark, Songsiridej and Lertratanakul (1991) and the Disabilities of the Arm, Shoulder and Hand (DASH) by Hudak et al. (1996). However, there is not a scale that evaluated specific actions of WB in the scientific literature.

Giving that necessity, the Shoulder Pain Index for Wheelchair Basketball (SPI-WB) players was developed to rate the perception of SP in WB associated with activities of daily living (ADLs) and specific sport skills (SS). This questionnaire was developed by Pérez et al. (2006), to evaluate SP and then design a strategy to prevent SP, based on the Wheelchair User's Shoulder Pain Index (WUSPI) by Curtis et al. (1995a; 1995b), which is probably the main index used in applied research on non-athlete wheelchair population about this topic.

Moreover, Arroyo and González (2009), Park and Cho (2013) and Vij, Kataria and Bansal (2015), conducted the validation of WUSPI in Spanish, Korean and Hindi, respectively. In this line, Larsen, Bruun, Hansen, Hansen and Juul-Kristensen, (2015) developed the translation and cross-cultural adaptation of the Danish version of the WUSPI. This questionnaire has been used in different studies, also in a sample of WB players (Curtis & Black, 1999; Finley & Rogers, 2004; Samuelsson et al., 2004; Yildirim et al., 2010; Van Straaten et al., 2014; Tsunoda et al. 2016; Rice & Rice,

2017). Previous studies (Arroyo & González, 2009; Curtis et al., 1995; Park & Cho, 2013; Vij, Kataria, & Bansal, 2015) not include specific items to assess SP in concrete sport specific skills during WB competition and training. For that reason, it is important to develop a questionnaire that include specific skills items such as shooting, rebounding, one hand long passes and other situations to addresses SP in WB athletes.

In this regard, this study aimed to assess the validity and reliability of specific WB items incorporated by Pérez-Tejero et al. (2006) on an elite sample of WB players, using, as previous studies (Curtis et al., 1995a; Arroyo-Aljaro & González-Viejo, 2009; Mullaney et al., 2010; Park & Cho, 2013) goniometric measurements of the shoulder joint to validate the questionnaire. The validation of the proposed questionnaire, including these new specific WB items related to WB skills (Curtis et al., 1995a; Pérez-Tejero et al., 2006; Arroyo-Aljaro & González-Viejo, 2009; Park & Cho, 2013; Vij et al., 2015) will define in our opinion a new, pertinent and useful tool for SP assessment in this adapted sport. For all the above-mentioned, this study aimed to analyze the validity and reliability of the SPI-WB on its modified and version from the Wheelchair Users Shoulder Pain Index (WUSPI) in a sample of elite WB players.

Material and Method

Study Design

The present study was a cross-sectional study, clinical measurement, as a part of a non-randomized clinical trial (NCT02842008). The protocol for this study was approved by the ethical committee of the Technical University of Madrid. Data collection procedure was performed per the Declaration of Helsinki (Idänpään-Heikkilä, 2001). Figure 8 detail the research design used.

Figure 8. Research design.

Participants

A convenience sample of WB players ($N=17$) from the Spanish preselection male national team voluntarily participated in the study, with an age (30.24 ± 7.40) range between 16 to 43 years. This sample is representative sample of general population of WB players in Spain according the characteristics of the players (Table 4).

To participate in the study, the following three inclusion criteria were determined: (1) to be selected as member of the Spanish preselection male national team, (2) to use a manual wheelchair for at least 3 hours a day and (3) at least one year before the study. All participants provided written informed consent and the rights of the participating subjects were protected.

Table 4.
Participant's characteristics.

Player	Age	Functional class	Years since injury	Wheelchair users ADLs	Years using wheelchair ADLs	Years sports	Type of disability	SCI level
1	37	1	11	Yes	11	11	SCI	D5
2	40	1,5	32	Yes	32	21	SCI	D9
3	38	2	18	Yes	18	17	SCI	D10
4	29	3	29	Yes	14	12	SCI/SB	L4-L6
5	40	3	18	Yes	18	22	SCI	D12-L1
6	27	3	27	Yes	6	15	SCI/SB	L4-L5
7	27	3	27	Yes	7	15	SCI/SB	L4-L5
8	32	4	19	No	-	12	Lower limb injury	-
9	30	4	16	No	-	11	AMP	-
10	22	3	18	Yes	21	5	SCI	-
11	31	1	16	Yes	16	16	SCI	D11
12	16	1,5	16	Yes	16	3	SCI	-
13	30	3	13	Yes	10	3	SCI	D12-L3
14	25	4,5	2	No	-	6	Knee injury	-
15	24	1	14	Yes	10	7	SCI	D4-D6
16	43	2	21	Yes	20	1	SCI	D10
17	23	1	7	Yes	7	-	SCI	D11

ADLs, activity of daily living; SCI, Spinal Cord Injury; SB, Spine Bifida; AMP, Amputation.

Instruments

Scientific evidence support that SPI-WB was created based on the Wheelchair Users Shoulder Pain Index (WUSPI) (Curtis et al., 1995a; Curtis et al., 1995b) to measure the incidence of SP on this sport and how it could affect the development of the WB players (Pérez-Tejero et al., 2006). Items related to ADLs were included according to the typical characteristics properly of the people with disabilities who use

wheelchair for ADLs and only for sport practice. Previous studies are focus in the ADLs of wheelchair users (Curtis et al., 1995a; Arroyo & González, 2009). 4 WB specific items were added related to the questionnaire.

SPI-WB consisted of three main components: a) demographic data, identifying factors relevant to the athlete lifestyle, including shoulder dysfunction (Curtis et al., 1995a) (15 items) and six items more referring to years of experience in WB practice, actual pain at right/left shoulder, time since SP onset, SP location (Figure 9), numbness or cramps at shoulder level and pain in other different body part; b) pain related ADLs (15 items), distinguishing between wheelchair users (5 specific items) and all participants (10 items) and c) 4 items related to SP perception when performing specific WB skills: shooting, pushing, rebounding or one-handed long pass during game situation (Pérez-Tejero et al., 2006). Finally, items not related to WB were matched respect to the study of Arroyo and González (2009), so, in the present study, the WUSPI validated Spanish version by these authors was used. In other to obtain the results, each item was self-rated along a 10 cm visual analog scale (VAS) covering from “no pain” up to “worst pain ever experienced” for a given item.

Figure 9. Shoulder pain location.

Goniometer was selected to explore shoulder ROM (Mulroy et al., 1996; Mullaney et al., 2010) and the notation system used was 0° of 180°. To determine the presence of injury, the Parameters Standard Grade Mobility according to the American Academy of Orthopedic Surgery (AAOS) and the American Medical Association (AMA) were used (Riddle et al., 2007; Mullaney et al., 2010).

Measures

After player acceptance of study participation, clinical evaluation was conducted during a 5 days training camp, being the player was in a seated position while tested. A single experienced clinician stabilized the shoulder ROM; for standardized goniometric measurements, intra- and inter-rater reliability were used prior to the study. Firstly, SPI-WB was applied; secondly general assessment of ROM was performed using the goniometer measuring flexion, extension, internal rotation, external rotation and abduction of both shoulders. The SPI-WB was applied twice: second day (time 1) and fourth day (time 2) of training.

Statistical Analysis

The characteristics related to the use of a wheelchair for ADLs and SS were established per player (Table 1). After checking the normality of the data, SPI-WB validation process was performed in relation to shoulder ROM (following AAOS and AMA standards) using Spearman's rank correlations to examine current validity. The interpretation of the effect size was performed considering $r = 0.1$ small effect, $r = 0.3$ moderate effect and $r = 0.5$ or more large effect (Cohen, 1992). Cronbach's alpha coefficient was used to assess internal consistency and Intraclass Correlation (ICC) based on fixed effects was used to determine the reliability of total score (Curtis et al., 1995a; Curtis et al., 1995b, Arroyo-Aljaro & González, 2009; Park & Cho, 2013). For

validation purposes, SPI-WB definitive version was based on the WUSPI Spanish version (Arroyo-Aljaro & González, 2009), where the indicated four items related to specific WB skills was introduced. According to George and Mallery (2003) to assess Cronbach's alpha coefficients the following ranges were established: > 0.9 is excellent, > 0.8 is good, > 0.7 is acceptable; > 0.6 is questionable, > 0.5 poor and < 0.5 unacceptable. Software used for data processing and analysis were Excel (Microsoft Office 2007) and SPSS V18.0 program. Significance level was set at $\alpha \leq 0.05$.

Results

82. 4% of the WB players used the wheelchair for ADLs and WB sport practice, while 17. 6% of them used it just for WB sport practice. Most of the subjects reported spinal cord injuries (SCI, 70.6%) as cause of disability. 94.1% of the participants have right shoulder as dominant side. SP was evident in 52.9% of the WB players according to an individual categorical item related to SP, while 41.1% of those reported pain in their right shoulder, and 11. 8% of the participants presented bilateral SP.

A total score was used to analyze the data. ICC was calculated for every item and for total index scores at both times 1st and 2nd test administration. ICC ranged from 0.46 to 1 for individual items, with an average ICC of 0.80, while ICC for total index scores was significant ($r = 0.98$, $p < 0.05$), indicating that the instrument was reliable based on the significant correlation between the different elements of the SPI-WB (except for item n°17 “*SP while pushing my sport wheelchair*”; 0.46, Table 5). Items n° 9 (“*SP putting on a t-shirt or pullover*”), 10 (“*SP putting on a button-down shirt*”) and 13 (“*SP driving*”) were excluded of the analysis because their variance was zero. Cronbach's Alpha coefficient was statistically significant ($\alpha = 0.98$).

Table 5.
SPI-WB Intraclass Correlation Coefficient per item.

Items	Time 1		Time 2		ICC
	Average	SD	Average	SD	
Transfers					
1	0,29	0,83	0,29	0,83	1
2	0,44	0,98	0,44	0,98	1
3	0,44	0,98	0,44	0,98	1
4	0,56	1,04	0,94	1,55	0,87
5	0,88	1,75	1,03	1,78	0,97
6	0,88	1,52	0,88	1,52	1
ADLs					
7	1,32	1,79	1,18	1,79	0,97
8	0,15	0,61	0,30	0,83	0,79
9	0	0	0,15	0,60	0
10	0	0	0	0	0
11	0,44	1,32	0,30	0,83	0,92
12	0,30	0,83	0,44	0,98	0,88
13	0	0	0,15	0,61	0
14	0,15	0,61	0,15	0,61	1
15	0,30	0,83	0,44	0,98	0,88
SS					
16	0,74	1,47	0,59	1,09	0,94
17	0,59	1,09	1,47	1,78	0,46
18	1,03	1,99	0,88	1,52	0,97
19	1,47	1,99	1,47	1,78	0,94
Total score	9,98	17,8	11,54	21,0	0,98

SD: standard deviation; ADLs: activities of daily living; ICC: interclass correlation.

These overall results are considered excellent internal consistency of the presented SPI-WB. Regarding ROM, descriptive data obtained for right abduction, right internal rotation and left internal rotation were below the AAOS and AMA standards (Table 6).

Table 6.

Relationship of ROM with Shoulder Pain.

Shoulder Movement	AAOS	AMA	Mean	SD	Min.	Max.
Right flexion	180	150	172,35	12,39	150	190
Left flexion	180	150	167,06	24,69	110	190
Right extension	60	50	65,00	11,46	35	80
Left extension	60	50	65,29	12,81	40	80
Right abduction	180	180	167,94	16,30	130	185
Left abduction	180	180	167,06	24,24	100	185
Right internal rotation	70	90	65,88	19,70	20	100
Left internal rotation	70	90	69,12	16,89	30	100
Right external rotation	90	90	87,06	11,05	60	110
Left external rotation	90	90	80,00	12,75	40	90

AAOS, American Academy of Orthopaedic Surgeons; AMA, American Medical Associations, DS, Standard Deviation.

Correlation between SPI-WB scores with ROM were (negatively) significant (Table 7), showing that subjects presenting less shoulder ROM were referring more pain during both ADLs and SS. In general, the practical significance was small to large. However, according to left shoulder extension abduction and internal rotation and right shoulder flexion, internal and external rotation, the practical significance was large. On other hand, related to arm dominance, there was not relationship between SP and ROM, being left shoulder more affected.

Table 7.

Spearman rank correlations between SPI-WB items and goniometrics measurements of shoulder movement

	Left Shoulder						Right Shoulder					
	Extension		Abduction		Internal Rotation		Flexion		Internal Rotation		External Rotation	
	<i>R</i>	<i>P</i>	<i>R</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>P</i>	<i>r</i>	<i>p</i>
Transfers												
>10-min duration	-0,63	0,02	-0,37	0,19	-0,53	0,05	-0,40	0,16	-0,57	0,04	-0,04	0,89
Ramp/uneven	-0,40	0,15	-0,53	0,05	-0,27	0,36	-0,34	0,23	-0,40	0,16	-0,79	0,01
ADLs												
Washing back	-0,55	0,02	-0,57	0,02	-0,28	0,27	-0,22	0,39	-0,12	0,64	-0,05	0,03
Sleeping	-0,58	0,02	-0,19	0,46	-0,06	0,83	-0,03	0,90	-0,05	0,85	-0,23	0,37
SS												
Shooting	-0,61	0,01	-0,22	0,40	-0,32	0,22	-0,53	0,03	-0,24	0,36	-0,42	0,09
Pushing wheelchair	-0,62	0,01	-0,18	0,50	-0,26	0,32	-0,53	0,03	-0,21	0,41	-0,40	0,11
Rebounding and one long passes	-0,73	0,01	-0,28	0,28	-0,33	0,19	-0,29	0,27	-0,15	0,55	-0,44	0,08
Sport situations	-0,70	0,01	-0,30	0,24	-0,12	0,66	-0,29	0,25	-0,09	0,74	-0,40	0,11

Note: ADLs, activities of daily living; SS, sporting skills; r, value for Spearman Correlation. Values in bold were significant at $p \leq 0.05$.

Discussion

This study, for its application in the context of a WB national team under main competition preparation, was particularly relevant. The adequate validity and reliability assessed in the present study of the SPI-WB is important, as now it could be used as a specific instrument or complementary tool to evaluate the health condition of the players, focusing in the prevention and treatment of SP.

To our knowledge, it is worrying the percentage of players who referred to have pain in the sample studied, especially in a preparation process. In our study, SP was evident in 52.9% of the WB players; however, Curtis et al. (1999) and Pérez-Tejero et al. (2006) reported values of 70% and 85% respectively of incidence of SP in their samples, so even being in our opinion high, the incidence of SP in this study is lower than those studies.

Eight of the nine subjects with SP (41.2 %) reported pain at the right shoulder and 11.8% reported bilateral pain, considering that 94.1% of the participants have right shoulder as dominant side. Regarding the use of the wheelchair, 82.4% of the study sample used the wheelchair for ADLs and 17.6% used it just to practice WB. Previously in the literature, a pilot study by Pérez-Tejero et al. (2006) presented a higher percentage of the sample (58.6%) using the wheelchair just for WB practice. The results of this study demonstrated that the SPI-WB had high levels of reliability and adequate correlation between the items of the questionnaire (Curtis et al., 1995a; Arroyo & Aljaro, 2009; Park & Cho, 2013; Vij et al., 2015) showing a high internal consistency. Its reliability was reported by ICC, with an average all-items ICC of 0.80 (Table 2), but if item nº 17 (“*SP while pushing my sport wheelchair*”, 0.46) is not included in the analysis, average ICC reaches 0.91. Probably, item nº 17 is too general and should be specified in the context on the game (i.e. related to technical actions). This overall ICC level is similar to those presented by Curtis et al. (1995), Arroyo & González (2009) and Park & Cho (2013) based on these results the WUSPI. In wheelchair athletes, the elevated level of physical activity has been associated with soft tissue injuries (Curtis et al., 1995b; Finley & Rodgers, 2004; Finley et al., 2018) that may influence the final score of the SPI-WB.

Shoulder ROM measurements in this study were related with SP, asking about pain perception during specific ADL and SS situations (Curtis et al., 1995; Pérez-Tejero et al., 2006; Park & Cho, 2013) so ROM at shoulder level was used in this study as a validation reference. In WB, some studies associated muscle imbalance in strength shoulder joint and ROM as a risk factor in shoulder injuries (Kazemi, Shojaedin, & Hadadnezhad, 2017; Wilroy & Hibberd, 2017). SPI-WB detected the effect of SP in ADLs and SS even when there were low levels of pain, showing significant negative

correlation with ROM (Table 4) in contrast to other studies (Curtis et al., 1995a; Arroyo & González, 2009). The concurrent validity of the instrument was checked through goniometric measurements as an element of contrast for the validation. This evaluative measure is able to quantify the influence of SP in daily function of wheelchair users (Riddle et al., 1987; Mullaney et al., 2010). According to ROM, the average data obtained were according to data from AAOS and AMA (Table 3), except for the right abduction; right and left shoulder internal rotation values were lower in contrast to AAOS and AMA standards, even though WB players registered a functional mobility (Table 3). Some studies (Wang, et al., 2005; Goosey-Tolfrey & Leicht, 2013) demonstrated how different characteristic can influence shooting, rebounding and others WB skills during performance. The different correlations indicated that a lower ROM was significantly related to the degree of SP during transfers (>10 min duration, ramp/uneven), ADLs (washing back, sleeping) and SS (shooting, pushing wheelchair, rebounding and one hand long passes and specific sport situations) ($p \leq 0.05$, Table 4). In wheelchair user population, there are many factors such as overuse and impingement positioning that could cause pain (Burnham et al., 1993; Nyland et al., 1997; Fullerton et al., 2003; Wilroy & Hibberd, 2017; Finley et al., 2018) and these conditions could have a relationship with shoulder ROM.

The prevalence of SP in wheelchair athletes is small in relation to those who do not practice sports (Fullerton et al., 2003); however, it is present in WB training and preparation, so it seems appropriate to screen the players' shoulder health condition along the season and to implement strategies for shoulder injuries prevention. In this regard, the SPI-WB could be an appropriate tool to provide relevant information about the incidence of SP in WB players. Also, this scale could provide specific information about WB players' movements during real ADLs and WB practice specifically related

to specific skills items to addresses SP in WB athletes, so immediate feedback can be provided to technical staff in order to provide recommendations to prevent SP and improve WB players' performance. Probably, exercise protocols for SP prevention and shoulder level could be designed in the future to maintain an adequate muscle imbalance, using the SPI-WB as tool for assessment.

This study demonstrated the validity and reliability of the SPI-WB and provided information for the rehabilitation goals, injury detection and prevention during WB training and competition. These results cannot be generalizable to others adapted sport neither persons with physical disabilities or wheelchair users. In our study, one limitation was the small sample size. However, we consider this sample, for its characteristics, as representative of general population of WB players in Spain.

In conclusion, the SPI-WB is a useful outcome measure to assess the physical condition of the WB players for clinical practice, especially shoulder condition, since according to the findings; it demonstrated a high reliability and validity. This index provides a complementary tool in research to characterize SP as a result of injuries in WB players, and to determine the most appropriate prevention program.

WHEELCHAIR BASKETBALL: INFLUENCE OF SHOULDER PAIN IN SPORT SKILLS

Saleky García Gómez^{1,2} and Javier Pérez-Tejero^{1,2}

¹ Sanitas Foundation Chair for Inclusive Sport Studies, Faculty of Physical Activity
and Sports Sciences, Technical University of Madrid, Madrid, Spain.

² AFIPE research group.

Article published in the

Journal of Sport Psychology

Impact Factor (JCR): 0.789

Abstract

Shoulder injuries are a common problem among wheelchair basketball players (WB). The purpose of this study was to detect the influence of shoulder pain (SP) in sport skills. Fifty-one WB players aged from 15 to 42 (21 females, 23, 86 ± 1 , 38 years and 30 males, 23, 90 ± 1 , 46 years) were evaluated. Shoulder Pain Index for Wheelchair Basketball (SPI-WB) was used to determine SP in relation to specific WB skills. Gender and age were compared using T-test and One Factor ANOVA, respectively. The level of significance was set at $p \leq 0.05$. 27, 5% of the sample reported actual SP. Statistical analysis revealed a main effect for gender regarding SP during shooting skills, especially for females. There were no significant differences according to rebounding/one-handed long passes and other sport situations. In conclusion, SP could affect the specific activities of WB according to gender, especially during shooting in females, so ways to promote shoulder health must be develop.

Keywords: adapted sport, Paralympic sport, physical disability, shoulders injuries.

Introduction

Degenerative conditions of the shoulder remain a significant source of pain and impairment in general population (Killian et al., 2012; Zurita et al., 2016). In wheelchair users, previous studies reported shoulder pain (SP) as a common problem in this population, showing a range from 14 up to 85 percent of SP in different studies (Curtis & Black, 1999; Ballinger et al., 2000; Fullerton et al., 2003; Samuelsson et al., 2004; Pérez-Tejero et al., 2006; Wessels et al., 2013), mainly as a consequence of the increased load at this joint and repetitive stress of daily and sport activities (Fullerton et al., 2003).

Shoulder injuries such as sprains, strains, tendinitis, bursitis, impingement syndromes and avascular necrosis are a common problem in wheelchair basketball (WB) players (Nyland et al., 1997; Curtis & Black, 1999). WB is characterized by high-intensity activity for wheelchair propulsion and maneuvering as well as reaching overhead for shooting, passing, and rebounding, being these a risk for overuse and impingement syndrome (Vanlandewijck et al., 2001; Curtis & Black, 1999). Different aspects of the propulsion technique, as fast propulsion to create greater forces and increasing the number of push cycles per minute, put a high demand through the shoulder gird (Kulig et al., 2001). Also, muscle imbalance has been shown to be a factor that can be implicated in the pathogenesis of the shoulder pain (SP) in wheelchair athletes (Burnham et al., 1993; Curtis & Black, 1999; Kulig et al., 2001).

Some studies stated that sport activities could be affected by the physical condition of the player, specifically shoulder pain (SP) (Burnham et al., 1993; Fullerton et al., 2003, García-Gómez & Pérez-Tejero, 2016). The amounts of training hours and active competition have been associated with incidence of injuries in wheelchair users (Curtis et al., 1999). In some studies, 85% of WB players have been reported to experience SP along some part of season related to competition (Pérez-Tejero et al., 2006).

Wheelchair basketball is an intermittent activity demanding several skills (Cavedon et al., 2015; Pérez- Tejero and Pinilla, 2015), implicating specific movements as pushing the wheelchair, braking and pivoting, dribbling, shooting, passing, catching, rebounding, tilting and reacting to contact (IWBF, 2014). Several authors explain the relationship of fundamental WB movement or skills and game statistics (Goosey-Tolfrey, Morriss, & Butterworth, 2002; Malone, Gervais, & Steadward, 2002; Wang et al., 2005; Gómez, Pérez-Tejero, Molik, Szyman, & Sampaio, 2014; Pérez- Tejero & Pinilla, 2015). According to previous studies (Wessels et al., 2013; García-Gómez & Pérez-Tejero, 2016) the correlation between SP and joint mobility could affect WB skills performance. These can be affected by the health condition of the player, as a shoulder injury, functional class and wheelchair propulsion, among others. For instance, Wang et al., 2005, showed in a sample of male and female the significant influence of the sitting height on average rebounds per game. On the other hand, according to Gómez et al. (2014) recovering the ball, steals, blocked shots or opponent's turnovers are the more important variables in both genders in unbalanced WB games in major competitions. Even more, some authors (Goosey-Tolfrey et al., 2002; Malone et al., 2002) explained how functional class can influence shooting performance in WB.

In this regard, it seems relevant to explore the possible consequences shoulder pain injuries on WB sport skills, this information important for the physiotherapist and coach to consider the health assessment and screening of the player along the sport season, and to develop specific preventive training programs considering the shoulder joint.

Performance optimization of WB players is dependent on the use of a multidisciplinary approach. Evidence is available about WB performance in male and female players focusing in physiological, biomechanics, technical and tactical aspects (Vanlandewijck et al., 2004; Goosey-Tolfrey et al., 2005; Wang et al., 2005). However, on the authors' knowledge, it is still unknown how shoulder pain could influence specific WB skills as shooting, rebounding, one-handed long

passes and other sport situations. Therefore, the purpose of this study was to assess the influence of shoulder pain in those WB sport skills (SS).

Methods

Participants

Fifty-one WB players, 21 females and 30 males, aged from 15 to 45 years, were evaluated through the *Shoulder Pain Index for WB (SPI-WB)* (García-Gómez & Pérez-Tejero, 2016). All participants were given the information about the purpose of the study and signed an informed consent form before the study. Also, declaration of Helsinki (2013) for research on humans was observed.

The study protocol was approved by ethical committee of the Technical University of Madrid. The following inclusion criteria for study participation were determined: to be a WB player the actual season: (1) to be selected as member of the Spanish preselection sub 23, female or male national team, (2) to use a manual wheelchair for at least 3 hours a day and at least one year before the study for the subjects who use wheelchair for daily activities, (3) at least one year using wheelchair for WB practice for subjects that use wheelchair only for the sport and (4) to accept the voluntary participation in the study by signing the inform consent.

Measures

The SPI-WB was used to measure SP in the population studied and it was developed by Pérez-Tejero, Martínez-Sinovas and Rossignoli (2006) based on the Wheelchair Shoulder Pain Index (WUSPI) (Curtis et al., 1995; Park & Cho., 2013) with the inclusion of specific WB skills and its aim was to analyze the perception of SP during a functional activity and how it affects the development of the WB players.

This self-reported questionnaire assesses individual data and pain characteristics related to functional activities of WB players along three main domains: transfers, activities of daily living

(ADLs) and sport skills (SS; as shooting, rebounding/ one-handed long passes and other WB situations). It has 40 items, where the first 11 items contain information concerning general and individual data, six items about the actual situation of pain, four items of pain characteristics, five items related to pain perceived during transfers (transferring in and out of the wheelchair by lifting own's body weight from a seated position), nine items assessing SP when performing ADLs and four items related to pain perceived while performing WB sport-specific skills (Pérez-Tejero et al., 2006).

A previous study has demonstrated that SPI-WB shows high internal consistency ($\alpha=0,899$), high test-retest reliability (ICC=0,976) and concurrent validity was assessed through significant negative correlations between SPI-WB scores and goniometric measurements (range of motion) of shoulder (García- Gómez & Pérez-Tejero, 2016).

Procedure

Procedures for questionnaire administration were as follows: First, all the process to the participant to fill out the SPI-WB was explained; secondly, players had to complete the questionnaire by their own (paper and pencil). To deal with study aims, analysis was focused in the activities related WB skills as shooting, rebounding/one-handed long passes and other WB situations.

- Shooting: Is considered as the most important part for determining the outcome of a game. A shot for a field goal is when the ball is held in a player's hand(s) and is then thrown into the air towards the opponents' basket.
- Rebounding: It refers to the capacity of the player to take possession of the ball.
- One-handed long passes: It refers to making a pass using a hand, normally pumped an interior player.
- WB situations: Fundamental movements to performance WB such as pushing the wheelchair, braking and pivoting, dribbling, catching, tilting and reacting to contact.

Statistical Analysis

All demographic data were analyzed using descriptive statistics. Gender and age referred SP were compared using independent T-student and ANOVA respectively after check the normality of the data, indicating the value of effect size. The interpretation of the effect size was performed considering Cohen's d ; $d=0.2$ small effect, $d=0.5$ moderate effect and $d=0.8$ or more large effect and partial eta squared considering $\eta^2=0.01$ small effect, $\eta^2=0.06$ moderate effect and $\eta^2=0.138$ large effects. SPSS V18.0 program was used for the data analysis. The level of significance was set at $p \leq 0.05$.

Results

Table 8 shows sample's demographic data. At the moment of the study, 27.5% of the sample reported SP.

Table 8.

Demographic characteristics of the sample.

Gender	Age (years)	Years since disability	Years of federated sport	Years of recreative sport
Female	23.86 $\pm$ 1.38	14.60 $\pm$ 7.41	7.83 $\pm$ 1.75	5.31 $\pm$ 1.16
Male	23.90 $\pm$ 1.46	16.05 $\pm$ 8.27	8.22 $\pm$ 1.50	6.29 $\pm$ 1.15

According to the results, the type of disability of the population studied was spinal cord injury, amputation and others disability related to orthopedics lesion being most common SCI (21.6% females, 39.2% males). 33.3% of the players are class 2-2.5 (13.7% females, 19.6% males). In WB, as a descriptive aspect, according to the subjects that use wheelchair for daily activities more females than males use wheelchair as an element to mobility for ADLs (Table 9). In this regard, there are more lower classes in this sample.

Table 9.

Comparison of gait, shoulder pain and type of shoulder pain by gender.

	Gait		Shoulder pain		Type of shoulder pain		
	Wheelchair Users	Crutch/prosthesis and others	Without Pain	With pain	Acute pain	Subacute pain	Chronic pain
Female	0.57	0.43	0.62	0.38	0.56	0.17	0.28
Male	0.53	0.47	0.80	0.20	0.67	0.17	0.17

According to general data, females reported more SP than males (Table 9). In this regard, there is a difference between the type of pain in females and males, being more affected players who use wheelchair as an element to mobility. On the other hand, according to age, shoulder pain relate to shooting is more frequently in players with less than 20 years; however, players with age less than 20 and between 20 and 30 years had shoulder pain when performing rebounds and one handed long passes.

Statistical analysis revealed a main effect for gender regarding SP during shooting skills, especially for females ($t_{39}=2, 44; p \leq 0.05$). According Cohen's (effect size for interaction) there was a moderate positive association between SP while shooting and gender (Table 10), so females had significantly more SP than male while shooting. In this regard, there was no statistical significant difference according to other SS such as rebounding/one-handed long passes and other sport situation; however, the practical significance was small to moderate (Table 10).

Table 10.

Statistical and practical significance according to gender.

Gender (n= 51 subjects, 21 female and 30 male)	Statistical Significance	Practical Significance Cohen's d
Shooting	$p \leq 0.05$	Moderate
Rebounding/one-handed long passes	$p \geq 0.05$	Small
Sport situation	$p \geq 0.05$	Moderate

In addition, the value of F for shooting, rebounding/one-handed long passes and SS indicates that there were no statistical significant differences for SP according to the age; practical significance is small.

Discussion

The 27, 5% of the sample reported actual SP. This observation is congruent with previous reports which show a range from of 14 to 85 percent (Curtis et al., 1999; Ballinger et al., 2000; Fullerton et al., 2003; Samuelson et al., 2004; Pérez-Tejero et al., 2006; Wessels et al., 2013; García-Gómez & Pérez-Tejero, 2016).

In WB, those who have high classes (3 – 4, 5 points) normally crutches, prostheses and other items for ADLs, but for trainings and sports competitions they sit down and use the wheelchair. In the case of the sample studied more females than males use wheelchair as an element to mobility in everyday activities. In general, most players in the sample studied use wheelchair in ADLs, which explains mostly with lower classes.

The result suggests that the origin of pain on the sample of players who use the wheelchair just to perform in WB probably is caused by SS like shooting, pushing wheelchair and specific sport situations. According to some authors, SP may result from lifting, especially with abduction and internal rotation (Curtis et al., 1995; Park et al., 2005). It is important to consider deficiency in

flexion and shoulder abduction in training, also have to consider that the internal rotation could influence rebounds in conducting, being the internal rotation a very important factor to performance WB (Wang et al., 2005).

One study addressed the association of age and gender with SP (Alm et al., 2008). There are a few studies (Fullerton et al., 2003; Wessels et al., 2013) dealing with gender difference regarding the prevalence of SP; however, Boninger et al. (2003) explain the association of female gender and development of degenerative changes at shoulder level. Thus, there are no studies in our knowledge addressing SP incidence according to gender during specific WB skills as shooting, rebounding/one-handed long passes and specific sports. Some studies (Goosey-Tolfrey et al., 2002; Malone et al., 2002; Wang et al., 2005) demonstrate how different characteristics can influence shooting, rebounding and other WB performance.

SP is more prevalent among females than males; these results are in line with the data of Wessels et al. (2013). According to our results, females presented SP during SS, specifically shooting; however, they suggest the relationship of shoulder pain with the extension of the shoulder: this can be related with anatomical differences or difference in muscle mass. Therefore, we could relate as shoulder pain could affect WB performance and how this could affect game statistics (Figure 10).

Figure 10. Relationship between shoulder pain, sport skills and game statistics.

The results obtained offer relevant information for comparing the females and males performance in WB training and competition as well as to create a tool to prevent shoulder pain in this population. This information might be useful for clinical practice and research. Further research is needed to determine the relationship between SP, as a consequence of shoulder injuries, and games statistics. On other hand, it is required to establish the difference of SP according to classes and use of wheelchair.

Conclusions

SP might affect the specific activities of WB according to gender, especially during shooting in females, so ways to promote shoulder health must be develop.

EXPERT'S OPINION OF A HOME-BASED EXERCISE PROGRAM FOR SHOULDER PAIN PREVENTION: APPLICATION IN WHEELCHAIR BASKETBALL PLAYERS

Saleky García-Gómez¹, Javier Pérez-Tejero¹, Carmen Ocete¹, Rubén Barakat²

¹ Sanitas Foundation Chair for Inclusive Sport Studies, Faculty of Physical Activity and Sports Sciences, Technical University of Madrid, Madrid, Spain.

² AFIPE research group.

Article published in the journal

Psychology, Society &, Education

Impact factor (SJR 2014): 0.12

Abstract

Researchers suggest that exercise is an important tool as an element to treat and prevent shoulder injuries in wheelchair users, but no evidence can be found about a specific preventive program for shoulder injuries in wheelchair basketball (WB) players. The aim of the study was to assess the structure and content validity of a home-based exercise program, as an instrument to prevent of shoulder pain (SP) in this population. The proposed program was designed considering previous studies but to be applied in this specific population and; it was composed by exercises based on active mobility (four exercises), strengthening (five exercises) and strength (five exercises) of the shoulder joint. An ad hoc questionnaire was administered to a convenience sample of nine experts (one rehabilitation physician, one sport physician, four physiotherapists and three coaches) that fulfilled the defined inclusion criteria. The results showed that experts considered the shoulder home-based exercise program (SHEP) as adequate tool for SP prevention in WB; however, some experts suggested some changes to improve it. According to the qualitative analysis performed, findings revealed two main underlying factors such as “design” (content and structure) and “application” that could influence in the adequate use of the home-based exercise program. This study provided evidence that the presented home-based exercise program is a validate tool and could be a powerful tool to prevent shoulder pain in WB player’s population.

Keywords: adapted sport, exercise program, shoulder pain, shoulder program.

Introduction

Degenerative joint disease of the shoulder appears as a significant source of soft tissue injuries in general population, (Killian et al., 2012). Studies suggest that exercise is an important tool as an element to treat and prevent shoulder pain (SP) as a result of injuries (Nawoczinski et al., 2006; Van Straaten et al., 2014) in wheelchair users. In this regard, some studies documented the influence of a home-based exercise program on shoulder injuries in wheelchair users (Curtis et al., 1999; Jacobs, Mahoney, Nash, & Green, 2002; Nash, van de Ven, van Elk, & Johnson, 2007; Mulroy et al., 2011), pointing out its benefits for shoulder health in this population. Furthermore, it has been shown that the results of these programs suggest that posterior shoulder muscles strengthening (to provide shoulder stability) and stretching (to promote the mobility of the shoulder) are fundamental training contents in these programs, in order to prevent postural changes related with muscular imbalance. For those reasons, an intervention program would be a useful for prevent SP in WB players.

Most of the previous studies report shoulder injuries as a main problem in this population (Samuelsson et al., 2004; Wessels et al., 2013), being SP one of the most common symptoms of physical dysfunction, mainly as a consequence of the increased load at this joint and repetitive stress of daily and sport activities (Nyland et al., 1997; Fullerton et al., 2003). About 70% of wheelchair user's population has experienced SP in some moment of their life (Curtis et al., 1995a). Precautions to prevent overuse injuries of the shoulders must be taken for those who do upper extremity exercise (Burnham et al., 1993; Jacobs & Nash, 2004).

In this regard, wheelchair athletes sustain injuries that are related to the demands of their specific sports (Curtis, 1997), for instance, in WB, probably the most popular adapted sport practiced (Crespo-Ruiz et al., 2011). However, to the authors' knowledge, no studies of a home-based exercise program to prevent SP have been implemented in WB players. These players train

for many hours over a long period (Curtis & Dillon, 1985; Curtis et al., 1995); moreover specific movements implicated in this sport, such as pushing wheelchair and overhead for shooting, do rebounds and long passes; also, players with age less than 30 years reported SP when performing specific WB situation during competition. (García-Gómez & Pérez-Tejero, 2017). In addition, SP affect more ADLs than sport activities in WB players related to age, years of wheelchair use; however, SP related to sport activities had more SP do rebounding/one-handed long passes according to wheelchair use (García-Gómez & Pérez-Tejero, 2016).

Both novice and elite WB players experience soft tissue injuries to the upper extremity specifically in wheelchair basketball (Curtis et al., 1995; Curtis, 1997). In contrast, other study specifies that older males have a higher risk of SP (Tsunoda et al., 2016).

To the authors' knowledge, it is unknown the impact to a shoulder home-based exercise program (SHEP) in this specific population. In this regard, it seems relevant to design, to validate and to apply a SHEP to facilitate own administration in WB players. For all of the above mentioned, the aim of the study was to assess the structure and content validity of a SHEP prevention in WB players.

Method

Participants

To assess the validity of a SHEP, 14 possible candidates to participate as expert in this study were identified: nine participants (including one rehabilitation physician, one sport physician, four physiotherapists and three coaches, Figure 11). The inclusion criteria for the experts were to (1) be a physiotherapist with minimal of five years of experience in WB high level competition (2) be a coach or physical trainer with minimal experience of five years in WB high level competition and (3) be a physician with experience in WB high competition.

All participants were contacted and recruited through e-mail by a member of the team research. All of them provided written consent for participation in the study, and information regarding demographics data and WB experience was obtained. The present study is part of a non-randomized clinical trial (NCT02842008). The protocol for this study was approved by the ethical committee of the Technical University of Madrid.

Design

Three phases were established to design, apply and assess the relevance of the proposed SHEP in WB players (Figure 12).

Exercise program for shoulder pain prevention in WB players

The SHEP it is composed by different exercises based on active mobility, strengthening and strength to be administered three times per week (Table 9). This exercise program was based in previous studies (Nawoczinski et al., 2006; Curtis et al., 1999; Mulroy et al., 2011; Van Straaten et al., 2014) assessing the effect of exercise on shoulder pain and how affects function.

Figure 12. Research Design: Expert Opinion research.

Instrument

A questionnaire was designed *ad hoc* composed by nine questions, being:

- Three questions related to demographic data, workplace and professional relation with WB.
- Five open questions related to SHEP: utility, content, and necessity of the program, other opinions and aspects to be improved.
- Fourteen affirmations to be assessed by a Likert scale of six possibilities (from zero to five, its means from totally disagree to totally agree) related with different aspects of the proposed home exercise program. Affirmations were related with the following topics (adapted from Yoo, Hwang, Lee, & Kim, 2003): clear and well defined objective, content organized per objective, the program is perceived as an important therapeutic tool, scientific bases, contains sufficient quantity and quality of information, current, contrasted and updated information, logical structure, clear and simple explanation, efficiently detailed

structure, appropriate for therapeutic approach and relationship exercise, useful in relation to the object of study and its real applicability, easily reproducible, sequence of appropriate exercises and number of repetitions and adequate rest time.

Questionnaire provision to the experts was strictly confidential and communication between experts was not promoted along its administration neither after the study.

Procedure

Firstly, all experts were informed of the purpose and methodology of the study, and, after their participation confirmation, the designed questionnaire was sent to each expert through personal email, including a link to an online website where the questionnaire was fulfilled and data were stored. In this regard, experts were requested to provide their feedback on the SHEP including general and specific characteristics of the program.

Data Analysis

Qualitative Analysis

The observations, comments and opinions provided were systematically collected regarding the professional occupation of the experts. After data collection, qualitative analysis was performed following Heinemann (2003) proposed methodology: in a first phase, intensive floating reading was used in order to create a general outline of the content, topics and arguments. In a second phase, prior to analysis, data codification and categorization were performed using NVivo 18.0 program, and major results, topics and arguments were structured by experts' profession. According to the codification of the experts, it was specified the professional occupations of each expert, we will refer the physiotherapist, as "PH", coaches as "CH", rehabilitation physician as "RP" and sport physician as "SP; with a number, for example, for the physiotherapist, expert number one the codification was "PH1".

Statistical analysis

For statistical analysis, demographic data were analysed using descriptive statistics. SPSS V18.0 program was used for the data analysis.

Results

Qualitative analysis

According to the data analysis, there is a major trend of the answers regarding the design of the program with 53 content units, focused mainly on the content (40 units of contents) and structure (13 units of contents) of the program and its application, with 30 content units. The analysis of the answers of the experts it has been made per professional occupation.

The demographic characteristics of the experts showed that the majority of the participants were men's (88%) and the majority of participants per professional occupations were physiotherapists (44%). According to the experts, the proposed home-based exercise program with the adequate changes could be a useful tool in the context of the WB.

Design of the shoulder home-based exercise program

Content of the shoulder home-based exercise program

Physiotherapist

Related to the opinion of the physiotherapists they were more focused in aspects related to the content of the SHEP. Physiotherapists explained SHEP could include global movements and proprioceptive exercises of the shoulder for example PH1 said, *"I think it would not be too much to include proprioceptive exercises, not only for the shoulder"*. In this regard, PH2 consider that *"an exercise prevention program should have more global movements than analytics movements"* and *"a proprioceptive exercise program help to workout in general balancing tensions"*. In this regard,

PH2 suggested *“performing shoulder global movements and strengthening exercises using resistive and exercises for stabilization of the shoulder”*.

According to the physiotherapist main suggestion active movements in the first phase (PH2 *“Active and dynamic stretching should be integrated prior to the completion of the strengthening program”*) of the home-based exercise program should be more extensive for example PH2 says, *“I consider that the section of active movements should be more extensive”*.

Coaches

According to the content of the SHEP, one of the three coaches considers as a readaptation program not as a prevention exercise program; CH3 *“seems a program of readaptation and not of prevention”*. In this regard, CH2 clarifies that the SHEP is *“a battery of simple exercise that deals with its main aim”* and CH1 explained, *“it would be necessary the creation of a prevention exercise program like this”*. Thus, CH1 considers that *“there are gestures and actions that produce shoulder pain that could cause difficulties in the ADLs”*. Also, there was a difference point of view of the coaches in order to include exercises that implicate increased joint range. CH1 considers *“include a battery of exercises where the range of motion is as large as possible”* while CH3 does not see it as a primary element to develop the SHEP *“do not stretch passively-sustained in prevention exercises”*; also, suggested *“a differentiation in the typology of the exercises”* in the section 3, referred to the strengthening exercises.

Rehabilitation Physician and Sport Physician

Related to the content, rehabilitation physician (RP1) consider *“sometimes the redaction of the exercise seems a little bit complex”* while sport physician (SP1) explain *“they are simple and easy exercises”*. Both physicians consider SHEP a useful tool, for example RP1 said that *“I find it useful because it offers in a systematic way and a complete approach of aspects such as active mobility, stretching and strengthening sections.”*

Structure of the shoulder home exercise program

All the experts concluded as an important element to include photographs or videos to explain the different SHEP exercises, as well as PH1 and CH1 suggested changing the sequence of the exercise (active mobility, strengthening, and strength); for example, CH1 consider that *“the program should include active mobility before the realization of the strength exercises”*. In this regard, PH1 suggested the extension of the active mobility section. On other hand, SP1 suggested, *“to categorize the concrete times of the strengthening instead of generalizing between 20 and 30 seconds”*. SP1 consider adequate the structure of the SHEP *“the exercises are perfectly described”*.

Application of the home-based exercise program

Physiotherapist

In the context of this study, all the physiotherapists consider an exercise program as a useful tool for prevent SP (for example PH1: *“everything that improve a better stability and flexibility of the shoulder it would be good for general population and much more for WB players”*; PH2: *“an exercise program always is useful to facilitate de activities of daily living such a transfers, etc.”*; PH3: *“A good strengthening of the shoulder and that users are aware of the work they must do is always good for injury prevention”*; PH4: *“an exercise program work and prepare all the muscles involved in wheelchair propulsion since the shoulder complex suffer with ripped and braked”*.

In contrast, PH 2 considers *“there are players with a much more developed musculature and that is why I do not consider that a specific exercise program is the most necessary”* understanding that *“to include relax massages for long training process would be the most useful”*.

Related to the application of the SHEP, two physiotherapists considered it is necessary to take into account the functional classification of the players, since the lower points (1.0-2.0, those with higher physical impairment) could lose stability when they do the exercises with both arms simultaneously. Thus, PH2 explained, *“a player with low point could not be able to do active*

exercise with two arms at the same time because he/she could lose stability” and PH4 suggested to “divide exercises according higher and lower points”. In addition, PH2, PH3 and PH4 consider fundamental the individualization of the exercise program to the player; PH3 explain, “exercise program should be individualized”.

Coaches

To the coaches’ opinion, SHEP included the necessary exercises to prevent SP, for example, CH1 explained that *“All athletes should have an exercise program to prevent injuries, and especially those to prone to have chronic injuries”*. In this regard, CH2 considered *“at the moment there is not an exercise program to develop in the wheelchair basketball training”*. Although, CH2 indicated that *“exercise program’s is not done in a systematic, continuous and consistent way in the context of the training sessions”*.

On other hand, CH3 explained that players must do the exercise program *“depending on the time of the season will be made more or less volume and intensity”*. Also, CH1 consider the individualization of the program *“by adjusting the development of the exercise program to the specific case of each player”*.

Rehabilitation Physician and Sport Physician

Rehabilitation physician and sport physician explain the usefulness of the SHEP, RP1 explained, *“the approach is very complete and acceptable for the wheelchair basketball players”*; in this line, SP1 considered that exercise program *“facilitates the strengthening of the main muscles of the shoulder, avoiding the appearance of the impingement syndrome”*.

Quantitative analysis

Regarding aspects related to the analysis of the SHEP, the average obtained from items related to clear and well-defined objective, the scientific bases and appropriate for therapeutic

approach of the program was higher than the rest of the aspects evaluated (Table 11). On the other hand, for the items related to the contains sufficient quantity and quality of information, sequence of appropriate exercise and logical structure, clear and simple explanation a lower average of the answers was obtained (Table 11).

Table 11.

Aspects related to the evaluation of the home-based exercise program.

	X	XS
Clear and well-defined objective.	3.22	0.67
Content organized per objective.	3.11	1.26
Perceived as an important therapeutic tool.	3.22	0.97
Based on scientific bases.	3.67	1.00
Contains sufficient quantity and quality of information.	2.56	1.01
Current, contrasted and updated information.	3.11	0.78
Logical structure, clear and simple explanation.	2.56	1.33
Efficiently detailed and detailed structure	3.00	1.12
Appropriate for therapeutic approach.	3.33	0.71
Appropriate relationship exercise	2.78	0.97
Useful in relation to the object of study and its real applicability.	3.11	1.05
Easily reproducible.	3.11	1.05
Sequence of appropriate exercise.	2.44	1.42
Number of repetitions and adequate rest time.	3.22	0.67

From 0 (totally disagree) to 5 (totally agree).

Discussion

The purpose of the current study was to assess the structure and content validity of the SHEP for the prevention of SP in WB according to the opinion of the experts group. The analysis of the data was based on qualitative and quantitative techniques per the design related to content and structure of the SHEP and their application.

Previous research (Nawoczinski et al., 2006; Mulroy et al., 2011; Van Straaten et al., 2014) indicated that home-based exercise program could optimize movement performance in ADLs. The SHEP was developed according to consistent previous studies (Curtis et al., 1999; Jacobs et al., 2002; Nawoczinski et al., 2006; Nash et al., 2007; Van Straaten et al., 2014; Mulroy et al., 2011). However, we contrasted the information of the literature with the experts who had relationship with WB players (Table 12). After expert's opinion analysis, all the changes were made to improve the instrument.

Table 12.

Qualitative aspects to improve per occupation profile related to Shoulder Prevention Exercise Program (SHEP) in contrast with literature.

Occupation Profile	Design		Application	SHEP elements according to literature
	Content	Structure		
Physiotherapist	-Global movements. -Proprioceptive exercise. -Active mobility.	- Photographs or video. -Sequence of exercise.	-Useful tool. -Relax massages. -Individualization of the SHEP.	Included 3 sessions: -Active mobility (Mulroy et al., 2011). -Strengthening using resistive bands (Curtis et al., 1999; Nawoczenski et al., 2006; Mulroy et al., 2011; Van Straaten, et al., 2014)
Coach	-Global movements. -Range of motion.	-Active mobility before strength.	-Useful tool. -Included in training sessions.	-Strength (Curtis et al., 1999; Nawoczenski et al., 2006; Mulroy et al., 2011). Specified the time of the activity and rest (Curtis et al., 1999; Mulroy et al., 2011) and this program should be a complement of training that included photographs.
Rehabilitation Physician	-Redaction of the SHEP.	-Photographs or video.	-Useful tool.	
Sport Physician	-Easy to use.	-Specified time of rest	- Useful tool.	

Design of the shoulder home exercise program

Content

The result of the current study provides evidence that physiotherapist, rehabilitation physician and sport physician are more specific suggesting change in the aspects related to the design of the instrument specifically in the content. In this regard, related to the design of the program, the physiotherapist and coaches explained that the program in general is useful for WB players. However, they considered that SHEP could include global movements and proprioceptive exercise of the shoulder. In this regard, the physiotherapist suggested performing shoulder global movements as strengthening using resistive bands and stabilization of the shoulder. We include strengthening using resistive bands as previous studies (Mulroy et al., 2011; Jacobs et al., 2002; Nawoczinski et al., 2006; Nash et al., 2007; Van Straaten et al., 2014); however, exercise of stabilization was not included. The literature above mentioned has relationship with the descriptive data obtained that shows item related to base on scientific bases was higher than the other aspects evaluated.

Structure

Other suggestion of the expert was to include photographs or video to explain the exercise program and consider the sequence of the exercise, this aspect had relationship with the quantitative analysis that shows a lower average in contrast with others. Per the physiotherapist and coaches, we needed to include more active mobility as a warm-up phase in the first phase of the exercise program. In this regard, literature supports the use (Mulroy et al., 2011) of this sequence (active mobility, strengthening, and strength).

Application of the shoulder home exercise program

Experts explained that the application of a shoulder home-based exercise program it is necessary for WB players, since shoulder injuries are a common problem in this population. Being relevant to know the etiology of the shoulder injury, based in the muscle imbalance and overuse by long concentration. However, coaches suggested change related to the application.

According to the experts' opinion, the home exercise program it is necessary for WB players. However, it is crucial to implement a systematic follow up of the home exercise program in the context of the training sessions. Some studies demonstrated that similar program that included stretching and strengthening exercise modified for the specific needs of the persons with SCI could be effective reducing shoulder pain (Curtis et al., 1999; Mulroy et al., 2011).

One physiotherapist PH2 considers *“they are players with a much more developed musculature and that is why I do not consider that a specific exercise program is the most necessary”* understanding that *“must include relax massages for long training process would be the most useful”*. However, a few studies (Gutierrez, Thompson, Kemp, & Mulroy, 2007) support the implementation of exercise program in the context of this population. Moreover, the coordinated action of the muscle around the glenohumeral joint is the principal in maintaining the joint integrity (Rozendaal, 1997). Related to the observation of the physiotherapist, the execution should be done considering the functional classification of the players, since the lower points (1.0-2.0) could lose stability when they do the exercises with both arms simultaneously for example, in the strengthening exercise for serratus anterior, scapular retractors and depressors and glenohumeral external rotation. However, in the study of Van Straaten,

Cloud, Morrow, Ludewig, & Zhao (2014) prescribed exercise with both arms considers that the sample included wheelchair users who had spinal cord injury at C6-7 level. In addition, it is needed to consider if players have shoulder pain, which explains the necessity of the individualization of an exercise program.

Experts evaluated the SHEP using 14 items that include clear and well defined objective, content organized per objective, the program is perceived as an important therapeutic tool, scientific bases, contains sufficient quantity and quality of information, contrasted and updated information, logical structure, clear and simple explanation, efficiently detailed structure, appropriate for therapeutic approach and relationship exercise, useful in relation to the object of study and its real applicability, easily reproducible, sequence of appropriate exercises and number of repetitions and adequate rest time (Table 11).

Quantitative analysis shows that the average obtained for the item refers to the scientific bases of the program were higher than the rest of the aspects evaluated; however, for the sequence of appropriate exercise a lower average of the answers was obtained (Table 12), this information had relationship with the suggestions of the expert in the qualitative analysis.

A limitation of this study can be the number of experts who participated. However, we ensured that each participant has some relationship with the field of WB and fulfilled the selected and demanding inclusion criteria. Future research should examine the effects home-based exercise program in WB, in order to prevent shoulder pain and to adapt this program in others wheelchair sports.

Conclusions

The current study provides evidence for adequate structure and content validity of the home-based exercise program as a valid tool and could be an option to prevent shoulder pain in wheelchair basketball players according to the opinion of the experts. However, it is necessary to determine its effectiveness in this specific population.

A HOME EXERCISE PROGRAM AS PREVENTIVE TOOL FOR SHOULDER FUNCTION IN WHEELCHAIR BASKETBALL PLAYERS WHEN PREPARING MAJOR COMPETITION

Saleky García Gómez¹, Javier Pérez Tejero¹, Marco Hoozemans, ²Rubén Barakat³

¹ Sanitas Foundation Chair for Inclusive Sport Studies, Faculty of Physical Activity and Sports Sciences, Technical University of Madrid, Madrid, Spain.

² Move Research Group Vrije University, Amsterdam, Holland.

³ AFIPE Research Group.

Target Journal: Clinical Rehabilitation Journal

Impact Factor: 2.823

Date of submission: In press

Abstract

Objective: Performance in elite wheelchair sports is influenced by shoulder function, so preventive measures are needed in order to maintain health along training periods. In this regard, the aim of the study was to assess the effects of a 10-week shoulder home exercise program (SHEP) on shoulder pain (SP) and range of shoulder motion (ROM) in a sample of elite wheelchair basketball (WB) players in their preparation to major competition. **Methods:** Thirty-six male and female WB players from the Spanish pre-selection national teams were assigned to either an exercise or a control group. For the exercise group, a hands-on protocol with exercises and photographs on how to perform each exercise was provided. As part of a non-randomized clinical trial (NCT02842008), outcomes were assessed at baseline and post intervention. Shoulder function and ROM were measured with the Shoulder Pain Index for Wheelchair Basketball players (SPI-WB), impingement tests and ROM, respectively. **Results:** Changes for SPI-WB scores were not statistically significant after the intervention for exercise and control group, with a large effect size. No significant findings between baseline and 10-week time points for SPI-WB were assessed between groups. For shoulder extension ROM, there were significant differences after intervention in the exercise group with medium effect sizes; however, there were non-significant changes after the intervention in either group for flexion, abduction, internal and external rotation, with effect sizes varying from 0.596 to 0.960. **Conclusions:** Preventive goal of SHEP was demonstrated in this population, as SP did not increase after intervention; even more, shoulder injuries did not increase in the sample along the preparation for major competition, so this program seems appropriate to maintain shoulder health in elite WB players.

Keywords: adapted sport, wheelchair injuries, shoulder, prevention, exercise

Introduction

Shoulder disorders are a common problem in wheelchair users (Samuelsson et al., 2004; Finley & Ebaugh, 2017) and a huge proportion of them (14-80%) experience shoulder pain (SP) at some moment in their life (Curtis et al., 1995a; Curtis et al., 1995b; Curtis & Black, 1999; Ballinger et al., 2000; Fullerton et al., 2003; Samuelsson et al., 2004). SP is one of the most common symptoms of physical dysfunction, mainly because of increased shoulder load and repetitive stress because of wheelchair handling during daily activities (Curtis, 1997; Nyland, 1997; Fullerton et al., 2003). The risk for SP further increases when wheelchair users also participate in wheelchair sports such as wheelchair basketball (WB), which is probably the most popular adapted sport practiced worldwide (Crespo-Ruiz et al., 2011). In previous studies, about 72-85% of WB players reported current SP because of ADL or sports activities (Curtis & Black, 1999; Pérez-Tejero et al., 2006; García-Gómez & Pérez-Tejero, 2017). In addition, to the wheelchair handling activities that are required for ADLs (activities of daily living), playing WB during practice and competition implicates the performance of more explosive movements when maximally pushing, breaking or turning the wheelchair (Vanlandewijck, Theisen, & Daly, 2001; de Witte et al., 2017) and the performance of overhead movements for shooting, rebounding and long passes, which can promote SP, as well as train for many hours over a long period (Curtis & Dillon, 1985; Curtis et al., 1995a; García-Gómez & Pérez-Tejero, 2017).

Different studies suggest that exercise is a useful tool to prevent and treat SP in wheelchair users (Nawoczinski et al., 2006; Van Straaten et al., 2014). The effectiveness of exercise interventions has been studied using programs for stretching and strengthening relevant muscle groups (Curtis et al., 1995a; Curtis et al., 1999; Nawoczinski et al., 2006; Nash et al., 2008; Mulroy et al., 2011; Middaugh, Thomas, Smith, McFall, & Klingmueller, 2013; Van Straaten et al., 2014). In these studies,

exercise programs were prescribed for 3 days per week along 6 weeks up to 6 months (Curtis et al., 1999; Nawoczinski et al.; 2006; Mulroy et al., 2011; Wilroy & Hibberd, 2017), with requiring doses of three to five times for active movements, three sets of 10-30 repetitions for resistance shoulder exercises and 3-5 repetitions for each stretching position, holding for 15-30s. Related to outcome measures, some studies determined SP and function in wheelchair users; however, only one study (Wilroy & Hibberd, 2017) determine the influence of exercise program in shoulder ROM specifically internal/external rotation in WB.

Recently, literature reported that shoulder exercises programs decrease SP and improve functionability in wheelchair users (Jacobs & Nash, 2004; Cratsenberg et al., 2015; Mulroy et al., 2017; Van Straaten et al., 2017). Furthermore, it has been shown that the results of these programs suggest that providing shoulder stability and mobility of the shoulder are fundamental training contents in these programs, in order to prevent postural changes related with muscular imbalance. For those reasons, an intervention program would be a useful for SP prevention in WB players.

Based on the information and evidence available in the literature, a Shoulder Home-Based Exercise Program (SHEP) (Appendix I) was developed focusing on the prevention of shoulder chronic soft tissue in WB players; the validity of this program was demonstrated based on expert's opinion (García-Gómez et al., 2017). The proposed program (Appendix I) includes a warm-up phase, resistance shoulder exercises and stretching lasting from three days per week up to ten weeks, taking into consideration that an exercise program should have different training contents, such as strength exercises for shoulder girdle stabilization muscles and strength optimization of the of

muscles used for pulling and pushing the wheelchair's hand rim. García-Gómez et al. (2017) study reported evidence for adequate structure and content validity of the SHEP as a valid tool and could be an option to prevent SP in WB players according to the experts' opinion. The exercise program included special attention to front chest musculature and back of the shoulder joint, which is often tight when the wheelchair user has a limited inward rotation of the shoulder (Van Straaten et al., 2017).

Also, it is relevant to address that no literature in our knowledge has been carried out dealing with the impact of a preventive shoulder function program in the context of the training period of elite WB players when preparing major competition. For all of the above mentioned, the aim of the present study was to assess the preventive effect of a 10-week SHEP on SP and ROM in WB players along a training period.

Method

Participants and study design

Thirty-six WB players (15 males and 21 females), with a mean age of 26 (SD 7.6, range 15-45) years, were recruited as a convenience sample from the Spanish pre-selection of the male and female national WB teams. The present study was a clinical cross-sectional study, as part of a non-randomized clinical trial (NCT02842008). The protocol of the study was approved by the ethical committee of the Technical University of Madrid. The study was performed in accordance with the Declaration of Helsinki (World Medical Association, 2000). All participants provided written informed consent. The rights of the participants were protected, and parents were informed in the case participant had an age of less than 18 years.

The inclusion criteria of the participants were: a) players had to be part of either the male or female pre-selection of the Spanish WB national team, b) participant needed to have an official license at the Spanish Sport Federation for People with Physical

Disabilities at the time of the study (2015-2016 season), c) participants had to use a wheelchair at least one year before the study and needed to have at least one year of experience in the sport competition; d) participant had to use a wheelchair for daily activities, for at least three hours a day and for at least six hours of wheelchair basketball practice per week; e) for those players do not using wheelchair for daily activities, to use the manual wheelchair at least for 6 hours of wheelchair basketball training per week. An exclusion criteria was having a history of acute injuries in the post-surgical process or dislocation along the year before the study. These conditions may affect the effectiveness of the exercise intervention, as the SHEP may not be appropriate in case of differential diagnoses such as acute injuries at cervical region and recent traumatic injury in the shoulder region one year before the study. The study was developed along the four months before major competition for female team (2016 Atri European Championship B, Italy, reaching gold medal) and male team (2016 Rio de Janeiro, Paralympic Games, Brazil, reaching the silver medal) in close collaboration with both national teams' technical staffs.

Intervention

Once determined eligible for inclusion into the study, participants enrolled. Participants were parallel assigned to the exercise group or the control group; each player was assigned to one group paired according to the wheelchair use during daily activities or only for sport practice. In both groups at baseline, where participants with and without SP.

For exercise group, researchers explained the SHEP after the first evaluation and supported the participants through email along the study with a questionnaire related to adherence and self-efficacy to the exercise program, daily activities performed and to verify if players present any shoulder symptoms. Participants were instructed to perform

all exercises without experiencing any shoulder symptoms. The SHEP consisted of 14 exercises (Appendix I), including a warm up, strengthening exercises and a general protocol of postural hygiene (Appendix II). A hands-on instruction program with photographs presenting how to perform each exercise was provided. Each participant was instructed to perform each session exercises for 30 minutes each day for the time of the study (10 weeks). The control group received the general protocol for postural hygiene (Appendix II) as a standard care instrument. Participants in this group were assessed about their daily and sports activities that they performed along the 10 weeks of SHEP development in exercise group.

Outcomes measures

Outcomes were assessed before and after the 10-week intervention period in both exercise and control groups. At fourth and eight weeks during the intervention period, daily and sports, activities performed were assessed per participant. The SPI-WB was used to assess SP. This index was based on the WUSPI (Curtis et al., 1995a, 1995b) and was found to be valid and reliable with a Cronbach $\alpha = 0.899$ and a significant ICC of $r = 0.976$ (García-Gómez, Pérez-Tejero, García, & Barakat, 2018). The SPI-WP contained the following three main components: a) demographic data identifying factors relevant to the athlete's lifestyle (including fifteen items related to shoulder dysfunction and six items related with years of experience in WB, pain at the right or left shoulder at the moment of assessment, time since SP onset, SP location, numbness or cramps at the shoulder and pain in other body parts; b) pain related to ADLs (15 items), distinguishing between players who use wheelchair for ADLs (5 specific items) and players who use the wheelchair only for sport activities (10 items); and c) four items related to SP perception when performing specific WB skills, including shooting, pushing the hand

rims, rebounding or one-handed long passes, and other game situations (Pérez-Tejero et al., 2006).

In addition, clinical tests were performed to diagnose orthopedic shoulder injuries, including Neer's Sign and Hawkins-Kennedy Test to determine subacromial impingement (Hawkins & Kennedy, 1980; Neer, 1983). These two clinical diagnostic tests are commonly performed by primary practitioners dealing with shoulder subacromial impingement (Hughes et al., 2008; Hughes, 2011). The Jobe test was also used to evaluate the integrity of the supraspinatus muscle and tendon (Jobe & Moynes, 1982) being a simple technique which can improve the clinical diagnosis of rotator cuff tears (Gillooly et al., 2010). Finally, a single experienced clinician using a medium plastic goniometer (Riddle et al., 1987; Mulroy, 1996) performed goniometric measurements. Previous study determines the intra (ICC from 0.60 to 0.95) and inter-rater reliability (ICC=0.74) of the ROM assessment in a similar population (García-Gómez et al., 2018).

Statistical analysis

For descriptive statistics, data were checked for normality by exploring z-values for skewness and kurtosis, histograms, q-q plots, box plots and the results of the Shapiro-Wilks test for the exercise and control groups separately. For continuous variables, mean and standard deviation (SD) were determined, while for categorical variables frequency and percentage (%). T-tests or its non-parametric equivalent for continuous data or Chi-square tests for categorical data were used to compare the exercise and control groups at baseline. The normality of the change scores (from baseline to 10 weeks) of the outcome variables for the two groups was again checked by visual inspection of their histograms, q-q plots and box plots. Z-values of skewness and kurtosis, and a Shapiro-Wilks test were carried out on the change scores as well. The

data were assessed as not normally distributed, so Wilcoxon rank-sum tests were used to determine if there were differences between pre-post scores for each group. Also, a Mann-Whitney U test was used to determine if there were significant differences in change scores of the outcomes variables between the two groups. In addition, Spearman's rank correlation test was calculated as a measure of effect size (Rosnow & Rosenthal, 1996; Kerby, 2014). An r-value higher than 0.1, 0.3 and 0.5 was considered as a small, medium and large effect size, respectively (Cohen, 1992). Statistical analyses were performed with IBM SPSS Statistics 24.0 (IBM Corporation, Armonk, NY, USA) and $p \leq 0.05$ was accepted as being significant.

Results

Of the 18 WB players from the exercise group, 12 fully completed the SHEP, while two participants withdrew because they didn't have time to complete the 10-week exercise program, and two participants started the program two weeks later. The remaining two participants were lost to follow up. At the fourth and eighth week, 58.3% of this sample showed adherence to the SHEP. In the control group, four participants were withdrawn from the clinical trial because they were lost to follow up. Figure 13 shows the consort flow diagram. There were significant differences between groups for type of disability, level of injury, dominant side, SP and time of SP in demographic characteristics and outcome variables at baseline for total of participants eligible.

Figure 13. Consort flow diagram for the Shoulder Home Exercise program (SHEP) for wheelchair basketball player's trial.

Demographic data and values of the clinical characteristics of the exercise and control groups' participants at baseline are described in Table 13.

Table 13.
Baseline demographic characteristics of SHEP (N=36)

Characteristics	Exercise group (N=18)	Control group (N=18)	<i>p</i>
Gender			
Male	(9)50%	(7)38.9%	0.505
Female	(9)50%	(11)61.1%	
Age (y)	27.11±6.720	25.9±7.615	0.650
Occupation			
Administrative	(4)22.2%	(6)33.3%	
WB player	(4)22.2%	(5)27.8%	0.670
Student	(6)33.3%	(5)27.8%	
Others	(4)22.2%	(2)11.1%	
Functional class			
1-1.5	(4)22.2%	(3)16.7%	0.670
2-2.5	(4)22.2%	(5)27.8%	
3-3.5	(7)38.9%	(5)27.8%	
4-4.5	(3)16.7%	(5)27.8%	
Type of disability			
Spinal cord injury	(12)66.7%	(10)55.6%	P<0.001
Post-polio	(2)11.1%	0	
Amputation	0	(2)11.1%	
Others	(4)22.2%	(6)33.3%	
Level of injury			
T2-7 (high paraplegia)	(8)72.7%	(6)60%	P<0.001
T8 and below (low paraplegia)	(3)27.3%	(4)40%	
Wheelchair users			
Daily	(11)61.1%	(12)66.7%	0.096
Only for Sport	(7)38.9%	(6)33.3%	
Dominant Side			
Right	(16)88.9%	(15)83.3%	P<0.001
Left	(2)11.1%	(3)16.7%	
Years since disability	18.28±90398	16.95±8.794	0.628
Years of federated sport	11.83±9.532	10.28±8.428	0.743
Years of recreative sport	10.28±8.428	8.86±8.013	0.542
Shoulder pain			
Yes	(5)27.8%	(7)38.9%	0.046
No	(13)72.2%	(11)45.8%	
Time of shoulder pain			
One week	(1)20%	(1)14.3%	0.050
Two weeks	(1)20%	(1)14.3%	
More than 12 weeks	(3)60%	(5)71.4%	

Values are mean (SD) for continuous variables, frequency (%) for categorical variables. For categorical variables, Chi-square test was used and for continuous variables U-Mann Whitney was used Values in bold type was significant at $p \leq 0.05$.

Outcomes at baseline and after 10 weeks

Scores of the primary outcome SPI-WB and secondary outcome ROM are summarized in Table 14.

SP according to SPI-WB

In the exercise group before the intervention, seven (58.3%) players presented SP and stayed unchanged after intervention. According to control group, nine (64.3%) players showed SP at baseline; however, 11 (78.6%) players reported SP at 10 weeks. In both, exercise and control group, related to SPI-WB score SP decreased after intervention, but there were not significant differences between two time points ($p>0.05$).

Before the intervention, seven (58.3%) players of the intervention group presented SP and stayed unchanged after intervention. For the control group, nine (64.3%) players showed SP at baseline; however, 11 (78.6%) players reported SP at 10 weeks. In both the exercise and control group the SPI-WB score did not significantly change from baseline to post intervention ($p=0.401$ and $p=0.583$, respectively) and also the change from baseline to post intervention was not significantly different between groups ($p=0.742$, $r=0.743$) (Table 14).

Range of motion

For shoulder extension ROM, there were significant differences from baseline to 10 weeks in the exercise group, decreasing 10 (SD 12) degrees in extension, while in the control group a decrease of 5 (SD 11) was observed. The differences in changes in ROM between the groups was not significant ($p=0.252$) with a medium effect size ($r=0.249$). There were neither significant changes, nor difference in changes, after the intervention period in either group for flexion, abduction, internal and external rotation, with effect sizes varying from 0.596 to 0.960.

Table 14.
SP and ROM scores at baseline and post intervention assessment

Outcome measures	Exercise Group (n=12)	p-value of change in time	Control Group (n=14)	p-value of change in time	p-value of differences between groups in changes in time	Effect size
SPI-WB						
Baseline	6.30(32)		6.60(23)			
Post intervention	3.75(12)	0.401	10(19)	0.583		
Change	0(24)		0(22)		0.742	0.743
Flexion ROM						
Baseline	180(8)		180(0)			
Post intervention	173.75(17)	0.056	177.50(13)	0.575		
Change	2.50(18)		0(7)		0.860	0.859
Extension ROM						
Baseline	71.25(9)		62.50(14)			
Post intervention	60(12)	0.005	60(0)	0.288		
Change	10(12)		5(11)		0.252	0.249
Abduction ROM						
Baseline	180(35)		180(0)			
Post intervention	177.50(16)	0.672	180(9)	0.498		
Change	0(24)		0(9)		0.940	0.916
Internal Rotation ROM						
Baseline	71.25(20)		66.25(13)			
Post intervention	71.25(23)	0.368	70(13)	0.212		
Change	-1(12)		0(13)		0.980	0.960
External Rotation ROM						
Baseline	90(0)		90(8)			
Post intervention	90(0)	0.593	90(3)	0.458		
Change	0(0)		0(2)		0.667	0.596

Values are median (range) for continuous variables. p values for the change scores of the outcomes variables between the two groups were obtained using U-Mann Whitney. Within-group p were obtained using Wilcoxon test. *Values in bold type were significant at $p \leq 0.05$.

SP according to clinical test

Of the 12 participants who received the exercise intervention, seven (58.3%) reported SP according to impingement test detecting specific shoulder injuries before the intervention; however, only two of them (16.7%) reported SP after intervention. Related to the control group, seven (50.0%) reported SP according to clinical test detecting specific shoulder injuries before the intervention; however, six (42.9 %) reported SP after intervention.

Discussion

The purpose of this study was to assess the effects of a 10-week SHEP on SP and ROM as a prevention tool in world class level WB players in preselection and preparation for major competition such as the 2016 Atri (Italy) European WB Championship B for female teams (Spanish team reaching gold medal) and the 2016 Rio de Janeiro (Brazil) Paralympic Games for male teams (Spanish team reaching the silver medal). After SHEP intervention, WB players reported a reduction of SP in exercise group according to SPI-WB scores; however, there were not statistically significant change. Related to ROM, players preserve the shoulder ROM after intervention; though there was a reduction in extension of the shoulder in exercise group. For these reason, the presented SHEP appears as a convenient tool to maintain the shoulder condition during the trainings process, where players realize a high level of training, high impact loading and repeated actions that can develop injuries.

According to previous researches, elite females and males WB players report many injuries such as ischial deep tissue injury (Mutsuzaki, Tachibana, Shimizu, Hotta, Fukaya, Karasawa, et al., 2014; Shimizu, Mutsuzaki, Tachibana, Tsunoda, Hotta, Fukaya, et al., 2017), upper limbs muscle strength alterations (Akinoğlu & Kocahan, 2017). Also, high prevalence of SP and rotator cuff pathology were found (Lim, Yoo,

Lee, Lee, & Kwon, 2014) and the difference of the risk of SP between males and females (Tsunoda et al., 2016; García-Gómez & Pérez-Tejero, 2017). In this regard, many studies are developed in this population including the evaluation and prevention of shoulder injury in collegiate WB payers (Wilroy & Hibberd, 2017). However, we did not find any research dealing with the development and application of shoulder exercise prevention program in WB players in the context of preselection and preparation for an international competition. The presented study is a non-randomized clinical trial, where data collection was done in this process of training period, so the main focus of the SHEP (always in coordination with teams' technical staff) was to maintain/improve the health condition of the players. In this regard, the program reduced SP (ns, already present in part of the sample) and players did not develop any shoulder injuries along the sport preparation process ending in major competition, with the indicated performance.

It is relevant to know that the SHEP focuses in SP prevention and not to treat shoulder injuries; this could be a main issue between previous researches (Mulroy et al., 2011; Van Straaten et al., 2014; Satyavanshi et al., 2017). In fact, exercise programs for shoulder injuries prevention in sports that include overhead movements need to be design and implemented to prevent re-injury of the shoulder (Cools et al., 2015), and SHEP seems appropriate to maintain shoulder health. Previous studies (Curtis et al., 1999; Nawoczenski et al., 2006; Mulroy et al., 2011; Van Straaten et al., 2014) show significant changes in order to reduce SP in wheelchair users. These studies had a baseline SPI-WB score range from 22.8 to 51.2, and after intervention from 12.5 to 15. In our case, in both the exercise and control group the SPI-WB score did not significantly change from baseline to post intervention; being the outcomes baseline for SP less than the research mentioned. Of the proportion of participants that have SP at the beginning of the SHEP; three of twenty-six players had positive findings of

tendinopathy; meanwhile of the total sample, seven players presented SP, which explain that some players experience SP during the process of training and competition. In this regard, probably the difference between athletic and nonathletic population may influenced the results between the different studies about SP.

According to the results of clinical tests, of SHEP group, seven reported shoulder injuries before the intervention; however, only two of them reported SP after intervention. Related to the control group, seven of them showed positive clinical test before the intervention; however, six reported SP after intervention. The SHEP was focused in prevention, nonetheless it could influence in the reductions of the shoulder injuries. Furthermore, to provide an appropriate approach, all the players were instructed to use a postural recommendation.

The present study targeted 10 weeks of home-based exercise program that included warm up, strength and strengthening exercises; being similar to Curtis et al. (1999) and Mulroy et al. (2011) shoulder exercise programs, focusing in rotator cuff muscles. A recent study found that high-intensity interval training could be a feasible and safe tool to prevent SP in wheelchair users (Gauthier et al., 2018), but no information is available when dealing with elite WB athletes who are in a preselection system.

Some studies prescribed exercise programs from 5 weeks to 6 month (Curtis et al., 1999; Nawoczinski et al., 2006; Mulroy et al., 2011; Troy et al., 2014; Van Straaten et al., 2014; Satyavanshi et al., 2017; Wilroy & Hibberd, 2017; Gauthier et al., 2018); however there was one study develop by Norrbrink et al., 2012 prescribed 10 weeks of an exercise program focus in double-poling ergometer approach.

Comparing exercise and control group, there were not statistical differences between exercise group and the control group for SP, in line with the results from other

study (Curtis et al., 1999). However, some researches showed significantly changes related to SP between groups (Nawoczinski et al., 2006; Mulroy et al., 2011), having a decrease a SP after the intervention.

Regarding ROM, no changes were found between groups, neither after intervention. Participants maintain shoulder ROM though extension ROM decreases after exercise program. One research reported that improve in ROM reduces SP in a pre-post-test in WB payers (Wilroy & Hibberd, 2017); while in our study statistically significant change in ROM was not found this could be influenced by the exercise doses. In the study develop by Curtis et al (1999) players performed the home-based exercise three days per week similar to Mulroy et al. (2011) and Van Straaten et al. (2014) trials; for strengthening they performed 3 sets of 10 repetitions with a rest of 45 seconds similar with Mulroy et al. (2011), and for stretch 5 repetitions per exercises holding for 20 to 30 seconds (Curtis et al., 1999).

In this line, there is no consensus about the type of exercise and dosage in the intervention program (Østerås, Torstensen, & Østerås, 2010); however, the shoulder injuries prevention should have emphasis on stretching of the posterior shoulder capsule, strengthening of the posterior cuff and scapular muscle balance (Cools et al., 2015). In this regard, the SHEP seems useful in order to maintain ROM along the training period, which is really necessary when dealing with WB players that train at least three hours a day in this period.

Of the participants who were include the SHEP group, two discontinued intervention, and other four did not complete the exercise program for different reasons. In exercise group and most of players of control group compliment the recommendation of postural hygiene. Two players of exercise group required additional instruction in exercise performance. Moreover, two players changed the resistive band and increased

the repetitions; one of them decreased the repetitions on stretching. On other hand, in the control group, one player modified the sport wheelchair along the study.

In order to supervise the intervention process, an online follow up questionnaire was sent to the participants, asking specific items such as SHEP compliment, SP, postural hygiene and ADL performed at that given moment. At four weeks, 75% participants fully performed SHEP completely; however, at eight weeks all the participant performed the exercise program. Related to postural hygiene, in the exercise group the entire participants compliment the guide of hygiene. However, in control group, 78.6% complimented the instructional.

There are some of limitations related to the home-based exercise program: one study limitation is analysis and interpreting these findings with a small sample size. Therefore, we cannot conclude that others aspects such a change in the daily activities that participants performed along the SHEP intervention could influence the results.

One very interesting point in our view is the commitment and interest of the teams' technical staff in order to be aware about SHEP development and players adherence, and they value probably the most important result: WB players were free of injury when ready for major competition, even after such a long and exigent preparation process, being this fact key to perform at top class international competition.

Further researches needed to orientate future steps in order to develop technological innovations in order to include preventions programs in the preparation of WB players.

Conclusions

SHEP appears to be useful in order to prevent injury and to control SP and ROM in WB elite players in the training preparation for major competition. Also, adherence to the program was high. SP was reduced, but not significantly in the sample after intervention, neither for ROM there were not significant changes: functionality and health of the shoulder were preserved along the exigent training preparation for world class competition. After SHEP development, application and sport performance achieved, it seems clear that preventive programs for shoulder griddle should be always incorporate along sport training regimes in when preparing WB elite competition, like Paralympic Games are.

4. SUMMARY, CONCLUSIONS AND FUTURE PERSPECTIVES

4.1 Summary of the findings and conclusions

The purpose of this research was to determine the effectiveness of a therapeutic exercise program for injuries prevention in WB players. This project was structured in five sequential researches representing the chapters of this doctoral dissertation. To address this objective, it was divide in 5 studies based on hypotheses:

- Evaluate SP in a sample of elite WB players during their preparation for a major competition (Study I).
- A Shoulder Pain Index for Wheelchair Basketball (SPI-WB) could provide information about SP in ADLs and specific activities the game in WB players (Study II).
- Shoulder pain could affect WB sport skills development (Study III).
- A newly designed SHEP had the adequate structure and content validity to prevent SP in WB players (Study IV).
- SHEP could maintain shoulder health related to SP and ROM in WB players in their preparation for major competition (Study V).

The first study revealed that more than fifty percent of the sample studied reported SP while training; this fact is surprising, especially in the selection and preparation for a WB championship. Many aspects could influence SP such as functional class, age, wheelchair use and the type of disability. Players with lower class had SP during ADLs. In a previous study, athletes who use a wheelchair for ADLs (1-3.5, functional class) are lower compared to those who participate in sports (Fullerton et al., 2003).

Relate to age, subjects with ages between 20 and 30 years had more SP than others; however, other author explain that SP it is no necessary a consequence of age

(Wessels et al., 2013). On other hand, wheelchair use was related to SP when players participate in a specific sport skill.

Factors like overuse and impingement positioning could cause pain (Burnham et al., 1993; Nyland et al., 1997; Fullerton et al., 2003), and these conditions could influence the shoulder ROM. According with the results, there was a relationship between SP, evaluated with questionnaire and clinical test, and ROM. This information was similar with previous studies (Curtis et al., 1995; Park et al., 2005; Arroyo-Aljaro & González-Viejo, 2009). However, players can perform ADLs and SS related to WB without any problem. Being appropriate to keep track of these conditions and implement strategies that could prevent shoulder injuries in WB (Vanlandewijck et al., 2001) using complementary tools such as questionnaire in the clinical approach during their preparation.

The aim of the second study was to assess the validity and reliability of the SPI-WB, because it could be used as a specific instrument or complementary tool to evaluate the shoulder condition of the players, focusing in the prevention and treatment of SP. The results of this study demonstrated that the SPI-WB had high levels of reliability and adequate correlation between the items of the questionnaire in contrast with others studies (Curtis et al., 1995a; Arroyo & Aljaro, 2009; Park & Cho, 2013; Vij et al., 2015) showing a high internal consistency. ICC reported its reliability, with an average all-items ICC of 0.80; this overall ICC level is similar to those presented by Arroyo and González (2009), Park and Cho (2013) and Curtis et al. (1995) based on these results the WUSPI. The concurrent validity of the instrument was checked through goniometric measurements as a gold standard of contrast for the validation, except for the right abduction; right and left shoulder internal rotation values were lower in

contrast to AAOS and AMA standards, even though WB players registered a functional mobility.

The prevalence of SP in wheelchair athletes is small in relation to those who do not practice sports (Fullerton et al., 2003); however, it is present in WB training and preparation, so it seems appropriate to screen the players along the season. In this regard, SPI-WB could be an appropriate tool to provide relevant information about the incidence of shoulder pain in WB players for the rehabilitation goals, injury detection and prevention. In addition, this scale could provide specific information about WB movements during real ADLs and WB practice.

The result suggests that the origin of pain on the sample of players who use the wheelchair just to perform in WB probably is caused by SS like shooting, pushing wheelchair and specific sport situations. According to previous studies, SP may result from lifting, especially with abduction and internal rotation (Curtis et al., 1995; Park et al., 2005). It is important to consider deficiency in flexion and shoulder abduction in training, also have to consider that the internal rotation could influence rebounds in conducting, being the internal rotation a very important factor to performance WB (Wang et al., 2005).

One study addressed the association of age and gender with SP (Alm et al, 2008). There are a few studies (Fullerton et al., 2003; Wessels et al., 2013) dealing with gender difference regarding the prevalence of SP; however Boninger et al., (2003) explain the association of female gender and development of degenerative changes at shoulder level. Thus, there were no studies in our knowledge addressing SP incidence according to gender during specific WB skills as shooting, rebounding/one-handed long passes and specifics sports. In our study, SP is more prevalent among females than males;

these results are in line with the data of Wessels et al. (2013). According to our results, females presented SP during SS, specifically shooting; however, they suggest the relationship of SP with the extension of the shoulder: this can be related with anatomical differences or difference in muscle mass.

The results obtained offer relevant information for comparing the females and males' performance in WB training and competition as well as to create a tool to prevent SP in this population. This information might be useful for clinical practice and research. Further research is needed to determine the relationship between SP, because of shoulder injuries, and games statistics. On other hand, it is required to establish the difference of SP according to classes and use of wheelchair.

Study IV presented the design related to content and structure of the newly designed SHEP and its application in a sample of WB players. According to the qualitative analysis performed, findings revealed two main underlying factors such as "design" (content and structure) and "application" that could influence its use and implementation. Previous research (Nawoczinski et al., 2006; Mulroy et al., 2011; Van Straaten et al., 2014) indicated that a home-based exercise program could optimize movement performance in ADLs. In this line, the presented SHEP was developed according to consistent previous studies (Curtis et al., 1999; Jacobs et al., 2002; Nawoczinski, et al., 2006; Nash et al., 2007; Mulroy et al., 2011; Van Straaten et al., 2014). However, we contrasted the information of the literature with WB experts. They explained that the application of a SHEP it is necessary for WB players, since shoulder injuries are a common problem in this population. Also, for them it was relevant to know the ethology of the shoulder injury, normally from muscle imbalance and overuse by long concentration.

According to the experts' opinion, it is crucial to implement a systematic follow up of the home exercise program in the context of the training sessions. Some studies demonstrated that similar program that included stretching and strengthening exercise modified for the specific needs of the persons with SCI could be effective reducing shoulder pain (Curtis et al., 1999; Mulroy et al., 2011). In this line, Experts evaluated quantitative aspects of the SHEP and certified that this program can be a useful tool for the health approach.

Finally, study V aim was to assess the effects of a 10-week SHEP on SP and ROM as a prevention tool in world class level WB players in preselection and preparation for major competition such as the 2016 Atri (Italy) European WB Championship B for female teams (Spanish team reaching gold medal) and the 2016 Rio de Janeiro (Brazil) Paralympic Games for male teams (Spanish team reaching the silver medal). After SHEP intervention, WB players reported a reduction of SP in exercise group according to SPI-WB scores; however, there were not statistically significant change. Related to ROM, players preserve the shoulder ROM after intervention; though there was a reduction in extension of the shoulder in exercise group. For these reason, the presented SHEP appears as a convenient tool to maintain the shoulder condition during the trainings process, where players realize a high level of training, high impact loading and repeated actions that can develop injuries

Some studies (Nawoczinski et al., 2006; Mulroy et al., 2011; Van Straaten et al., 2014; Satyavanshi et al., 2017; Mulroy et al., 2017) show how exercise program could influence in SP in wheelchair population. On other hand, previous researches (Tsunoda et al., 2016; Shimizu et al., 2017; Akinoğlu & Kocahan, 2017) are developed in elite WB population including the evaluation and prevention of shoulder injury in collegiate WB payers (Wilroy & Hibberd, 2017). Nonetheless, this study implemented the SHEP

to maintain/improve shoulder condition of the elite WB players in this particular context working in line with teams' technical strategy. In this regard, the program did not reduced significantly SP in time and comparing with control group, but players do not develop shoulder injuries and according to ROM the SHEP seems useful in order to maintain ROM along the training period. SHEP appears to be a useful and clear preventive program to monitored SP and ROM in WB elite players along sport training regimes.

4.2 Strengths, Limitations and Futures Perspectives

Strengths

Some strengths of the design and implementation of the SHEP in the context of this doctoral dissertation should be highlighted:

- Clinical cross-sectional study, as part of a non-randomized clinical trial with a comparison between exercise and control group. In this regard, in control group we provided postural recommendations, which are broadly accepted from an ethical point of view.
- It was developed in the context of a preparation and concentration of the Spanish Male and Female WB national teams for their participation in major competition.
- Collaborations between researchers and teams' physiotherapists of the WB national teams were crucial for studies' success.
- Participants who were included in this study and complete the intervention process had 80% of adherence to the exercise protocol.

- The design of the SHEP was developed with a multidisciplinary approach; including an expert's opinion group, composed by rehabilitation physicians, sport physicians, physiotherapists and coaches in the process.
- In the 10 weeks of intervention, a physiotherapist monitored all the activities.

Limitations

In the process to develop the design and implementation of this project and after analyse and compare the results with others researches, we found some aspects to improve:

- Small sample size needs to be considered in the interpretation of these findings in order to generalize the results to other adapted sports or other categories of physical impairment.
- Adherence to the program was calculated; however, self-efficacy was calculated only before intervention.
- Questionnaires, clinical test and goniometric measurements were used; however, we did not include strength testing.

Future Perspectives

The present study could be a starting point to develop this kind of protocols in wheelchair sports to prevent and reduce SP in this population. Moreover, to orientate future steps in order to develop technological innovations that include a protocol with aspects related to the musculoskeletal condition in this case specific tool for prevent and treat shoulder injuries in adapted sport (Figure 14).

Figure 14. Research Transfer proposed.

SPI-WB: Shoulder Pain Index; SHEP: Shoulder home-based Exercise program.

Future research should take in consideration the points below:

- To include strength-testing outcomes.
- To develop a research on WB clubs using this protocol as screening along competitive season.
- Research assessing the possible relationship between SP and WB sport performance.

4.3 Practical implications

In general, experts in sport and health science have suggested exercise to prevent and treat injuries. In this study, the focus was to develop a strategy due to the trend of wheelchair users in specific WB players to have shoulder injuries because of the characteristics of the game, as well as the ADLs influence in develop SP. This doctoral dissertation included recommendations in order to prevent shoulder injuries and

promote the multidisciplinary approach to diagnose, evaluate and treat injuries in WB population. Below, we highlight some practical applications to be considered:

- WB players seem to require regular evaluations of the shoulder in order to maintain an adequate health.
- Multidisciplinary team need to be coordinated to implement the strategy to promote an adequate way to perform ADLs and prevent injuries.
- It is necessary to have the support of the WB clubs to prevent shoulder injuries in WB players.
- It would be necessary to run this type of SHEP with young WB players to strengthen the preventive approach of athletes.
- There is an indirect relationship between SP and ROM; however, it is necessary to implement strategies to stabilize the shoulder joint as a main prevention tool.

4.4 Conclusions

The general aim of this doctoral dissertation was to identify the effects of a home-based exercise program to prevent SP in WB players in order to include this kind of protocols in clinical approach. Therefore, conclusions presented below allude to the five contributions represented by each of the five articles of this doctoral dissertation.

Conclusions of Study I

Conclusion 1: SP presented high incidence in the sample studied, and there was a clear relationship between SP and ROM.

Conclusions of Study II

Conclusion 1: The SPI-WB appears as a reliable and valid instrument to assess pain in this population, so it can be used as a complementary tool for athlete's clinical screening.

Conclusions of Study III

Conclusion 1: SP could affect the specific activities of WB according to gender, especially during shooting in females, so ways to promote shoulder health must be developed.

Conclusions of Study IV

Conclusion 1: Home-based exercise program has adequate structure and content validity and could be an option in order to prevent SP in WB players according to the opinion of the experts.

Conclusions of Study V

Conclusion: SHEP appears to be useful in order to prevent injury and to control SP and ROM in WB elite players in the training preparation for major competition. Also, shoulder injuries did not increase along sport training period. Elite WB players maintain the health condition of the shoulder along the context of training process.

5. REFERENCES

REFERENCES

- Akınoğlu, B., & Kocahan, T. (2017). Characteristics of upper extremity's muscle strength in Turkish national wheelchair basketball players team. *Journal of Exercise Rehabilitation*, 13(1), 62.
- Alm, M., Saraste, H., & Norrbrink, C. (2008). Shoulder pain in persons with thoracic spinal cord injury: prevalence and characteristics. *Journal of Rehabilitation and Medicine*, 40(4), 277-283.
- Arroyo-Aljaro, R. & González-Viejo, M.A. (2009). Validación al castellano del Wheelchair user Shoulder Pain Index (WUSPI). *Rehabilitación*, 43(1), 2-9.
- Asker, M., Brooke, H. L., Waldén, M., Tranaeus, U., Johansson, F., Skillgate, E., & Holm, L. W. (2018). Risk factors for, and prevention of, shoulder injuries in overhead sports: a systematic review with best-evidence synthesis. *British Journal of Sports Medicine*.
- Aytar, A., Zeybek, A., Pekiavas, N. O., Tigli, A. A., & Ergun, N. (2014). Scapular resting position, shoulder pain and function in disabled athletes. *Prosthetics and Orthotics International*, 39(5), 390-396.
- Barfield, J. P., Newsome, L., John, E. B., Sallee, D., Frames, C., Soangra, R., & Malone, L. A. (2016). A case report of shoulder fatigue imbalance in wheelchair rugby: implications to pain and injury. *Case Report*, 2, 16002.
- Ballinger, D. A., Rintala, D. H., & Hart, K. A. (2000). The relation of shoulder pain and range-of-motion problems to functional limitations, disability, and perceived health of men with spinal cord injury: a multifaceted longitudinal study. *Archives of Physical Medicine and Rehabilitation*, 81, 1575-1581.

- Beaudreuil, J., Nizard, R., Thomas, T., Peyre, M., Liotard, J. P., Boileau, P., ... & Orcel, P. (2009). Contribution of clinical tests to the diagnosis of rotator cuff disease: a systematic literature review. *Joint Bone Spine*, 76(1), 15-19.
- Boninger, M. L., Dicianno, B. E., Cooper, R. A., Towers, J. D., Koontz, A. M. and Souza, A. L. (2003). Shoulder magnetic resonance imaging abnormalities, wheelchair propulsion, and gender. *Archives of Physical Medicine and Rehabilitation*, 84, 1615-1620.
- Burnham, R.S., May, L., Nelson, E., Steadward, R., & Reid, D.C. (1993). Shoulder pain in wheelchair athletes. The role of muscle imbalance. *American Journal of Sport Medicine*, 21(2):238–242.
- Cavedon, V., Zancanaro, C., Milanese, C. (2015) Physique and performance of young wheelchair basketball players in relation with classification. *PloS One*, 10(11).
- Cools, A. M., Johansson, F. R., Borms, D., & Maenhout, A. (2015). Prevention of shoulder injuries in overhead athletes: a science-based approach. *Brazilian Journal of Physical Therapy*, 19(5), 331-339.
- Cohen J. (1992) A power primer. *Psychol Bull*, 112:155–9.
- Curtis, K.A., Drysdale, G.A., Lanza, R.D., Kolber, M., Vitolo, R.S. & West, R. (1999). Shoulder pain in wheelchair users with tetraplegia and paraplegia. *Archive of Physical Medicine Rehabilitation*, 80(4), 453-457.
- Curtis, K. A., & Dillon, D. A. (1985). Survey of Wheelchair Athletic Injuries: Common Patterns and Prevention. *Paraplegia*, 170-175
- Curtis, K.A., Roach, K.E., Applegate, E.B., Amar, T., Benbow, C.S., Genecco, T.D., et al. (1995a). Reliability and validity of the Wheelchair User's Shoulder Pain Index (WUSPI). *Paraplegia*, 33(10), 595-601.

- Curtis, K.A., Roach, K.E., Applegate, E.B., Amar, T., Benbow, C.S., Genecco, T.D., et al. (1995b). Development of the Wheelchair User's Shoulder Pain Index (WUSPI). *Paraplegia*. 33(5), 290-293.
- Curtis, K. A. (1997). Prevention and treatment of wheelchair athletic injuries. *Athletic Therapy Today*, 2(1), 19-25.
- Curtis, K.A., & Black, K. (1999). Shoulder pain in female wheelchair basketball players. *Journal of Orthopedics Sports and Physical Therapy*, 29(4), 225-231.
- Curtis, K. A., Tyner, T. M., Zachary, L., Lentell, G., Brink, D., Didyk, T ..... Pacillas, B. (1999). Effect of a standard exercise protocol on shoulder pain in long-term wheelchair users. *Spinal Cord*, 37(6), 421-426.
- Clark, C., & Adkison, D. (2004). Shoulder instability. In D. Brown & R. Neumann (Eds.), *Orthopedic Secrets*. (pp. 107-111). Philadelphia PA: Third edition. Hanley & Belfus.
- Cratsenberg, K. A., Deitrick, C. E., Harrington, T. K., Kopecky, N. R., Matthews, B. D., Ott, L. M., & Coeytaux, R. R. (2015). Effectiveness of exercise programs for management of shoulder pain in manual wheelchair users with spinal cord injury. *Journal of Neurologic Physical Therapy*, 39(4), 197-203.
- Crespo-Ruiz, B. M., Del Ama-Espinosa, A. J., & Gil-Agudo, A. M. (2011). Relation between Kinematic Analysis of Wheelchair Propulsion and Wheelchair Functional Basketball Classification. *Adapted Physical Activity Quarterly* 28, 157-172.
- Dec, K. L., Sparrow, K. J., & McKeag, D. B. (2000). The physically-challenged athlete. *Sports Medicine*, 29(4), 245-258.

- DePauw, K., & Sherrill, C. (1994). Adapted physical activity: present and future. *Physical Education Review*, 17(1), 6-13.
- DePauw, K. P., & Gavron, S. J. (2005). *Disability sport*: Human Kinetics.
- De Witte, A. M., Berger, M. A., Hoozemans, M. J., Veeger, D. H., & van der Woude, L. H. (2017). Effects of offense, defense, and ball possession on mobility performance in wheelchair basketball. *Adapted Physical Activity Quarterly*, 34(4), 382-400.
- Fairbairn, J. R., & Huxel Bliven, K. C. (2018). Incidence of Shoulder Injury in Elite Wheelchair Athletes Differ Between Sports: A Critically Appraised Topic. *Journal of Sport Rehabilitation*, 1-14.
- Figoni, S. F. (2009). Spinal Cord Disabilities: Paraplegia and Tetraplegia *ACSM's Exercise Management for Persons with Chronic Diseases and Disabilities-3th Edition* (298-305). Champaign, United States of America: Human Kinetics Publishers.
- Finley, M.A., & Rodgers, M.M. (2004). Prevalence and identification of shoulder pathology in athletic and nonathletic wheelchair users with shoulder pain: A pilot study. *Journal of Rehabilitation Research and Development*, 41(3B):395-402.
- Finley, M., Ebaugh, D., & Trojian, T. (2018). Agreement of Musculoskeletal Ultrasound and Clinical Assessment of Shoulder Impairment in Manual Wheelchair Users with Various Duration of Spinal Cord Injury. *Archives of Physical Medicine and Rehabilitation*, 99(4), 615-622.
- Fliess-Douer, O., Vanlandewijck, Y. C., Post, M. W., Van Der Woude, L. H., & De Groot, S. (2013). Wheelchair skills performance between discharge and one year after inpatient rehabilitation in hand-rim wheelchair users with spinal cord injury. *Journal of Rehabilitation Medicine*, 45(6), 553-559.

- Fullerton, H.D., Borckardt, J.J., & Alfano, A.P. (2003). Shoulder pain: a comparison of wheelchair athletes and nonathletic wheelchair users. *Medicine & Science in Sports & Exercise*, 35(12):1958-1961.
- Frontera, W.R., Slovik, D.M., & Dawson, D.M. (2006). *Exercise in rehabilitation medicine*. 2nd ed. United States of America, USA: Human Kinetics.
- Froehlich-Grobe, K., Aaronson, L. S., Washburn, R. A., Little, T. D., Lee, J., Nary, D. E., Norman, S. E. (2012). An exercise trial for wheelchair users: project workout on wheels. *Contemporary Clinical Trials*, 33(2), 351-363.
- Froehlich-Grobe, K., Lee, J., Aaronson, L., Nary, D. E., Washburn, R. A., & Little, T. D. (2014). Exercise for everyone: a randomized controlled trial of project workout on wheels in promoting exercise among wheelchair users. *Archives of Physical Medicine and Rehabilitation*, 95(1), 20-28.
- García-Gómez, S., Pérez-Tejero, J. (2016) Shoulder pain according to age, wheelchair use and years of injury in wheelchair basketball players. In CIDESD International Congress “Exercise and Health, Sports and Human Development”, Évora, Portugal, 11 – 12 November 2016. *Motricidade*, 13(1), 117.
- García-Gómez, S., & Pérez-Tejero, J. (2017). Wheelchair basketball: influence of shoulder pain in sport skills. *Journal of Sport Psychology*, 26(3), 45-49.
- García-Gómez, S., Pérez –Tejero, J., Ocete, C., & Barakat, R. (2017) Expert’s opinion of a home-based exercise program for shoulder pain prevention: application in wheelchair basketball players. *Psychology, Society, & Education*, 9(3), 433-445.
- García-Gómez, S, Pérez-Tejero, J., García, B., Barakat, R. (2018). Validity and Reliability of the Shoulder Pain Index for Wheelchair Basketball Players. *Journal of Sport Psychology*. (Accepted)

- Garg, S., Prince, D., & Cole, A. (2010). Managing rotator cuff disorders. *Topical Reviews*, 6(7).
- Gauthier, C., Brosseau, R., Hicks, A. L., & Gagnon, D. H. (2018). Feasibility, Safety, and Preliminary Effectiveness of a Home-Based Self-Managed High-Intensity Interval Training Program Offered to Long-Term Manual Wheelchair Users. *Rehabilitation Research and Practice*, 2018.
- George, D. & Mallery, P. (2003). *SPSS for Windows step by step: A Simple Guide and Reference*. 11.0 Update 4th ed. Boston, USA: Allyn & Bacon.
- Gil-Agudo, A., Del Alma Espinosa, A., & Crespo-Ruíz, B. (2010). Wheelchair Basketball Quantification. *Physical Medicine Rehabilitation Clinics of North America*, 21:141-156
- Gillooly, J. J., Chidambaram, R., & Mok, D. (2010). The lateral Jobe test: a more reliable method of diagnosing rotator cuff tears. *International Journal of Shoulder Surgery*, 4(2), 41.
- Gómez, M. Á., Pérez, J., Molik, B., Szyman, R. J. and Sampaio, J. (2014). Performance analysis of elite men's and women's wheelchair basketball teams. *Journal of Sports Sciences*, 32(11), 1066-1075.
- Goosey-Tolfrey, V.L., & Leicht, C.A. (2013). Field-based physiological testing of wheelchair athletes. *Sports Medicine*, 43(77).
- Goosey-Tolfrey, V. L. (2005). Physiological Profiles of Elite Wheelchair Basketball Players in Preparation for the 2000 Paralympic Games. *Adapted Physical Activity Quarterly*, 22, 57-66.
- Goosey-Tolfrey, V., Morriss, C. and Butterworth, D. (2002). Free throw shooting technique of male wheelchair basketball players. *Adapted Physical Activity Quarterly*, 19(2), 238-250.

- Gutierrez, D. D., Thompson, L., Kemp, B., & Mulroy, S. J. (2007). The relationship of shoulder pain intensity to quality of life, physical activity, and community participation in persons with paraplegia. *The Journal of Spinal Cord Medicine*, 30(3), 251-255.
- Guttmann, L. (1976). Textbook of sport for the disabled. Brisbane: University of Queensland Press.
- Hawkins, R. J., & Kennedy, J. C. (1980) Impingement syndrome in athletes. *American Journal of Sports Medicine*, 8(3), 151-158.
- Heinemann, K. (Ed.). (2003). Introducción a la metodología de la investigación empírica en las ciencias del deporte. Barcelona: Paidotribo.
- Hegedus, E. J., Goode, A., Campbell, S., Morin, A., Tamaddoni, M., Moorman, C. T., Cook, C. (2008). Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. *British Journal of Sports Medicine*, 42(2), 80-92.
- Hegedus, E. J., Goode, A. P., Cook, C. E., Michener, L., Myer, C. A., Myer, D. M., Wright, A. A. (2012). Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. *British Journal of Sports Medicine*, 46(14), 964-978.
- Heyward, O. W., Vegter, R. J., De Groot, S., & Van Der Woude, L. H. (2017). Shoulder complaints in wheelchair athletes: A systematic review. *PloS ONE*, 12(11), e0188410.
- Hudak, P. L., Amadio, P. C., Bombardier, C., Beaton, D., Cole, D., Davis, A., et al. (1996). Development of an upper extremity outcome measure: the DASH

- (Disabilities of the Arm, Shoulder, and Hand). *American Journal of Industrial Medicine*, 29(6), 602-608.
- Hughes, P. (2011). The Neer sign and Hawkins-Kennedy test for shoulder impingement. *Journal of Physiotherapy*, 57(4), 240.
- Hughes, P. C., Taylor, N. F. & Green, R. A. (2008). Most clinical tests cannot accurately diagnose rotator cuff pathology: a systematic review. *Australian Journal of Physiotherapy*, 54, 159-170.
- International Wheelchair Basketball Federation (IWBF). (2014). Official Player Classification Manual. Canada.
- Idänpään-Heikkilä, J. E. (2001). Ethical principles for the guidance of physicians in medical research: The Declaration of Helsinki. *Bulletin of the World Health Organization*, 79(4), 279-279.
- Jacobs, P. L., Mahoney, E. T., Nash, M. S., & Green, B. A. (2002). Circuit resistance training in persons with complete paraplegia. *Journal of Rehabilitation Research and Development*, 39(1), 21.
- Jacobs, P. L., & Nash, M. S. (2004). Exercise recommendations for individuals with spinal cord injury. *Sports Medicine*, 34(11), 727-751.
- Jacob, S., Decker, D. M., & Lugg, E. T. (2016). Ethics and law for school psychologists. John Wiley & Sons.
- Jobe, F. W., & Moynes, D. R. (1982) Delineation of diagnostic criteria and a rehabilitation program for rotator cuff injuries. *American Journal of Sports Medicine*, 10(6), 336-339.
- Kerby, D.S. (2014). The simple difference formula: an approach to teaching nonparametric correlation. *Comprehensive Psychology*, 3.

- Kazemi, O., Shojaedin, S. S., & Hadadnezhad, M. (2017). Relationship between proprioception and rotator muscles strength with shoulder pain of wheelchair basketball athletes. *Journal of Gorgan University of Medical Sciences*, 19(3).
- Kentar, Y., Zastrow, R., Bradley, H., Brunner, M., Pepke, W., Bruckner, T., ... & Akbar, M. (2018). Prevalence of upper extremity pain in a population of people with paraplegia. *Spinal Cord*, 1.
- Killian, M. L., Cavinatto, L., Galatz, L. M., & Thomopoulos, S. (2012). Recent advances in shoulder research. *Arthritis Research & Therapy*, 14(3), 214.
- Kulig, K., Newsam, C. J., Mulroy, S. J., Rao, S., Gronley, J. K., Bontrager, E. L., & Perry, J. (2001). The effect of level of spinal cord injury on shoulder joint kinetics during manual wheelchair propulsion. *Clinical Biomechanics*, 16(9), 744-751.
- Lewis, J. S. (2009). Rotator cuff tendinopathy/subacromial impingement syndrome: is it time for a new method of assessment? *British Journal of Sports Medicine*, 43(4), 259-264.
- Lim, K.-B., Yoo, J., Lee, H.-J., Lee, J. H., & Kwon, Y.-G. (2014). Evaluation of pain and ultrasonography on shoulder in poliomyelitis wheelchair basketball players. *The Korean Journal of Sports Medicine*, 32(1), 20-26.
- Mantilla, J. I. A. (2018). Fisioterapia y su rol en el alto rendimiento: una revisión sistemática de la literatura/Physiotherapy and his role in high performance: a systematic review of literature. *Revista Iberoamericana de Ciencias de la Actividad Física y el Deporte*, 7(1), 1-12.
- Malone, L. A., Gervais, P. L., & Steadward, R. D. (2002). Shooting mechanics related to player classification and free throw success in wheelchair basketball. *Journal of Rehabilitation Research and Development*, 39(6), 701.

- Middaugh, S., Thomas, K., Smith, A., McFall, T., & Klingmueller, J. (2013). EMG biofeedback and exercise for treatment of cervical and shoulder pain in individuals with a spinal cord injury: a pilot study. *Topics in Spinal Cord Injury Rehabilitation, 19*(4), 311-323.
- Moon, Y., Jayaraman, C., Hsu, I. M. K., Rice, I. M., Hsiao-Wecksler, E. T. and Sosnoff, J. J. (2013). Variability of peak shoulder force during wheelchair propulsion in manual wheelchair users with and without shoulder pain. *Clinical Biomechanics, 28*(9), 967-972.
- Morrow, J. R., Jackson, A. W., Disch, J. G., & Mood, D. P. (2005). *Measurement and Evaluation in Human Performance*. Champaign, IL: Human Kinetics.
- Morrow, M. M., Van Straaten, M. G., Murthy, N. S., Braman, J. P., Zanella, E., & Zhao, K. D. (2014). Detailed shoulder MRI findings in manual wheelchair users with shoulder pain. *Biomed Research International, 2014*.
- Mulroy, S.J., Gronley, J.K., Newsam, C.J., & Perry, J. (1996). Electromyographic activity chair propulsion of shoulder muscles during wheelchair propulsion by paraplegic persons. *Archive of Physical Medicine Rehabilitation, 77*, 187-193.
- Mulroy, S. J., Thompson, L., Kemp, B., Hatchett, P. P., Newsam, C. J., Lupold, D. G., ... & Winstein, C. J. (2011). Strengthening and optimal movements for painful shoulders (STOMPS) in chronic spinal cord injury: a randomized controlled trial. *Physical Therapy, 91*(3), 305-324.
- Mulroy, S., Haubert, L. L., Eberly, V., Connors, S., & Weiss, W. (2017). Effectiveness of Two Intervention Programs to Prevent Shoulder Pain after Spinal Cord Injury. *Archives of Physical Medicine and Rehabilitation, 98*(12), e174.

- Mullaney, M.J., McHugh, M.P., Johnson, C.P., & Tyler, T.F. (2010). Reliability of shoulder range of motion comparing a goniometer to a digital level. *Physiotherapy Theory and Practice*, 26(5), 327-333.
- Murphy, R. J., & Carr, A. J. (2010). Shoulder pain. *BMJ clinical evidence*, 2010.
- Mutsuzaki, H., Tachibana, K., Shimizu, Y., Hotta, K., Fukaya, T., Karasawa, M., . . . Wadano, Y. (2014). Factors associated with deep tissue injury in male wheelchair basketball players of a Japanese national team. *Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology*, 1(2), 72-76.
- Nawoczenski, D. A., Ritter-Soronon, J. M., Wilson, C. M., Howe, B. A., & Ludewig, P. M. (2006). Clinical trial of exercise for shoulder pain in chronic spinal injury. *Physical Therapy*, 86(12), 1604-1618.
- Nash, M. S., van de Ven, I., van Elk, N. and Johnson, B. M. (2007). Effects of circuit resistance training on fitness attributes and upper-extremity pain in middle-aged men with paraplegia. *Archives of Physical Medicine and Rehabilitation*, 88(1), 70-75.
- Nash, M. S., Koppens, D., van Haaren, M., Sherman, A. L., Lippiatt, J. P., & Lewis, J. E. (2008). Power-assisted wheels ease energy costs and perceptual responses to wheelchair propulsion in persons with shoulder pain and spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, 89(11), 2080-2085.
- Neer, C. S. (1972). Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. *The Journal of Bone and Joint Surgery*, 54(1), 41-50.
- Neer, C. S. (1983). Impingement lesions. *Clinical Orthopaedic and Related Research*, 73, 70-77.

- Norkin, C. C., & White, D. J. (1985). Introduction to goniometry. *Measurement of joint motion: a guide to goniometry*. FA Davis, Philadelphia, 1-7.
- Norris, C. (2014). Shoulder impingement. *SportEX Dynamics* 42, 21. Retrieved July 25, 2018, from EBSCOhost database.
- Norrbrink, C., Lindberg, T., Wahman, K., & Bjerkefors, A. (2012). Effects of an exercise programme on musculoskeletal and neuropathic pain after spinal cord injury results from a seated double-poling ergometer study. *Spinal Cord*, 50(6), 457.
- Nyland, J., Robinson, K., Caborn, D., Knapp, E., & Brosky, T. (1997). Shoulder rotator torque and wheelchair dependence differences of National Wheelchair Basketball Association players. *Archive of Physical Medicine Rehabilitation*, 78(4), 358-363.
- Larsen, C. M., Bruun, P., Hansen, S. S., Hansen, L. H. and Juul-Kristensen, B. (2015). Wheelchair Users Shoulder Pain Index (WUSPI) outcome questionnaire: Translation and Cross-Cultural Adaptation of the Danish Version.
- Lim, K.-B., Yoo, J., Lee, H.-J., Lee, J. H., & Kwon, Y.-G. (2014). Evaluation of pain and ultrasonography on shoulder in poliomyelitis wheelchair basketball players. *The Korean Journal of Sports Medicine*, 32(1), 20-26.
- Østerås, H., Torstensen, T. A., & Østerås, B. (2010). High-dosage medical exercise therapy in patients with long-term subacromial shoulder pain: a randomized controlled trial. *Physiotherapy Research International*, 15(4), 232-242.
- Park, J.Y., & Cho, S.H. (2013). The reliability and validity of Korean version of the Wheelchair User's Shoulder Pain Index in Wheelchair Users. *Journal of Exercise Rehabilitation*, 8(4), 573-582.

- Pérez-Tejero, J., Martínez-Sinovas, R., & Rossignoli, I. (2006). Shoulder pain in Spanish wheelchair basketball players. *Proceedings of the 15th European Congress of Physical and Rehabilitation Medicine and 45th National Congress of the Spanish Society of Physical and Rehabilitation Medicine*. Madrid, Spain. 16– 20 May 2006. pp 551-552. ISBN: 84-689-8644-5.
- Pérez-Tejero, J. (2007). Investigación aplicada propulsión en silla de ruedas deportiva. *Proceedings of the II Conferencia Internacional sobre Deporte Adaptado CIDA*. Málaga, Spain: 15 – 17 marzo.
- Pérez-Tejero, J. (2009). La investigación en actividades físicas y deportes adaptados: un camino aún por recorrer. *RICYDE Revista Internacional de Ciencias del Deporte*, 5(16), I-III.
- Pérez-Tejero, J. & Castellanos, S. (2009). Prevención del dolor de hombro y patologías asociadas en jugadores de baloncesto en silla de ruedas. In: Sampedro Molinuevo J. *Modelos de preparación física del baloncesto: una visión científica*. Spain: Cátedra Olímpica-Atos Origin. Madrid, 330-344.
- Pérez-Tejero, J. (2012). Baloncesto en silla de ruedas. In: Fernández, J. *Deportista sin adjetivos. El deporte adaptado a las personas con discapacidad física*. Spain. Consejo Superior de Deportes, Real Patronato sobre Discapacidad Ministerio de Sanidad, Política social e Igualdad, Comité Paralímpico Español, 303-353.
- Pérez J., Reina R., & Sanz D. (2012). Las Actividades Físicas Adaptadas para personas con discapacidad en España: perspectivas científicas y de aplicación actual. *Ciencia, Cultura y Deporte*, 21, año 8, vol. 7, 213 – 224.
- Pérez-Tejero, J. & Pinilla, J. (2015). Wheelchair basketball player performance by game statistics. *Cuadernos de Psicología del Deporte*, 15(3), 231-236.

- Pérez-Tejero, J., Duarte, C., Muelas, R., Prieto, M., Navarro, E. (2016). Análisis biomecánico del tiro libre en jugadores de baloncesto en silla de ruedas según su clasificación funcional. *Revista de Entrenamiento Deportivo*, 31 (3), 1-11.
- Primer, A. P. (1992). Quantitative methods in psychology. *Psychological Bulletin*, 112, 1,155-159.
- Rice, L. A., & Rice, I. M. (2017). Evidenced Based Education Interventions to Preserve Upper Limb Function Among Full Time Manual Wheelchair Users. *Medical Research Archives*, 5(3).
- Riddle, D.L., Rothstein, J.M., & Lamb, R.L. (1987). Goniometric reliability in clinical setting: shoulder measurements. *Physical Therapy*, 67:668-673.
- Roach, K. E., Budiman-Mak, E., Songsiridej, N., & Lertratanakul, Y. (1991). Development of a shoulder pain and disability index. *Arthritis & Rheumatism*, 4(4), 143-149.
- Rosnow, R. L., & Rosenthal, R. (1996). Beginning behavioral research: A conceptual primer. Prentice-Hall, Inc.
- Rozendaal, L. A. (Ed.). (1997). Stability of the shoulder: intrinsic muscle properties and reflexive control. The Netherlands: NWO-NW Netherlands Organizations for Scientific Research- Medical Sciences.
- Samuelsson, K.A., Tropp, H., Gerdle, B. (2004). Shoulder pain and its consequences in paraplegic spinal cord-injured, wheelchair users. *Spinal Cord*, 42(1), 41-46.
- Satyavanshi, A., Pattnaik, M., & Mohanty, P. (2017). Comparison of two types of strengthening exercises in upper limbs for improvement of wheelchair propulsion in paraplegics. *Journal of Novel Physiotherapy and Rehabilitation*, 1, 027-033.

- Seaman, J. A. (2007). *Making Connections: From Theory to Practice in Adapted Physical Education*: Holcomb Hathaway, Publishers.
- Sherrill, C., & DePauw, K. P. (1997). Adapted physical activity and education. *The History of Exercise and Sport Science*, 39-108.
- Silvestri, J. (2018). Shoulder Preservation in Spinal Cord Injury: One Clinic's Approach to Treatment and Prevention. *Current Physical Medicine and Rehabilitation Reports*, 1-7.
- Shimizu, Y., Mutsuzaki, H., Tachibana, K., Tsunoda, K., Hotta, K., Fukaya, T., . . . & Wadano, Y. (2017). A survey of deep tissue injury in elite female wheelchair basketball players. *Journal of Back and Musculoskeletal Rehabilitation*, 30(3), 427-434.
- Starrs, P., Chohan, A., Fewtrell, D., Richards, J., & Selfe, J. (2012). Biomechanical differences between experienced and inexperienced wheelchair users during sport. *Prosthetics and Orthotics International*, 36(3), 324-331.
- Tweedy, S.M. & Vanlandewijck, Y.C. (2011). International Paralympic Committee position stand—background and scientific principles of classification in Paralympic sport. *British Journal of Sports Medicine*, 45:259-269.
- Tsunoda, K., Mutsuzaki, H., Hotta, K., Tachibana, K., Shimizu, Y., Fukaya, T., ... & Wadano, Y. (2016). Correlates of shoulder pain in wheelchair basketball players from the Japanese national team: A cross-sectional study. *Journal of Back and Musculoskeletal Rehabilitation*, (Preprint), 1-6.
- Troy, K. L., Munce, T. A., & Longworth, J. A. (2015). An exercise trial targeting posterior shoulder strength in manual wheelchair users: pilot results and lessons learned. *Disability and Rehabilitation: Assistive Technology*, 10(5), 415-420.

- Tuakli-Wosornu, Y. A., Mashkovskiy, E., Ottesen, T., Gentry, M., Jensen, D., & Webborn, N. (2018). Acute and Chronic Musculoskeletal Injury in Para Sport: A Critical Review. *Physical Medicine and Rehabilitation Clinics of North America*, 29(2), 205-243.
- van der Woude, L. H. V., Janssen, T. W. J., & Veeger, D. J. (2005). Background on the 3rd International Congress "Restoration of (wheeled) mobility in SCI rehabilitation": State of the art III. *Journal of Rehabilitation Research and Development*, 42(3).
- Vanlandewijck, Y., Theisen, D., & Daly, D. (2001). Wheelchair propulsion biomechanics: implications for wheelchair sports. *Sports Medicine*; 31(5):339–367.
- Vanlandewijck, Y. C., Evaggelinou, C., Daly, D. J., Verellen, J., Van Houtte, S., Aspeslagh, V. & Zwakhoven, B. (2004). The relationship between functional potential and field performance in elite female wheelchair basketball players. [Comparative Study]. *Journal of Sports Science*, 22(7), 668-675.
- Van Straaten, M.G., Cloud, B.A., Morrow, M.M., Ludewig, P.M., & Zhao, K. D. (2014). Effectiveness of home exercise on pain, function, and strength of manual wheelchair users with spinal cord injury: a high-dose shoulder program with telerehabilitation. *Archives of Physical Medicine Rehabilitation*, 95, 1810-1817.
- Van Straaten, M. G., Cloud, B. A., Zhao, K. D., Fortune, E., & Morrow, M. M. (2017). Maintaining Shoulder Health after Spinal Cord Injury: A Guide to Understanding Treatments for Shoulder Pain. *Archives of Physical Medicine and Rehabilitation*, 98(5), 1061-1063.

- Vij, M., Kataria, C., & Bansal, K. (2015). Hindi translation and psychometric evaluation of the Wheelchair User's Shoulder Pain Index. *International Journal Health Rehabilitation Science*, 4(2):73-83.
- Walker, J. (2014). Shoulder pain: pathogenesis, diagnosis and management. *Nursing Standard*, 28(22), 51-58.
- Wang, Y.T., Chen, S., Limroongreungrat, W. & Change, L.S. (2005). Contributions of selected fundamental factors to wheelchair basketball performance. *Medicine and Science of Sports and Exercise*, 37(1):130-137.
- Wessels, Kg. K., Brown, J. L., Ebersole, K. T. & Sosnoff, J. J. (2013). Sex, shoulder pain, and range of motion in manual wheelchair users. *Journal of Rehabilitation Research and Development*, 50(3), 351-356.
- Wilroy, J., & Hibberd, E. (2017). Evaluation of a shoulder injury prevention program in wheelchair basketball. *Journal of Sport Rehabilitation*, 1-21.
- World Medical Association. (2000). Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects. *Bulletin of the World Health Organization*. Vol 79: World Health Organization; 2000.
- World Health Organization. (2001). International Classification Of Functioning, Disability and Health. Geneva: World Health Organization.
- World Health Organization. (2002). Towards a common language for functioning, disability and health. Geneva: World Health Organization.
- World Health Organization. (2011). World report on disability. Malta: World Health Organization. The World Bank.
- Yildirim, N. U., Comert, E., & Ozengin, N. (2010). Shoulder pain: a comparison of wheelchair basketball players with trunk control and without trunk control. *Journal Back Musculoskelet Rehabilitation*, 23(2), 55-61.

- Yoo, J. S., Hwang, A. R., Leez, H. C., & Kim, C. J. (2003). Development and Validation of a Computerized Exercise Intervention Program for Patients with Type 2 Diabetes. *Yonsei Medical Journal*, 44(5), 892-904.
- You, B.-c., Lee, W.-J., Lee, S.-H., Jang, S., & Lee, H.-S. (2016). Shoulder Disease Patterns of the Wheelchair Athletes of Table-Tennis and Archery: A Pilot Study. *Annual Rehabilitation and Medicine*, 40(4), 702-709.
- Zurita, F., Espejo, T., Cofré, A., Martínez, A., Castro, M., and Chacon, R. (2016). Influencia de la actividad física sobre la resiliencia en adultos con dolor de hombro. *SPORT TK-Revista EuroAmericana de Ciencias del Deporte*, 5(2), 53-58.

6. SUMMARIZED CV

1. - PERSONAL INFORMATION

- Name: Saleky García Gómez
- NIE: Y3090656E
- Address: C/Altamirano nº 18, 2º izquierda, 28008, Madrid.
- Place of birth: Moca, República Dominicana.
- Date of birth: 6 de octubre de 1985.
- Mobile: 604246563
- E-mail: saleky.ggomez@alumnos.upm.es
saleky@gmail.com

2. - ACADEMIC CURRICULUM

- PhD Student of Physical Activity and Sport Science. Technical University of Madrid. Spain.
- Master Degree in Physical Activity and Sport Science. Technical University of Madrid. 2013-2014. Spain.
- Executive Diploma in Business Management. Dominican-American University. 2009. Dominican Republic.
- Bachelor's Degree in Physical Therapy. Mother and Teacher Pontifical Catholic University. 2003-2007. Dominican Republic

3. - SCHOLARSHIPS AND AWARDS RECEIVED

3.1 Scholarships

- International Scholarship from the Ministry of Education, Sciences and Technologies of the Dominican Republic, to follow the Master's Degree in Research in Physical and Sports Sciences. 2013-2014.
- Credit for Academic Excellence. PUCMM Santiago, Dominican Republic. 2003 - 2007.

3.2 Awards received

- Award for better communication in the field of "Disability and Leisure" Relationship between shoulder pain and joint range in wheelchair basketball players. V International Congress of Inclusive Physical Activity and Sport. Almeria, 2016.
- International Master's Degree in Physical Activity and Sport Sciences. Ministry of Higher Education Sciences and Technology of Dominican Republic, 2013-2014.
- Credit to Academic Excellence. Degree in Physical Therapy at the Mother and Teacher Pontifical Catholic University. Santiago, 2003-2007
- Honorable Mention of the Department of Physical Therapy. Faculty of Health Sciences, Mother and Teacher Pontifical Catholic University. 2006.
- Presentation of the degree research considered the most outstanding of the Department of Physical Therapy. Faculty of Health Sciences, Mother and Teacher Pontifical Catholic University. 2008.

4. - TEACHING CURRICULUM

4.1 University Education and conferences.

- Teacher Department of Physical Therapy. Catholic University of Santo Domingo. (Anatomy II, Test and Measurements I, Therapeutic Exercise II, Rheumatology. Dominican Republic. Santo Domingo, Dominican Republic. 2011-2013.
- Invited Teacher Department of Physical Therapy. National Evangelical University. 2015.
- Invited lecture Update day Specialists in rehabilitation physician. Dominican Association of Rehabilitation. Dominican Republic. 2007.

5. - PROFESSIONAL CURRICULUM

- Pre-doctoral Student Intern in the Sanitas "Foundation Chair" on Inclusive Sports Studies, Technical University of Madrid. Madrid, Spain. January 2017-July 2018.
- Pre-doctoral internship in the Vrije University. Amsterdam, Holland. February-April 2018.
- Pre-doctoral internship in the National Hospital of Paraplegics of Toledo. November 2016- April 2017.

- Collaboration as a volunteer in Ilunion Wheelchair Basketball Team. Season 2015-2016, 2016-2017. Collaboration in concentration and preparation of the preselection absolute male, female and sub-23 Spanish wheelchair basketball. Superior Council of Sports. Madrid, Spain. 2015-2016.
- Participation as a volunteer in the European Wheelchair Basketball Championship 2017.
- Collaborator of the 50th Anniversary Congress of the Faculty of Physical Activity and Sports Sciences 1966-2016, Technical University of Madrid, Madrid, Spain. 2016.
- Collaboration in concentration of the preselection Sub 23 Spanish wheelchair basketball. High Performance Center of Sant Cugat. Barcelona Spain. 2015.
- Collaborator of the European Congress of Adapted Physical Activity EUCAPA. Madrid, Spain. 2014.
- Dr Robert Reid Cabral Hospital (2011-Current) Pediatric Physiotherapy. Santo Domingo, Dominican Republic.
- Central Hospital of the Armed Forces (2011-Current) Orthopedic and Neurological Physiotherapy. Santo Domingo, Dominican Republic.
- Physiotherapy. Medical Team of Special Olympics. Santo Domingo, Dominican Republic.
- Lincoln Trauma Physical Rehabilitation. (2009-2013) Santo Domingo, Dominican Republic. Pediatric, Orthopedic and Neurological Physiotherapy.
- Dominican Association of Rehabilitation. (2007-2009) Santo Domingo, Dominican Republic. Pediatric, Orthopedic and Neurological Physiotherapy.
- Cibao Board of Rehabilitation. Teaching Hospital José María Cabral and Báez. 2007. Santiago, Dominican Republic. Pediatric, Orthopedic and Neurological Physiotherapy.
- Cibao Board of Rehabilitation. 2006 Santiago, Dominican Republic. Pediatric, Orthopedic and Neurological Physiotherapy. Santiago, Dominican Republic.
- Cibao Board of Rehabilitation. Dr Toribio Bencosme Hospital. Moca, Dominican Republic. Pediatric, Orthopedic and Neurological Physiotherapy.

6. RESEARCH CURRICULUM

6.1 Publications

- Pérez-Tejero, J. & García-Gómez, S. (2018). Shoulder pain assessment in elite wheelchair basketball players. *Revista Andaluza de Medicina del Deporte*. Accepted. ISSN: 1888-7546
- García-Gómez, S., Pérez-Tejero, J., García, B., Barakat, R. (2018) Validity and reliability of the shoulder pain index for wheelchair basketball players. *Journal of Sport Psychology*. Accepted. ISSN: 1132-239X
- García-Gómez, S., Pérez Tejero, J., Ocete, C., & Barakat, R. (2017). Expert's opinion of a home-based exercise program for shoulder pain prevention: application in wheelchair basketball players. *Psychology, Society & Education* 9(3), 433-445.
- García-Gómez, S., & Pérez-Tejero, J. (2017). Shoulder pain according to age, wheelchair use and years of injury in wheelchair basketball players. *Motricidade*, 13(1), 117.
- García-Gómez, S. & Pérez-Tejero, J. (2017). Wheelchair basketball: influence of shoulder pain in sport skills. *Journal of Sport Psychology*, 26(3), 45-49.
- García-Gómez, S., Pérez-Tejero, J. & Rosa-Gaspar, F.J. (2016). Relationship between of shoulder pain and range of motion in wheelchairs basketball players. *Avances en Actividad Física y Deportiva Inclusiva*. Universidad de Almería. España.
- García-Gómez, S. & Pérez-Tejero, J. (2014) Valoración del dolor del hombro en la Selección Absoluta Masculina Española de Baloncesto en Silla de Ruedas. Master Thesis.
- García-Gómez, S. (2007) Validez de la Evaluación Neck Disability Index en Pacientes con Cervicalgia Crónica. Grade Research.
- Collaboration in the Project "Utilización de las TIC's en la Escuela de Odontología de la Universidad Autónoma de Santo Domingo". Master Thesis. 2010-2012

6.2 Posters y Comunications

- García-Gómez, S., Pérez-Tejero, J. (2017) High-level wheelchair basketball players' adherence to shoulder home-based exercise program: a follow up study.

- X Simposio de Fuerza, Madrid, Spain, 15-16 December 2017.
- Gil-Agudo, A., del-Ama, A.J., Alcobendas-Maestro, M., Lozano-Berrio, V., Benito-Penalva, J., García-Gómez, S., López-Dolado, E. (2017) The EXO-H2 robotic exoskeleton for gait rehabilitation after spinal cord injury: preliminary clinical findings. 56th ISCoS Annual Scientific Meeting. Dublín, Irlanda, 24-26 de octubre.
- Gil-Agudo, A., Pons, J.L., Alcobendas-Maestro, M., Lozano-Berrio, V., Benito-Penalva, J., García-Gómez, S., del-Ama, A.J. (2017) Estudio sobre la viabilidad clínica del exoesqueleto EXO-H2 para la rehabilitación de la marcha en pacientes con lesión medular incompleta. Iberdiscap 2017-IX Congreso Iberoamericano de Tecnologías de Apoyo a la Discapacidad. Bogotá, Colombia, 22-24 November 2017.
- García, S., Pérez-Tejero, J. (2016). Shoulder pain according to age, wheelchair use and years of injury in wheelchair basketball players. CIDESD International Congress "Exercise and Health, Sports and Human Development", Évora, Portugal, 11 – 12 November 2016. García-Gómez, S., Pérez-Tejero, J. (2016). Wheelchair basketball: influence of shoulder pain in sport skills. VIII Iberoamerican Congress of Basketball, Huelva University, 20-22 October 2016.
- García-Gómez, S., Pérez-Tejero, J., Rosa-Gaspar, F.J. (2016). Awarded oral communication in the field of "Disability and Leisure" Relationship between of shoulder pain and range of motion in wheelchairs basketball players. V International Congress of Adapted Physical Activity and Inclusive Sport. Almería, 9 -13 May 2016.
- García-Gómez, S., Pérez-Tejero, J., Rosa-Gaspar, F.J. (2016). Shoulder pain in wheelchair basketball players Sub 23, IX Congress of Spanish Association of Sports Sciences; Toledo, 21- 23 April 2016.
- Presentations at public and private levels of promotion and prevention of health. 2015. Dominican Republic.
- García-Gómez, S., Pérez-Tejero, J., Rosa-Gaspar, F.J. (2014). Evaluation of shoulder pain according to the range of motion in wheelchair basketball players, European Congress of Adapted Physical Activity, Madrid, 29 September-02 October 2014.

6.3 Participation in subsidized projects

- Collaboration and participation in the clinical trial that values robotic rehabilitation for gait with the EXO-H2 robotic exoskeleton for gait rehabilitation after spinal cord injury after spinal cord injury (Project funded by the Carlos III Health Institute of Spain in its call for the year 2015, PI15/01437)

7. - COURSE RECEIVED

7.1 Courses

- Imaging Course. Vrije University. Amsterdam, Holland. 2018.
- Functional Classification Course in Wheelchair. International Wheelchair basketball Federation. Brno, Czech Republic. 2017.
- Initial Training Course for University Teaching. University of Madrid. Madrid. 2016-2017.
- Physiotherapy Management of Spinal Cord Injuries. E-learnig program of the International Spinal Cord Society. United Kingdom. 2016
- VII Basic Thermography Course for the prevention and monitoring of sports injuries. Technical University of Madrid. 2014.
- Manual Therapy Maitland Concept. Module I and II. Mother and Teacher Pontifical Catholic University. Santiago. 2007
- Neuromuscular Bandage Training. Catholic University of Santo Domingo. 2011.
- Management of Burn Patient. Phisicians for Peace, Dominican Association of Rehabilitation, Shinnars. Santiago. 2008
- Evaluation and Prescription in the Equipment of Patients with Amputations. Cibao Board of Rehabilitation, Phisicians for Peace, Mother and Teacher Pontifical Catholic University. 2006
- Relaxation Techniques. Panamerican Institute of Pain. Santiago. 2005
- Electrotherapy. Panamerican Institute of Pain. Santiago. 2005

7.2 Actividades complementarias

- Continuing Education Conferences. Technical University of Madrid. 2014.
- Patient safety. Miríada X/ Cantabria University. 2013
- Basic Pranic Healing. Institute of Inner Studies. 2010
- Continuing Education Conferences. Mother and Teacher Pontifical Catholic University. 2003-2007.

8. - CONGRESS AND CONFERENCES

- Functional Classification Course. Spanish Paralympic Committed. Madrid, Spain. 2016
- I National Clinic of Coaches. Spanish Federation for people with Physical Disabilities. Getafe. 2016
- Internacional Congress “Madrid sin barreras: Accesibilidad, ajustes y apoyos”, Carlos III University of Madrid. Madrid. 2016.
- 50th Anniversary congress of the Faculty of Physical Activity and Sports Sciences, Technical University of Madrid, Madrid, Spain. 2016
- VIII Simposio Internacional de Actualizaciones en Entrenamiento de la Fuerza. Technical University of Madrid. 2015.
- Conference on “Novedades: deporte y discapacidad”. 26 September 2015. INEF- Technical University of Madrid, Madrid, Spain. 8 horas.
- European Congress of Adapted Physical Activity. October 2014. Madrid, Spain.
- Maternal Exercise effects on Carbohydrate Metabolism and Fetal Outcome. Michelle Mottola, Universidad de Western Ontario Technical Universidad Politécnica de Madrid. España. 2014.
-

7. APPENDIX

SHOULDER EXERCISE PROGRAM TO PREVENT SHOULDER INJURIES IN WHEELCHAIR BASKETBALL PLAYERS

Exercises will be performed in seating position, 3 times per week. If you feel any significant pain or discomfort, you must contact the physiotherapist in charge.

The time of execute the exercise program is from 25 to 30 minutes

A) ACTIVE MOVEMENTS

Description: With relax arms, move shoulders in different directions: (1) Raise arms out in front, (2) Circular movements, (3) Raise out both arms to the side above the head at the same time and (4) with the arms separated of the body move the arms forward and backward. Considerations: Be careful with trunk movements. 8 repetitions of each one.

B) STRENGTHENING: 3 sets 10 repetitions with 45s of rest between sets.**1. - Serratus anterior**

Description: Seated in upright position with resistive band attached to object in backward, hold the band with elbow in 90 degrees. Extended elbow and flexion the shoulder at the same time. Return to start position slowly. Repeated with opposite side. Considerations: Try to not move your trunk to do the exercise.

Figure 1. Strengthening of serratus anterior.

2. - Scapula retraction and depression

Description: Seated in upright position with resistive band attached in front of the wheelchair, hold the band with elbow extended. Move arms down and backward then return slowly to starting position. Repeated with opposite side. Considerations: Try to not move your trunk to do the exercise.

Figure 2. Strengthening of scapula retraction and depression.

3.- External rotation

Description: Wheelchair at 90° of a wall with resistance band secure on the opposite side, hold the band with arm in neutral position and the elbow in 90°. Pull the band out of the side away of the bodied. Hold the position and return slowly to initial position. Repeated with opposite side. Considerations: Avoid separate arm of the body to make the movement.

Figure 3. Strengthening of external rotation

4. - Internal rotation

Description: Wheelchair at 90° of a wall with resistance band secure on the same side, hold the band with arm in neutral position and the elbow in 90°. Pull the band inward to your stomach. Hold the position and return slowly to initial position. Repeated with opposite side. Considerations: Avoid separate arm of the body to make the movement.

Figure 4. Strengthening of internal rotation

5. - Shoulder Adduction

Description: Seated in upright position with resistance band attached above head height, hold the band with arm aligns at a height of shoulder with elbow straight. Pull the band with the hand trying to touch the opposite knee with the elbow straight and thumb pointing down. Repeated with opposite side. Considerations: Avoid separate arm of the body to make the movement. Considerations: Avoid doing neck flexion and don't move the upper trunk.

Figure 5. Strengthening of shoulder adduction

C) STRETCHING (5 repetitions of each one, hold each stretch for 20/30s. Rest 15s)

1. - Trapezius superior

Description: In upright position, use one hand to stabilize the trunk holding the wheelchair. With the opposite hand, lean away the necks to the opposite side. Considerations: Avoid neck rotation.

Figure 1. Stretching of trapezius superior

2. Posterior of the shoulder

Description: Seated in upright position, pull arm slowly around the front of the upper body using the opposite hand above the elbow to stretch. Considerations: Avoid neck rotation.

Figure 2. Stretching of posterior muscles of the shoulder

3. - Pectoral muscle

Description: Position wheelchair in a frame, shoulder 90° of abduction and elbow less than 90° holding in the border. Rotate upper body slowly away from the frame until the stretch and hold. Considerations: Hold the position and do not support with opposite arm.

Figure 3. Stretching of pectoral muscle

4. - Biceps braquial (long head)

Description: Position wheelchair in a frame, shoulder in extension and external rotation 90° of abduction and elbow less than 90° holding in the border of the frame. Rotate upper trunk slowly. Consideration: Be careful, it's necessary the depression and retraction of the scapula during the stretching.

Figure 4. Stretching of braquial muscle

5. - Trapezius (Medial and inferior portion)

Description: Seated in upright position, stretch upper limb holding hands over the shoulders. Considerations: Hold the position the time required, avoid neck rotation.

Figure 5. Stretching of medial and inferior portion of the trapezius

If you feel **unusual pain or discomfort**, contact with the physiotherapist or the research staff.
Francisco Javier Rosa Gaspar fjrosa_87@hotmail.com/
feddf.bsrsalud@gmail.com Saleky García Gómez saleky@gmail.com

POSTURAL RECOMMENDATIONS FOR WHEELCHAIRS BASKETBALL PLAYERS

SPANISH NATIONAL SELECTION 2016

Shoulder injuries could be as a consequence of overuse and postural alterations in the daily living activities o sport activities. In this regard, it is necessary to have an adequate posture to reduce stress to perform movements regardless of the activity being carried out. In order to reduce the load on the shoulder, as well as the possible damage to the spine to prevent injury and muscle imbalances we will use guidelines of postural hygiene. This uses the minimum tension and rigidity, thus allowing maximum efficiency and minimum energy expenditure.

When lying flat

The ideal lying position is side with both knees bent and place the pillow between your legs to keep the spine stable, because of that to be placed upside down or mouth above you can create tension at the lumbar level and alter the lumbar curvature; however if being side put a pillow at the level of the pelvis and stand slightly sideways diminishes the risk to develop disorders of the spine.

In the case of being upside down can use a thin pillow and ensure that the cervical and dorsal column keeps that same angle to the stand. Waking up is good to stretch to adapt our muscle tone to the activity. To lift us we must Flex the knees and turn the trunk to incorporate us side. Mattress and pillow features influence the positions adopted when these lying down. The mattress must be firm and straight, in such a way that it fits the curvature of his spine. Regarding the use of the pillow, take into account that we will use it to accommodate our body and prevent muscle strain.

Sitting position

Both for the activities of everyday life how sporting keep sitting posture / a must maintain an upright posture, although it must be dynamic and allow the functionality of joints, the backing of the same secure the back respecting normal curvatures.

Good posture provides stability, comfort and distributes the pressure to areas of lower risk of producing scars, in addition to influencing the effective propulsion of the wheelchair. You should avoid partial turns, the correct way to do is to turn the whole body at the same time and perform movements when you hold this position for a long time.

Working with a computer

The screen should place it at a safe distance and at its height, placing the keyboard to be low so as not to lift the shoulders and allow the forearms to rest on the table. The wrist

and forearms should be straight and aligned with the keyboard; you could use a palm rest.

Driving

You must position the seat in such a way that you can reach the pedals without having to stretch your legs, and rest on the backrest. The knees should be at or above hip level.

Lifting objects

The objects should be placed at the height of the chest, with the elbows flexed to ensure this as close to the body as possible. Avoid doing overuse lifting objects inappropriately.

These are general recommendations, since depending on the type of injury and level of injury in the case of spinal cord injuries could condition some postures.

If you have any question contact with the physiotherapist or the research staff.

Francisco Javier Rosa Gaspar fjrosa_87@hotmail.com

Saleky García Gómez saleky@gmail.com

SHOULDER PAIN INDEX FOR WHEELCHAIR BASKETBALL PLAYERS

The aim of this questionnaire is analyze the incidence of shoulder pain in wheelchair basketball players of the Spanish preselection of wheelchair basketball, the situations in which it appears and its relationship or not with personal characteristics (such as the type of disability) or the same competition. The questionnaire is individual and it is related to shoulder pain, and does not imply any assessment at the level of athletic performance.

At the beginning you will find a first part (A) in which you must fill in a series of personal data, level of sport practice and type of disability. Then, in the second part of the questionnaire (B) appear a series of statements that refer to different situations of daily life and the practice of sports in relation to the occurrence of shoulder pain during its implementation. **Part B.1. ONLY should be answered by wheelchair users who use it daily** and NOT by those who ONLY sit in the wheelchair to play sports. The rest of the questions (B.2.) **Must be filled in by all the participants**. After each statement you must assess on a scale of 1 to 10 the perceived pain (where 1 means "no pain" and 10 "worst pain ever experienced").

Finally, the questionnaire it is related to CURRENT MOMENT and not to previous situations.

Thank you for your collaboration.

A) INDIVIDUAL INFORMATION	
1.- Age: _____ years	2.- Gender (check what applied): Male ☐ Female ☐
3.- Wheelchair use (check what applied): a) Only for sport ☐ b) For daily activities ☐	
4. - Number of hours of training or physical activity practice in a week: _____ hours.	
5.- Number of hours of training in a week out of the wheelchair (strengthening, swimming, other sports without wheelchair, etc.) and specify que type of activity: Type of activity: _____ Number of hours: _____ hours.	
6. - Number of years since disability: _____ years.	
7. - Number of years using wheelchair for Daily Activities: _____ years.	
8. - Number of years practicing recreative sport: _____ years. Number of years practicing federate recreative sport: _____ years.	
9.- Type of disability (check what applied): Spinal Cord injury ☐ Polio ☐ Amputation ☐ Cerebral Palsy ☐ Others (specify wich one): _____	
10. - Indicate the level of spinal cord injury, if this is your disability: _____	
11. - ¿Complete or incomplete? (check what applied): Complete ☐ Incomplete ☐	

12.- ¿Currently do you have shoulder pain? (check what applied):

YES ☐

NO ☐

13. - If you answered “YES” in the question 12. ¿ In which shoulder do you have pain, in the right or the left? (check what applied):

Right ☐

Left ☐

14.- If you answered “YES” in the question 13 ¿ Can you can identify when the pain appeared? (check what applied):

☐ 1 week

☐ 6 week

☐ 2 week

☐ 12 week or more

15.-¿ Where exactly do you have shoulder pain? (check what applied)

Anterior View

Posterior View

16. - ¿Do you feel numbness or cramping on the side that is painful?(check what applied)

YES ☐

NO ☐

17. - ¿In this moment, do you have other pain? ¿Where? (check what applied):

YES ☐

NO ☐

18.- If you have shoulder pain ¿ It has recently received treatment for such pain?

YES ☐ _____ NO ☐

19.- If you have answered Yes to question 15, briefly indicate the type of treatment used:

20.- If not it hurts now shoulder and it has hurt him in the past, briefly indicate the cause and type of treatment used:

21.- Indicate your dominant side (check what applied):

Right ☐

Left ☐

B) SHOULDER PAIN.

Read the questions carefully and estimated the level of pain around the number that you see fit, where **1:** means "no pain" until **10** "worst pain ever experienced".

B.1. - ANSWER ONLY USERS WHO USE WHEELCHAIR FOR DAILY ACTIVITIES:

1. When I transferring from a bed to a wheelchair, I feel shoulder pain (for daily wheelchair users)

1: No pain [ ] _____ **10:** worst pain ever experienced [ ]

2. When I transferring from a wheelchair to a car, I feel shoulder pain (for daily wheelchair users)

1: No pain [ ] _____ **10:** worst pain ever experienced [ ]

3. When I transferring from a wheelchair to a tub or shower, I feel shoulder pain (for daily wheelchair users)

1: No pain [ ] _____ **10:** worst pain ever experienced [ ]

4. When I push the wheelchair for 10 minutes or more, I feel shoulder pain shoulder pain (for daily wheelchair users)

1: No pain [ ] _____ **10:** worst pain ever experienced [ ]

5. When I push the wheelchair up ramps or inclines outdoors, I feel shoulder pain (for daily wheelchair users)

1: No pain [ ] _____ **10:** worst pain ever experienced [ ]

B.2.- TO ANSWER FOR ALL PARTICIPANTS:

6. I feel shoulder pain when I loading your wheelchair into a car.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

7. When I lift objects down from an overhead shelf, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

8. When I put on pants, I feel pain in the shoulder.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

9. When I putting on a t-shirt or pullover, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

10. When I putting on a button down shirt, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

11. When I wash back, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

12. When I usually do daily activities at work or school, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

13. When I drive, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

14. When I performing household chores, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

15. When I sleeping, I feel shoulder pain.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

16. I feel pain when I do shooting.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

17. I feel pain when I do pushing sport wheelchair during the game.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

18. I feel pain when I do rebounding or one-handed long pass during game situation.

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

19. I feel pain when I do specific sport skills during games situations (which one):

_____

1: No pain [ ] _____ 10: worst pain ever experienced [ ]

Thank you!

GENERAL INFORMATION

Demographic Information

Name: _____ **Last name:** _____

Age: _____ **Gender:** F ☐ M ☐ **Fecha:** _____

Email: _____

Medical history:

Check what applied:

Do you have any allergies? Yes No Explain: _____

Do you smoke? Yes No ¿How many times in a day? _____

Do you drink coffee? Yes No ¿How many times in a day? _____

¿Do you have any injury or health problems?

Yes No

Explain: _____

¿Do you have a family with health problems such as?

Diabetes Yes No ¿Who? _____

Heart problems Yes No ¿Who? _____

Cancer Yes No ¿Who? _____

¿Do you have any musculoskeletal alteration (shoulder, elbow, hand, etc)?

Yes No

Explain: _____

If you answer Yes in the question below, explain briefly the treatment:

_____

¿Are you doing a physical exercise program?

Yes No

Explain: _____

If you answer Yes in the question below, specify time of training and what kind of exercise _____

Shoulder Evaluation

Goniometer measurements

Right	Hombro	Left
	Flexion	
	Extension	
	Abduction	
	Adduction	
	Internal Rotation	
	External Rotation	

Clinical Test

Positive			Negative	
Right	Left		Right	Left
		Neer test		
		Hawkins-Kennedy test		
		Jobe test		
		Patte test		

Goniometric measurements will fill the boxes with the degrees obtained to conduct assessment. On other hand, in the case of clinical test is marked with an X if it is positive or negative.

Evaluator name: _____

Date: _____

Last game played date _____ Last training date _____

SELF-EFICACY OF THE PLAYER EXERCISE PROGRAM

All the information obtained will be treated with confidentiality. Please read carefully and clearly complete the option chosen in each of the ratings. Indicate the degree of confidence of each one of the behaviors in a scale of 5 points. We deeply appreciate your collaboration.

Name:	Date:

Perception of the player	Degree of confidence				
	0	1	2	3	4
I'm sure I can do all the exercise.					
I'm sure I can follow the instructions.					
I'm sure I can remember all the exercises.					
I'm sure I can do the exercises tired.					
I'm sure I can do the exercises when I'm in bad temper.					
I'm sure I can do the exercises when I feel I do not have time.					
I'm sure I can do the exercises, even if I feel some discomfort.					
I'm sure I can do the exercises regularly.					
I'm sure I can follow the program.					
I am sure that I can overcome any obstacle that can make it difficult to do the exercises regularly.					

Indicate the adherence and compliance of the exercise program.

Perception of the player	Adherence	Degree of compliance		
		Low	Moderate	High
Frequency				
Frequency indicated by the physiotherapist				
Frequency with which the exercise program is carried out				
Duration (Minutes)				
Time indicated by the physiotherapist				
Time that the exercise program performs.				
Quality of execution (Percentage)				
Percentage of the time in which the exercise program is carried out in an appropriate manner				

Note: Based on studies by Abenza et al 2009 / 2011, Nawoczinski 2006 and Milne et al 2005.

Follow up Template Shoulder home-based exercise program to prevent shoulder pain	
	Check list
Warm-up	
Stretch	
○ Trapezius (Superior) ○ Back of the shoulder ○ Pectoral ○ Brachial biceps ○ Trapezius (Middle / Lower)	
Strengthening	
○ Serratus anterior ○ Rotator muscle ○ Retraction / Depression of scapula	
Control questions	
○ Have you been doing the exercises in the prescribed manner? ○ How many times are you doing the exercises? ○ Do you have any questions about any exercise? ○ Have you had any problems when doing the exercise program?	
Suitable materials	
Postural recommendations	
¿Do you have pain?	

INFORME QUE EMITE EL COMITÉ DE ÉTICA DE LA UNIVERSIDAD POLITÉCNICA DE MADRID

A petición de la Vicerrectora de Investigación, Innovación y Doctorado de la Universidad Politécnica de Madrid, D^a. Asunción Gómez Pérez, de un dictamen sobre los aspectos éticos del

Proyecto "Effects of a therapeutic exercise program for injuries prevention in wheelchair basketball players", cuyo investigador principal es D. Javier Pérez Tejero, del Departamento de Salud y Rendimiento Humano de la Facultad de Ciencias de la Actividad Física y del Deporte (INEF) de la Universidad Politécnica de Madrid, tras los pertinentes análisis, estudios y consultas. El Comité emite el siguiente informe:

El proyecto tiene como principal objetivo analizar la incidencia del dolor de hombro en jugadores en la concentración de baloncesto en silla de ruedas.

Para ello, se realizará primero un cuestionario individual referido sólo al dolor de hombro, sin entrar a valorar el rendimiento deportivo. La protección de datos queda garantizada porque todos los datos de carácter personal quedan registrados en un ordenador (proporciona dirección IP del ordenador) y los mismos, serán destruidos por los investigadores al concluir el estudio, garantizando, en todo momento, la confidencialidad. A cada participante se le asigna un código de participación numérico, de manera que la codificación y el mecanismo para llegar a saber a quién pertenece cada código estarán separados y este último protegido. El procesamiento de los datos se llevará a cabo utilizando Excel (Microsoft Office 2007) y el programa estadístico SPSS V18.0.

En la segunda parte del estudio, se proponen unos ejercicios preventivos, detallados en la información proporcionada por el investigador principal. En los que siempre estará presente un fisioterapeuta que será el que realice la evaluación del hombro en los diferentes momentos y proporcione el SPI-WB para ser cumplimentado. En cuanto al protocolo de medición del dolor este no supone el riesgo de exposición a radiaciones o intervención invasiva en ningún caso.

Por todo ello considero que no existen riesgos apreciables desde un punto de vista ético asociados al desarrollo del proyecto y por tanto, no hay inconveniente en **informar favorablemente la propuesta**, recomendando el efectivo cumplimiento de los compromisos declarados.

Y para que así conste, firmo el presente informe en Madrid a 14 de julio de dos mil dieciséis.

La Presidenta del Comité

**Ernestina
Menasalvas**

D^a Ernestina Menasalvas

Documento digitalizado por la Oficina
Mensual de
Resolución de documentos (CRM)
por Ernestina Menasalvas, en la Universidad
Politécnica de Madrid, con la firma
digitalizada por la Oficina de
Resolución de documentos (CRM)
Fecha: 2016.07.14 20:43:02 +02'00'

El Secretario del Comité

D. Juan Carlos Dueñas

CONSENTIMIENTO INFORMADO DEL PARTICIPANTE

Estimado participante,

Le informamos que, como jugador/a participante en esta concentración de BSR, ha sido seleccionado para formar parte del estudio “*Efectividad de un programa de ejercicios para la prevención de lesiones de hombro en el baloncesto en silla de ruedas (BSR)*”, cuyo objetivo principal es determinar la efectividad del mismo como herramienta preventiva. Como sabe, este es un problema muy recurrente en nuestra población, y es por ello que, especialmente en un proceso de preparación Paralímpica, es fundamental proteger esta articulación.

El jugador/a tendrá una participación activa tanto en la evaluación (pre y post intervención) como en la realización del programa en sí, y por ello es importante que el jugador/a que pueda sentir dolor de hombro (como señal de alguna posible patología), lo manifieste de manera clara y fehaciente. **Lo más importante es cuidar de su salud en este proceso de preparación deportiva** y es desde este objetivo el cual se plantea este estudio. Antes de aplicar cualquier intervención el examinador le explicará el protocolo del trabajo. En el caso de los participantes menores de edad, los padres o tutores estarán al tanto del proceso de la investigación.

Todos los documentos serán procesados de manera confidencial, siendo el equipo investigador y el cuadro técnico de la selección los responsables de la información obtenida. Se garantiza que estos datos se utilizarán SOLO con fines de evaluación terapéutica de cara a la práctica saludable de este deporte, así como la investigación sobre la incidencia de esta patología en jugadores de BSR nacionales en régimen de concentración. Si tiene alguna duda acerca del proceso no dude en ponerse en contacto con el equipo investigador.

Este estudio está diseñado bajo las directrices de la Declaración de Helsinki, sobre investigación con seres humanos, y está aprobado por el Comité Ético de la Universidad Politécnica de Madrid. De acuerdo a las condiciones anteriormente planteadas, al firmar se compromete a participar de manera voluntaria en esta investigación. El jugador/a en el transcurso de la investigación tendrá la potestad de declinar a su participación en el estudio, así como retirar sus datos.

Muchas gracias por su colaboración,

Responsables del proyecto: Javier Pérez Tejero, Francisco Javier Rosa Gaspar y Saleky García Gómez.

Nombre: _____ Apellidos: _____

Firma _____ Fecha: _____

ClinicalTrials.gov Protocol Registration and Results System (PRS) Receipt
Release Date: 07/19/2016

ClinicalTrials.gov ID: NCT02842008

Study Identification

Unique Protocol ID: UPMadrid

Brief Title: Effects of a Therapeutic Exercise Program for Injuries Prevention in Wheelchair Basketball (WB) Players

Official Title: Effects of a Therapeutic Exercise Program for Injuries Prevention in Wheelchair Basketball (WB) Players

Secondary IDs:

Study Status

Record Verification: July 2016

Overall Status: Recruiting

Study Start: July 2016

Primary Completion: July 2016 [Anticipated]

Study Completion: August 2017 [Anticipated]

Sponsor/Collaborators

Sponsor: Universidad Politecnica de Madrid

Responsible Party: Principal Investigator

Investigator: Saleky García Gómez [sgomez]

Official Title: PT PhD student

Affiliation: Universidad Politecnica de Madrid

Collaborators: Universidad Politecnica de Madrid

Oversight

FDA Regulated?: No

IND/IDE Protocol?: No

Review Board: Approval Status: Approved

Approval Number: 14/07/2016

Board Name: UPM ethical committee

Board Affiliation: Universidad Politecnica

Phone: +34 913 36 60 00

Email: secretaria.adjunto.vdoctorado@upm.es

Data Monitoring?: No

Plan to Share Data?: Undecided

Study Description

Brief Summary: Shoulder pain is the most common symptom of physical dysfunction in wheelchair basketball players. About the 85% of this population had shoulder pain in some moment of their life. Some studies suggest that exercise is an important tool as an element to treat and prevent shoulder injuries. For that reason, an intervention program would be a useful tool for prevent shoulder injuries in this population.

The purpose of this study is determine the effects of therapeutic exercise program wheelchair basketball players, in order to prevent shoulder injuries.

Detailed Description: The hypothesis of the study was that the exercise program was effective to prevent shoulder injuries in this population.

Conditions

Conditions: Athletic Injuries
Shoulder Pain
Shoulder Injury

Keywords: Exercise Therapy
Shoulder pain
Shoulder injuries
Shoulder function
Prevention
Wheelchair users

Study Design

Study Type: Interventional

Primary Purpose: Prevention

Study Phase: N/A

Intervention Model: Parallel Assignment

Number of Arms: 2

Masking: Open Label

Allocation: Non-Randomized

Endpoint Classification: Efficacy Study

Enrollment: 36 [Anticipated]

Arms and Interventions

Arms	Assigned Interventions
Experimental: Exercise group Wheelchair basketball players participating in home therapeutic exercise program that use the protocol of postural hygiene.	Behavioral: Exercise group This group will receive a home exercise program of shoulder based on mobility, strength and strengthening exercises, lasting 10 weeks, 3 times per weeks. The target dose use for mobility consisted in 8 repetitions for each 4 movements, for strengthening using resistive bands, 3 sets (including 5 exercises) of 10 repetitions with a 45 second rest between

Arms	Assigned Interventions
	sets and 5 repetitions for each 5 strength with a 30 second rest and general protocol of postural hygiene. The instructional of the program is 30 minutes each day during the time of the study (10 weeks) with a screening about the exercise program and the daily activities performed every 4 weeks. Physiotherapist provided support to subjects through email along 10 weeks.
No Intervention: Control group Wheelchair basketball players that not participate in home therapeutic exercise program and use a protocol of postural hygiene provided.	

Outcome Measures

Primary Outcome Measure:

1. Change from baseline shoulder pain at 10 weeks
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
The presence of shoulder pain will be measured at the beginning and at 10 weeks with "Shoulder Pain Index for Wheelchair Basketball (SPI-WB)" (submitting).

Secondary Outcome Measure:

2. Neer test
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
Neer's Test assesses for possible rotator cuff impingement. Pain is a positive test.
3. Hawkins-Kennedy test
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
Hawkins-Kennedy's test indicative a possible impingement between the greater tuberosity of the humerus against the coraco- humeral ligament.
4. Jobe test
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
Jobe's test assesses for possible supraspinatus weakness and/or impingement.
5. Patte test
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
Patte's test measure for possible infraspinatus and teres minor weakness and/or impingement.
6. Shoulder range of motion
[Time Frame: Baseline and at 10 weeks] [Safety Issue: No]
The range of motion will be evaluated in flexion, extension, internal rotation, external rotation and abduction with a goniometric at the beginning and at 10 weeks.
7. Players' adherence to the exercise program
[Time Frame: At 4 and 8 weeks] [Safety Issue: No]
Players will complete a questionnaire rating their adherence to the exercise program.
8. Players' self-efficacy to the exercise program
[Time Frame: Baseline] [Safety Issue: No]
Players will complete a questionnaire about the self-efficacy according to the exercise program.
9. Players adherence to the protocol of postural hygiene.
[Time Frame: At 4 and 8 weeks] [Safety Issue: No]
Players will complete a follow-up questionnaire rating their adherence to the protocol of postural hygiene.
10. Activities performed outside of the training and exercise program.
[Time Frame: At 4 and 8 weeks] [Safety Issue: No]

Players will be complete a follow-up questionnaire about the activities performed outside of the training and exercise program.

Eligibility

Minimum Age: 15 Years

Maximum Age: 45 Years

Gender: Both

Accepts Healthy Volunteers?: No

Criteria: Study Population 36 wheelchair basketball players belonging to the male and female preselection Spanish wheelchair basketball national team were recruiting during a campus. The inclusion and exclusion criteria were chosen to include a specific population.

Inclusion Criteria:

- Players belonging to the male and female preselection Spanish wheelchair basketball national team.
- Have the federal license at the Spanish Sport Federation for People with Physical Disabilities available at the time of the study (2015-2016 season).
- For players using wheelchair for daily activities, to use the manual wheelchair at least for 3 hours a day and 6 hours of wheelchair basketball training per week.
- For players not using wheelchair for daily activities, to use the manual wheelchair at least for 6 hours of wheelchair basketball training per week.
- Use wheelchair at least one year before the study and at least one year of experience in the sport competition.
- Acceptance of informed consent.

Exclusion Criteria:

- History of acute injuries in the post-surgical process or dislocation along the year before the study. These conditions may affect the effective of the exercise intervention.
- Differential diagnosis as acute injuries at cervical region and recent traumatic injury in shoulder one year before the study. The exercise program may not be appropriate for these conditions.

Contacts/Locations

Central Contact: Saleky García Gómez, PhD student

Telephone: 604 24 65 63

Email: saleky@gmail.com

Central Contact Backup: Javier Pérez Tejero, PhD

Telephone: 913 36 41 40

Email: j.perez@upm.es

Study Officials: Javier Pérez Tejero, PhD

Study Director

Universidad Politécnica de Madrid

Locations: Spain

Universidad Politécnica de Madrid

[Recruiting]

Madrid, Madrid, Spain, 28040

Contact: Saleky García Gómez, PhD student 604 24 65 63 saleky@gmail.com

References

Citations:

Links:

Study Data/Documents:

U.S. National Library of Medicine | U.S. National Institutes of Health | U.S. Department of Health & Human Services