García-Gómez, S.; Pérez-Tejero, J.; González-Aguado, A.; Barakat, R. (2022) How to Prevent Shoulder Pain in Wheelchair Basketball? Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 22 (87) pp. 707-717
Http://cdeporte.rediris.es/revista/revista87/artcomo1383.htm
DOI: https://doi.org/10.15366/rimcafd2022.87.017

ORIGINAL

HOW TO PREVENT SHOULDER PAIN IN WHEELCHAIR BASKETBALL?

¿CÓMO PREVENIR EL DOLOR DE HOMBRO EN BALONCESTO EN SILLA DE RUEDAS?

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Acknowledgements

To all the players of the Spanish female wheelchair basketball team for their participation in the study, to the staff for their constant support and interest and to the Spanish Federation of Sports for People with Physical Disabilities.

UNESCO Code / UNESCO Code:3299 Sports medicine. Other medical specialties. 3213.11 Physiotherapy / Physiotherapy.
Council of Europe classification / Council of Europe classification: 11. Sports Medicine / Sport Medicine; 14. Physiotherapy and rehabilitation / Physiotherapy and rehabilitation; 17. Others: Physical Activity and Health / Others: Physical Activity and Health; Sports Training / Sports training.

Recibido 30 de abril de 2020 **Received** April 30, 2020
Aceptado 26 de junio de 2020 **Acepted** June 26, 2020

ABSTRACT

Shoulder injuries are a problem in wheelchair basketball (WB). The objective of this study was to determine the effectiveness of a 12 weeks exercise program for shoulder pain (SP) prevention in elite WB players throughout the preparatory process of an international competition. 13 WB players from the Spanish Women's Pre-Selection (age 26.6 ± 6.1 years) participated in the study. The SP

questionnaire was applied before and after the exercise program, as well as functional tests and range of motion (ROM) assessment. SP was reduced significantly after the intervention (Z = -2.93, p≤0.05, d = 0.67). However, there were no significant changes based on the data related to functional tests (p≥0.05) and ROM (p≥0.05). The exercise program used was effective in reducing SP during the sports preparation process, which positively influenced players´ sport performance.

KEYWORDS: shoulder, wheelchair basketball, exercises, prevention.

RESUMEN

Las lesiones del hombro suponen un problema en el baloncesto en silla de ruedas (BSR). El objetivo de este estudio fue determinar la eficacia de un programa de ejercicio para el dolor del hombro en jugadoras de máximo nivel de BSR para tras 12 semanas de intervención a lo largo del proceso preparatorio de una competición internacional. Participaron 13 jugadoras de BSR de la Pre-Selección Española Femenina (edad 26.6 ±6.1 años), respondiendo a un cuestionario de DH antes y después del programa de ejercicio, evaluando también el rango de movimiento (RM) y aplicando pruebas funcionales. El DH se redujo significativamente después de la intervención (Z=-2.93, p≤0.05, d=0.67), pero sin cambios significativos ni en las pruebas funcionales (p≥0.05) ni en el RM (p≥0.05). El programa de ejercicio resultó efectivo para la reducción del DH durante el proceso de preparación, lo que influyó de manera positiva en rendimiento deportivo de las jugadoras.

KEYWORDS: hombro, baloncesto en silla, ejercicios, prevención.

INTRODUCTION

The prevalence of shoulder pain (SP) is a well-studied topic in different sports settings (1). In this regard, shoulder injuries are a problem in adapted sports, specifically in wheelchair basketball (WB) (2-3), being SP the most frequent condition in this sport (4) as a consequence of rotator cuff tendinopathies and subacromial impingement. There are different aspects that can influence WB players´ performance such as game time and functional classification (5), as well as factors related to the biomechanics of the wheelchair sport skills (6-7). In this sense, and according to previous studies, SP is more common in females than males (3, 8), presenting more pain during sports activities related to WB, such as shooting (3). Opposite to this, Tsunoda et al. (9) suggest that men are more at risk of developing SP in this sport.

Different tools have been developed to assess SP in WB players (10-11), which are normally based on the evaluation of the SP. In addition, there are studies that usually include ROM assessments, as well as functional tests (8-12). Due to the biomechanics of WB performance, players need to receive interventions that include upper limb strengthening (13). A shoulder maintenance program focused on adductors, external rotators, and scapular retractors was shown to

be important in keeping the shoulder stable in wheelchair athletes (14-15). Furthermore, the exercise programs prescribed by qualified personnel require attention both to prevent sports injuries and to achieve high performance in this sport (16).

Some studies (17-19) reported the effectiveness of intervention strategies in order to prevent the appearance of shoulder injuries in wheelchair users, these include wheelchair athletes; however, they are not specifically focused on WB players.

Previous studies have focused on the evaluation and prevention of shoulder injuries in WB players (20-21), explaining the influence of an exercise program on shoulder functionality. Therefore, in line with these, the evaluations and preventive exercise programs for SP should be included in the care protocol in the sports settings (22-23) especially in WB. Both biomechanical evaluation and preventive programs development are usually well perceived by WB players (24), as they help to maintain performance and availability for high competition, and even the physiotherapeutic approach is shown to be a fundamental part of preventing injury and maintain WB players condition, due to the great burden generated by the execution of sports gestures typical of this Paralympic sport.

For all this, the objective of this study was to determine the efficacy of an exercise program for shoulder pain in top level WB female players along 12 weeks of intervention throughout the preparatory process of an international competition.

MATERIAL AND METHOD

Participants

The sample was composed by 13 WB players from the Spanish female's preselection national team with an age range between 18 and 37 years (26.62 ± 6.09). The following inclusion criteria were specified: a) being part of the WB women's pre-selection, also, being in possession of the federative license at the time of the study; b) the participants must have used the wheelchair at least one year before the study, c) to have at least one year of experience in sports competition, d) to practice of WB at least six hours per week and e) for the participants who used the wheelchair during activities of daily living (ADL), it was determined that they should use it at least three hours per day. For those players who used the wheelchair only for sports practice, an additional criterion of use of the wheelchair in WB practice of at least six hours per week was established. As an exclusion criterion, history of acute phase injuries, shoulder dislocation and/or differential diagnoses along one year before the study was established. All participants signed the informed consent. Since the program was carried out throughout the preparatory period for the 2019 WB European Women's Championships in Rotterdam (The Netherlands), the application of the program had the full support and supervision of the physical trainer and physiotherapist of the Spanish national female team. The program took place

from the end of May to the beginning of August, ending days before competition.

Design

A pre-post intervention design was used after 12 weeks of intervention. Measurements were made at baseline and after 12 weeks. An ad hoc questionnaire was used to assess what type of activities the players carried out during the study. Participants were instructed to carry out all the exercises and they had to contact the research team if any alteration could occur along programme implementation. The research design was supervised and approved by the Ethics Committee of the Universidad Politécnica de Madrid; at all times the recommendations of the Declaration of Helsinki were followed (25). This protocol is registered at Clinical Trial.gov (NC T02842008).

Instruments

In this study, the Shoulder Pain Questionnaire in Wheelchair Basketball Players (CDH-BSR) (10) was used, consisting of three main information parts: a) demographic data, identifying relevant factors related to lifestyle and shoulder dysfunction, six items related to years of experience in practice of WB, SP time, pain location, numbness or cramps at shoulder level and pain in general; b) SP in the performance of ADL (15 items), distinguishing between wheelchair users (five specific items) and all other participants (10 items); and c) four items related with SP perception when performing specific BSR skills such as throwing, propelling the wheelchair, bouncing or making a long pass with one hand. Goniometric measurements were used to assess shoulder joint mobility (flexion, extension, abduction, adduction, external and internal rotation) (26). In addition, Neer, Hawkins-Kennedy and Jobe functional tests were used in order to detect possible musculoskeletal pathologies (27-28).

Intervention

First, general information about the study and informed consent was provided to the participants. Subsequently, pain was evaluated using the SP-WB questionnaire (10), before and after 12 weeks of exercise program intervention.

Shoulder exercise program to prevent shoulder injuries in BSR players

This program was designed to be performed at home, executing different shoulder exercises to prevent injuries by WB players. The structure and content validity of this program have been previously demonstrated (21). The content of the program includes three fundamental parts (Figure 1) (21):

- Exercises focused on the mobilization of both shoulders in the different sagittal, coronal and transverse planes.

- Strengthening exercises focused on the serratus anterior muscles, and those that perform retraction and depression of the scapula, rotation and adduction of the shoulder.

- Stretching exercises performed for the upper, medial and lower trapezius muscle, posterior shoulder, pectoral and biceps.

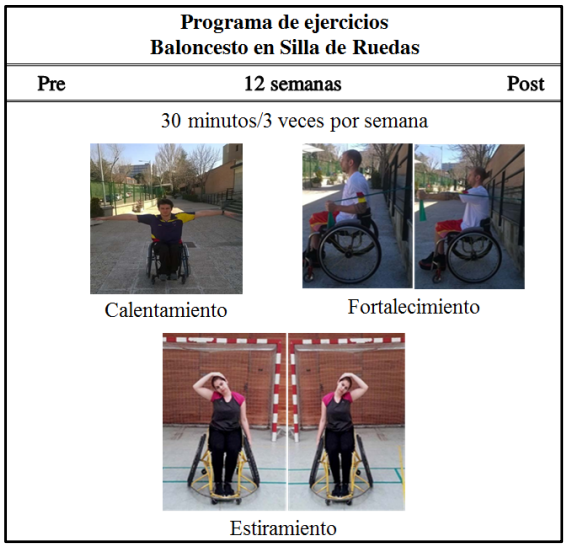

Figure 1. Exercise Program for SP prevention in Wheelchair Basketball Players [21]

Statistical analysis

Data normality was first verified by exploring skewness and kurtosis z-values, histograms, qq plots, box plots, and the results of the Shapiro-Wilks test. For continuous variables, the mean and standard deviation (SD) were checked, and for categorical variables, frequency and percentage were determined. The data were assessed as not normally distributed, so non-parametric tests (such as the Wilcoxon test) were used to check if there were significant differences between the pre-post assessments for SP, clinical tests and goniometric measurements. In addition, Spearman's rank correlation test was applied in order to study the relationship between SP, functional tests and goniometric measurements. Effect size (29-30) was assessed: values 0.1, 0.3 and 0.5 for small, medium and large, respectively (31). Finally, significance level of $p \leq 0.05$ was determined and the SPSS 22.0 statistical package was used.

RESULTS

At the beginning of the program, 53.8% of the players used the wheelchair for the ADL, while 46.2% used the chair only for sports practice. Table 1 shows the general characteristics of the participants.

Table 1. Characteristics of the participants.

Use of wheelchair	Age	Hours of training	Years of injury	Years use of wheelchair	Years federated sport	Years sport recreational
Daily	25.1 ±7.3	10.4 ±4.3	19.1 ±9.7	15 ±7.6	15.3 ±10.6	11.3 ±8.3
Only sport	28.3 ±4.3	8.7 ±5.3	14.2 ±10.3	0	6.8 ±5.2	5.17 ±4.5

Of the sample studied, 53.2% presented SP at the time of application prior to exercise program implementation. However, SP decreased significantly after the 12-week intervention according to the total questionnaire score (SP-WB, Z = -2.93, p = 0.03, d = 0.67). In this sense, when performing the analysis by items related to transfers (Z = -2.20, p = 0.028, d = 0.26), ADL (Z = -2.31, p = 0.021, d = 0.30) and WB practice (Z = -2.23, p = 0.026, d = 0.52), a significant decrease in SP was found after program application (Table 2).

On the other hand, there were no significant changes based on the data related to functional tests (p ≥0.05) and goniometric measurements (p≥0.05) (Table 2). However, there was an inverse correlation between pain and shoulder adduction (r = 0.59, p≤0.05, d = 0.59): the higher SP, the lower ROM. Likewise, based on clinical tests, there was an inverse correlation between the Neer test and shoulder adduction (r = 0.60, p≤0.05, d = 0.60).

Table 2. SP, ROM and functional tests before and after 12 weeks intervention

Measurements	Pre	Post	P	Effect size
SP-WB	31.69 ± 32.75	59.62 ± 49.29	**0.03** *	0.67
Transfers	3.92 ± 8.13	6.38 ± 10.17	**0.03** *	0.26
ADL	17.38 ± 18.83	23.54 ± 21.85	**0.02** *	0.30
Sports gestures	10.38 ± 9.37	16.08 ± 12.35	**0.03** *	0.52
ROM				
Flexion	152.46 ± 47.20	131.16 ± 81.91	0.69	0.34
Extension	49.08 ± 17.27	54.46 ± 45.38	0.94	0.16
Abduction	153.08 ± 47.47	130.43 ± 81.54	0.70	0.34
Adduction	39.04 ± 14.05	36.23 ± 22.10	0.88	0.16
Internal rotation	58.42 ± 27.06	44.90 ± 29.51	0.22	0.48
External rotation	85.62 ± 35.20	66.80 ± 41.99	0.71	0.63
Functional testing				
Positive	9 (69.2)	12 (92.3)	0.18	0.53
Negative	4 (30.8)	1 (7.7)		

* Values in bold were significant at p≤0.05.

DISCUSSION

This study aimed to determine the efficacy of an exercise program in female WB players to prevent injury at the shoulder level and reduce SP after 12 weeks of intervention in the preparatory process of a top-level international competition. To the authors' knowledge, there is no study evaluating this objective in female WB players teams in a competition of that level. Performing shoulder strengthening exercises has been shown to be effective in improving shoulder functionality and reducing pain in WB players (18, 20). In this research, according to the results obtained, there was a significant reduction in SP after a 12 weeks exercise program, so program effectiveness was evident following protocols that are considered effective for the maintenance, treatment and prevention of shoulder injuries (21). Similar results were observed in previous studies (14, 17) in wheelchair users.

The information obtained can be very useful for physiotherapists and trainers in order to develop specific shoulder training programs, since it shows the feasibility of this type of program in the context of preparing high-level competitions, and also its effectiveness in preventing injury and maintaining shoulder condition.

Regarding the effect of home-based intervention programs focused on the reduction of SP in WB players, scientific evidence is scarce; however, they serve as a basis for generating strategies that promote shoulder health in this population. In contrast to previous studies, it is explained that the characteristics of the program must be based on the stability and strengthening of the posterior shoulder muscles. In this regard, Van Straaten, Cloud, Zhao, Fortune, y Morrow (18) justify the need to include exercises to strengthen the rotator muscles, work the retraction and depression of the scapula, the muscular balance in the shoulder girdle for effective wheelchair propulsion, as well as stretching the shoulder muscles after sports activity.

In relation to the functional tests and goniometric measurements, prior to the intervention, an inverse correlation was evident between pain and shoulder adduction ($r = 0.59$, $p \leq 0.05$, $d = 0.59$), that is, the higher the SP, the less joint mobility. (8); This could affect ADLs and sports performance, revealing the need to carry out preventive programs. Likewise, in relation to functional tests, there was an inverse correlation between the Neer test and shoulder adduction ($r = 0.60$, $p \leq 0.05$, $d = 0.60$), which explains the possibility of evolving in subacromial impingement. However, after 12 weeks of intervention, there was a decrease in the positive cases in the functional tests. Regarding the ROM, there was no significant changes; although mobility remains within the functional range. Joint mobility is an important role in WB sporting gestures such as wheelchair propulsion and shooting (12).

The intervention proposed in this study has a structure consisting of a warm-up, strengthening and stretching phase similar to the study carried out by Mulroy et al (14). Other investigations focus on high-intensity training protocols (19), strength and isometric exercises (18) also achieved improvements in functionality and SP decreasing.

A methodological limitation of this study was the sample size. However, this fact responds to the relevance of carrying out an intervention program in a group with high sports standards: all participants were elite female WB players participating in the process of preparing for the WB European Championship 2019, a sports event where this group of players reached their best historical performance: fourth place and classification for the Tokyo Paralympic Games. On the other hand, the absence of a control group could be considered a limitation. While it may affect results robustness in terms of the intervention, this does not affect the utility and feasibility of the program used as a tool for maintaining shoulder health. Another possible limitation was the impossibility of performing imaging studies at shoulder level to confirm functional tests (although, players were recommended to perform a confirmatory medical evaluation). We consider that this study lays the foundations for effective practice in relation to the health of this group in a process as delicate as competitive preparation, as well as the basis for generating future research in this line focused on updating and improving the protocol. It is important to highlight that, as well as other studies in this area (33), the approach focuses on health maintenance of WB players.

Overall, this study is summarized in two main findings. First, it indicates that a home-based exercise program to reduce pain by maintaining the shoulder condition three times a week, followed by a physical therapist, had positive effects on elite female WB players. Secondly, these results reinforce the importance of interdisciplinary work in health and sport in a pre-competitive context.

CONCLUSIONS

An exercise program for injury prevention and maintenance of shoulder condition (based on performing mobility, muscle strengthening and stretching exercises and implemented for 12 weeks) was effective in significantly reducing SP during sport practice and daily activities in a sample of female WB players in their preparation for a first class international competition, guaranteeing shoulder health and increasing functionality. These results showed the importance of interdisciplinary work in health and sport in WB pre-competitive contexts.

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