

Proceeding Paper

Risk Factor Prevalence in Handball Athletes with and without Overuse Injury History [†]

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Abstract: Handball is a demanding sport with risk of overuse injuries. We aimed to compare scapular motion, the external/internal rotator strength ratio, and shoulder rotator range of motion of handball athletes with and without a history of overuse injury. Cross-sectional data were collected from male handball athletes. The results showed no differences between groups, except for dyskinesia in final assessment position and external rotation range of motion. Scapular dyskinesia prevalence was high in both groups. These findings emphasize the importance of identifying and addressing these risk factors in injury prevention and rehabilitation programs for handball athletes.

Keywords: handball; overhead; shoulder; overuse injury; risk factors; prevention



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1. Introduction

Handball is a team sport characterized by a high playing time, rapid changes in direction, abrupt landings from jumps, repetitive throwing, and frequent contact and collisions between players, making it a demanding sport with a high risk of injuries [1]. Indirect or non-contact injuries are among the most common types of injuries in handball [2]. Overuse injuries arise from multiple cumulative energy transfers resulting in physical complaints, leading to a reduction in training volume, pain, and decreased performance in training and competitions [3]. In this sport, there are various stress movements and positions that the shoulder joint is subjected to, especially during the throwing motion. Therefore, a weakness or imbalance that alters any of the components of the kinetic chain may lead to a dysfunctional shoulder or may put the individual at a high risk of upper limb injuries [4,5]. Since most injuries in this sport are caused by repetitive overuse of structures in a specific motion, deficits in a joint's range of motion (ROM), the ratio of external/internal (ER/IR) rotator strength of the shoulder, and scapular dyskinesia were identified as modifiable intrinsic risk factors, as their effect can be altered through targeted injury prevention programs [6].

The aim of this study is to compare the prevalence of risk factors such as scapular dyskinesia, the shoulder ER/IR strength ratio, rotation range of motion, and associated factors in handball athletes with and without a history of overuse injury.

2. Materials and Methods

2.1. Study Design

This was a cross-sectional study. We used Kforce-Link[®] pull dynamometer (Kinvent, Montpellier, France) to assess the ER/IR rotator force; a digital inclinometer, through the Clinometer[®] smartphone application (Plaincode, Stephanskirchen, Germany), to evaluate

shoulder ROM; and a measuring tape to assess scapular displacement through the lateral scapular slide test (LSST).

2.2. Participants

Handball clubs from Lisbon and Setúbal districts in the second division were contacted to obtain their permission to develop this study. Volunteer players from the integrating clubs participated in the study if they were registered male handball athletes in senior and under 20 teams, and athletes with a history of a dominant shoulder overuse injury in the last 12 months were allocated to the injury group. The exclusion criteria were underage, any cognitive impairments, orthopedic shoulder surgery in the last 12 months, and traumatic shoulder injury in the last 3 months.

2.3. Procedures

Assessments were made for both sides. For ROM measurement, a digital inclinometer through clinometer app was used. It was positioned parallel to the midline of the anterior region of the forearm. Passive IR and ER measurements were taken in the supine position with the dominant shoulder at 90° abduction and the elbow flexed at 90°. For strength measurements of the shoulder, three maximum voluntary isometric contractions of 5 s with 30 s pauses between repetitions were performed. For measurement of scapular displacement, a tape measure was used, measuring between the inferior angle of the scapula and D7 in neutral position, 45 and 90 degrees of shoulder abduction, according to the lateral scapular slide test.

2.4. Statistics

If normal distribution was verified, a parametric independent *t*-test was performed to compare the groups; otherwise, a Mann–Whitney U test was used. To investigate the relative contribution of the characterization variables to the neuromuscular profile of the athletes, a binary logistic regression model for each dependent variable was used.

3. Results

A total of 59 participants participated in the study. The healthy group had 39 athletes with an age of 22.8 ± 5.3 years and a body mass index (BMI) of 26.9 ± 4.5 kg/m². The unhealthy group had 20 athletes with an age of 24.0 ± 7.0 years and a BMI of 25.1 ± 3.7 kg/m². There were no differences between groups in a variable measurement mean comparison except for dyskinesia at 90° shoulder abduction and 45° horizontal abduction, with maximal IR ($p = 0.045$) and in external rotation ROM ($p = 0.035$). The prevalence of risk factors for each group is detailed in Table 1.

Table 1. Prevalence of risk factors by group.

	Healthy Group (n = 39)		Injury Group (n = 20)		<i>p</i>
	Risk n (%)	No Risk n (%)	Risk n (%)	No Risk n (%)	
Internal Rotation	11 (28.2%)	28 (71.8%)	7 (35%)	13 (65%)	0.402
External Rotation	17 (43.6%)	22 (56.4%)	3 (15%)	17 (85%)	0.026 *
TROM	11 (28.2%)	28 (71.8%)	4 (20%)	16 (80%)	0.233
Ratio ER/IR	10 (25.6%)	29 (74.4%)	5 (25%)	15 (75%)	0.609
Scapular Dyskinesia	19 (48.7%)	20 (51.3%)	10 (50%)	10 (50%)	0.572

Abbreviations: ER = external rotators; IR = internal rotators; TROM = total range of motion. *p*-value with chi-square for comparison of occurrences between groups; * *p*-value < 0.05.

4. Discussion

Handball is a throwing sport that places a high demand on the shoulder joint, making it prone to injuries. Recent studies have confirmed that between 17% and 44% of all overuse injuries in handball are in the shoulder [2,7]. Identification of changes in ROM, strength of rotational movements, and scapular position can be used to identify athletes at risk of

injury. Therefore, we compared the neuromuscular profile characteristics of athletes with and without a history of injury to identify the prevalence of identified risk factors in each group and investigated their association with sociodemographic characteristics.

4.1. Range of Motion

There were no differences between the groups regarding internal rotation (IR) range of motion. However, we found that an additional hour of training reduces the probability of having an IR deficit of more than 10° by 37.2%. Functional adaptations in handball result in a shift in the total available ROM, with a reduction in IR and an increase in ER that could be up to 16° , with increased anterior capsular laxity and excessive glenohumeral translation during ER [8,9]. Our results are consistent with this, as we observed significant differences between groups, with an average increase of $14.65 \pm 10.5^\circ$ in athletes with injury and $7.72 \pm 14.9^\circ$ in healthy athletes. These changes may contribute to the selective atrophy of the infraspinatus muscle, caused by a functional denervation of the suprascapular nerve. A gain in ER ROM of less than 5° has also been identified as a risk factor, as it could indicate a tendency for retraction of IR [10], and our results showed a significantly higher rate of this within the healthy group. These functional alterations may underlie shoulder overuse injuries and are a possible causative factor in the short to medium term, making their prevention extremely important.

A reduced total ROM could increase the probability of experiencing substantial shoulder problems throughout the season [10]. Nonetheless, we observed low rates of athletes presenting a reduced total ROM when compared to the non-dominant side in both groups. Reductions in IR and increases in ER present in the dominant shoulders of uninjured overhead athletes are regarded as normal soft tissue adaptations to repeated throwing [10], and the changes we found are in accordance with that.

4.2. Strength Ratio ER/IR

Although no significant differences in shoulder rotator strength were observed between the groups, the injury group had an ER/IR strength ratio significantly lower than 1. This may be due to the rehabilitation process performed to return to sports, which tends to correct the tendency to a ratio greater than 1 [11]. These findings contradict our hypothesis that athletes with a greater IR strength will be found among the healthy group. Scapular stability is crucial for normal shoulder function, especially in a handball athlete [11]. Our results showed that each additional year of training decreases the risk of a stronger ER than IR by 14.5%, and each added unit within the healthy body mass index (BMI) range decreases the risk of having a strength ratio imbalance in favor of ER by 23.8%.

4.3. Scapular Dyskinesis

The presence of significant scapular movement differences in athletes with injuries may be one of the causes of their injury history, as a combination of reduced scapular adduction/retraction capacity with excessive ER can contribute to an increased risk of anterior glenohumeral instability, which may be the underlying cause of the previously manifested overuse injuries [9]. Despite the fact that we found similar scapular dyskinesia occurrence rates between groups, the injury group had greater scapular displacement on the dominant side compared to healthy athletes in the final evaluation position. Current evidence indicates that most scapular problems in throwing athletes can be attributed to a loss of control of the normal resting scapular position and dynamic scapular movement, resulting in scapular protraction that can result in increased loads, altered movements, and reduced muscle activations that may be associated with decreased performance and increased injury risk [12]; our results are in line with this knowledge.

4.4. Limitations

We assessed the ROM with participants in supine with the shoulder at 90° abduction and the elbow at 90° flexion to replicate a shooting position, but this could promote mea-

surement errors through compensations. The cross-sectional design of our study prevented the determination of our findings as causes or consequences of overuse injuries. A longitudinal setting and improved strategies to control measurement errors are recommended for future studies.

5. Conclusions

Analyzing the rotation ROM, scapular displacement, and ER/IR strength ratio in handball athletes with and without a history of injury should be standard practice for the development of injury prevention programs and targeted rehabilitation for athletes with shoulder overuse injuries, since both groups present high rates of identified risk factors.

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