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Review

Shoulder injury in water polo: A systematic review of incidence and intrinsic risk factors

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ABSTRACT

Objectives: Water polo is a popular water-based contact sport that involves swimming, throwing and defending. Cumulatively, these repetitive overhead activities are thought to increase the risk of shoulder injury and, subsequently to affect players' physical conditioning as well as team performance. The purpose of this review was to examine available evidence relating to shoulder injury rates and risk factors for shoulder injury in water polo.

Design: Systematic review

Methods: CINAHL, AUSPORT, Pubmed, Pedro and SPORTDiscus databases were searched for original research papers using the predefined terms ("water polo") AND (shoulder OR glenohumeral* OR arm OR "upper limb").

Results: Twenty papers were identified as suitable for inclusion. Reported shoulder injury rates varied from 24% – 51%. Shoulder injuries were more likely to become chronic compared to all other reported injuries. Injury data during the last three World Championships indicates an increasing rate of shoulder injuries-per-year with participation in aquatic sports. Risk for shoulder injury in water polo is multi-factorial. Volume of shooting, range of motion, scapular dyskinesis, strength imbalance, proprioceptive deficit and altered throwing kinematics have been proposed to be associated with an increased risk of injury.

Conclusions: Although this review showed water polo to have a high propensity for shoulder injury, the descriptive nature of the included papers limited the inferences that could be drawn from the pooled literature. Future directions for research include collecting normative data for shoulder range of motion, strength ratio and proprioception with prospective analysis of these attributes in relation to injury rates and time lost.

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1. Introduction

Water polo originated in the mid-19th century in England and Scotland as an aquatic form of rugby.¹ Men's water polo was introduced at the modern Olympics in 1900 making the sport of water polo the first Olympic team competition.² Presently, the International Swimming Federation (FINA) is the international governing body for the sport.³

Water polo is a physically demanding sport, particularly on athletes' upper limbs, with intense bursts of sprint swimming,

changing direction every 6.2 s,⁴ and passing and shooting the ball repetitively from end-of-range shoulder abduction (Abd) and external rotation (ER) at arm speeds of up to $24.1 \pm 1.58 \text{ ms}^{-1}$.⁵

Risk factors identified for shoulder pain in swimmers are often extrapolated to water polo, despite the unique demands. Unlike competitive swimmers, water polo players use an adapted upright swimming posture to allow transport of the ball and a clear view of the opposition. The elevated posture eliminates the body roll observed in traditional freestyle swimming, increasing the required shoulder Abd and internal rotation (IR) and placing stress on the rotator cuff.⁶ Also in contrast to swimming, water polo is a contact sport. In defensive play, athletes keep their arms above their head to physically obstruct the opposition and block opposing players' throws, placing external force on the shoulder joint.^{7,8}

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Fig. 1. The water polo shot. Image provided with permission by Queensland Academy of Sport Water Polo program.

The aquatic environment means that water polo players generate throwing force without the contribution of a solid base of support, making it difficult to produce the conventional throwing proximal-distal kinematic chain sequence.^{6,9} When throwing in water polo, power is produced by the trunk rotating forward from hyperextension to 20° flexion to maximise shoulder ER by leaving the arm and ball behind the body (Fig. 1).⁹ The arm then moves in an arc, shifting the body towards the horizontal plane as the trunk simultaneously laterally flexes away from the throwing arm, increasing the height and velocity for ball release.^{9,10}

Despite the lower average ball velocity observed in water polo (16.5 ms⁻¹) compared to baseball (33 ms⁻¹) and American football (23 ms⁻¹), resultant joint torques is similar.¹¹ Horizontal adduction and IR torque in the penalty shot is 64/59Nm compared to 100/67 Nm and 78/66Nm for baseball and American football respectively.^{10,12,13} The observed force can be explained by the larger size and weight of the water polo ball (400–450 g) compared to baseball, and the reduced contribution of the lower extremity to the kinetic chain.^{10,14,15}

The aim of this paper was to review the available literature regarding shoulder injury rates and risk factors for shoulder injury in water polo. It has been previously suggested that shoulder injury rates are as high as 80% in elite water polo,^{1,6,16} however due to limited research results are often extrapolated from other overhead sports. Evaluation of the incidence of shoulder injury and the relationship between intrinsic risk factors and shoulder injury may help identify “at risk” athletes and enable targeted injury prevention strategies. Further, this review serves to identify current gaps in water polo research regarding shoulder injury rates, normative data and risk factors associated with shoulder injury.

2. Methods

CINAHL, AUSPORT, Pubmed, Pedro and SPORTDiscus databases were searched using the key terms (“water polo”) AND (shoulder OR glenohumeral* OR arm OR “upper limb”). No date limits were applied and the search was completed in August 2016. Two reviewers conducted the selection process and independently evaluated the characteristics and key outcomes of the study. Studies were included if they were in English and original research, and could be anthropometrical, descriptive, epidemiological or interventional. No restriction was placed on player’s age or competition level. Studies were excluded if multiple overhead sports were aggregated in the analysis or if non-conservative/surgical interventions were applied. The sequence of paper selection is presented in Fig. 2.

Articles were divided by the main themes of injury incidence, pain, strength, ROM, proprioception, pathoanatomy and posture. The quality of the final study yield was analysed using a modified version of the Critical Review Form for Quantitative Studies.¹⁷

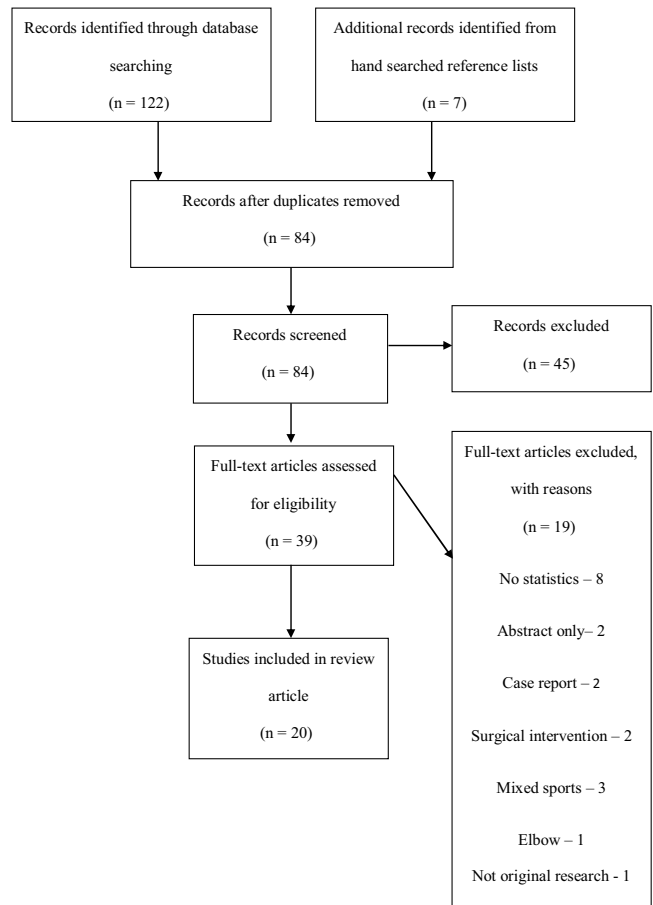


Fig. 2. PRISMA flow diagram. n = number.

To enable a numerical result each criterion was evaluated using a dichotomous ‘yes’ = 1, no or not applicable = 0 for a total achievable score of 12, with a score of greater than 50% required for inclusion. Final study ratings were collated and inter-rater difference discussed in a consensus meeting. The quality score and outcome summary is reported in Table 1.

3. Results

The review process returned 20 papers. Six papers considered epidemiology of shoulder pain and injury and the remaining 14 investigated intrinsic risk factors of shoulder injury in water polo players. Injury incidence was defined as the number of new injuries in a specified time period,¹⁸ and injury rate as the number of injuries divided by athlete-time-exposure.¹⁹

Shoulder injury incidence at major championships. Three studies evaluated shoulder injury incidence at major international championships.^{7,8,20} A cohort study of male water polo players competing at the 2004 Summer Olympics reported that 53% of injuries affected the head/neck, 12% the trunk and 6% the shoulder.⁷ Retrospective analysis of the 2009 FINA World Championships revealed that upper-limb injury was highest in water polo compared to other aquatic sports, with 37% of the total injuries (n = 48) being reported by water polo athletes, of which 19% affected the head/neck region and 12.5% affected the shoulder.²⁰ Analysis of injury incidence prior to and during the 2013 FINA World Championships demonstrated that water polo had the highest injury rate compared to all other aquatic sports (15.3 injuries/100-athletes) followed by open water swimming (11.7) and diving (11.4).⁸ Of injuries to the head and neck across all sports, water polo was

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