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Prevalence of shoulder pain in Swedish flatwater kayakers and its relation to range of motion and scapula stability of the shoulder joint

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ABSTRACT
Few studies have investigated the incidence of injuries in kayakers. The aim was to study the prevalence of shoulder pain in competitive flatwater kayakers and to evaluate any differences in range of motion or scapula stability of the shoulder joint among kayakers with or without the history of shoulder pain. Thirty-one kayakers were participated in the study, and a questionnaire including background data was used. Shoulder range of motion was measured with a goniometer, and the participants were observed for scapula dyskinesis in flexion and abduction. Of the participating kayakers, 54.8% (n = 17) had experienced shoulder pain. Kayakers who had experienced shoulder pain showed a significantly lower degree of internal rotational range of motion versus kayakers with no reported shoulder pain, with a mean degree of internal rotation in the right shoulder 49.3 vs 60.0 (P = 0.017) and the left shoulder 51.9 vs 66.0 (P = 0.000). Kayakers who had experienced shoulder pain were also observed with a scapular dyskinesis (n = 15 of 17 kayakers) to a significantly higher degree (P = 0.001) than kayakers with no reported shoulder pain. Findings suggest that screening for scapular dyskinesis and testing for rotational range of motion in the shoulder joint is essential in order to treat and maybe prevent shoulder pain in kayakers.

ARTICLE HISTORY
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KEYWORDS
Glenohumeral joint; paddling; pain; scapula dyskinesis; sport

Introduction

Few studies have investigated the incidence of injuries in kayakers. Fiore and Houston (2001) performed a retrospective study on injuries in whitewater kayakers and found that 61% of the reported injuries were located in the upper extremity and 50% of these injuries were located in the shoulder. Hagemann, Rijke, and Mars (2004) performed a survey to determine the prevalence of bony abnormalities and soft tissue abnormalities in the shoulders of 52 marathon kayakers and examined their correlation with findings in clinical testing. At the time of the investigation, 30 of the kayakers were asymptomatic, 13 had shoulder pain, 5 had pain and instability of the shoulder and 4 had only instability of the shoulder. Of the 30 asymptomatic kayakers, 7 had previously experienced shoulder pain. MRI showed acromioclavicular hypertrophy, acromial or clavicular spurs, supraspinatus tendonitis and supraspinatus partial tears as the most common findings. Acromial and clavicular spurs correlated to supraspinatus abnormalities but most symptoms were found to be due to secondary impingement and overuse and did not relate to bony restrictions in the shoulder (Hagemann et al., 2004).

Muscle pattern activity around the shoulder in the kayak stroke was studied by Trevithick, Ginn, Halaki, and Balnave (2007) who found an increasing to high activity in the supraspinatus, latissimus dorsi and upper trapezius muscle in the pull phase (Figures 2–3). During the pull phase of the stroke, the abducted shoulder joint extends and internally rotates against the resistance of the paddle, the scapula retracts and rotates downwardly. The upper trapezius higher activity can be seen as the role of the trapezius as a stabiliser of the scapula acting against the downward rotation that the rhomboids generate during the pull phase, and the increased activity of the supraspinatus might be caused by its stabilising role for the humeral head (Trevithick et al., 2007). During the exit phase (Figure 4), Trevithick et al. (2007) found decreasing activity in the latissimus dorsi, rhomboid major and serratus anterior muscles. During this phase, the paddle is taken out of the water as the scapula upwardly rotates simultaneously with a glenohumeral abduction movement. The serratus anterior showed decrease in muscle activity during this phase, even though it is an upward rotator of the scapula, and in both pull and recovery phases, the serratus anterior showed a consistently moderate to high activation. Trevithick et al. (2007) offers an explanation for this as the serratus anterior having a big role as a stabiliser of the scapula to the chest wall might have to activate harder in the pull phase and thereby reduces the activity during the less strenuous part of the exit phase. During the recovery phase, while the paddle blade of the same side is in the air, Trevithick et al. (2007) found an initial decrease in activity in both the supraspinatus and upper trapezius. A small increase in activity in the mid recovery phase occurs when the other paddle blade is immersed into the water, and the pull phase of that contralateral side is about to begin (Figure 1). The recovery arm is active in the

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Figure 1. Catch phase: Kayaker reaches forward with extended elbow and flexed shoulder to immerse the paddle blade as far toward the front of the kayak as possible. Kayaker's torso is rotated to the left, and right knee is bent to prepare for the pull phase.

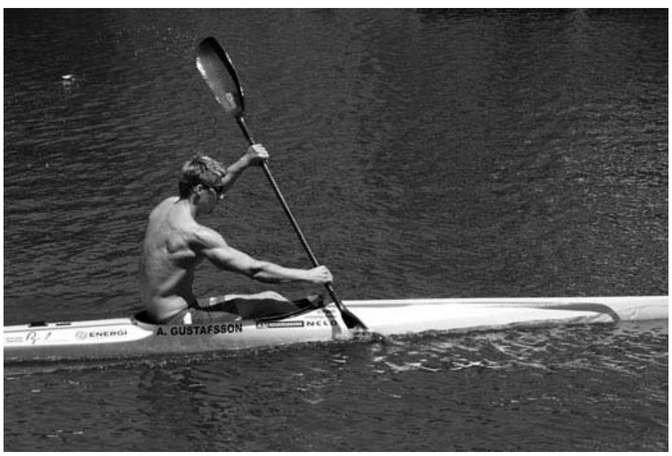

Figure 2. Pull phase begins: Kayaker pushes with right foot, and pulls with right arm and shoulder and rotates through core to the right. Left arm in recovery phase/pushes forward.

Figure 3. Pull phase continues: paddle glides outwards, right shoulder abducts and internally rotates, right leg extends and torso rotates to the right. Left shoulder in internal rotation, flexion and adduction.

Figure 4. Exit phase: paddle is lifted up from the water, right elbow bends, shoulder abducts and externally rotates. Short rest/glide phase; before left side paddle blade is immersed in the water to start left side stroke. Right side recovery phase/air phase starts.

quick immersion of the paddle blade, which Trevithick et al. (2007) believe can explain the sudden increase in activity in these muscles.

Humeral and scapular positions during the forward stroke have been studied in whitewater kayakers (Wassinger et al., 2011) on a kayak ergometer. During the pull phase when the paddle was in vertical position (Figure 3), the humerus on the pushing side was found to be at its peak elevation and peak internal rotation while adducted close to the sagittal plane. This minimises the subacromial space, at the same time as the scapula is in its greatest mean upward rotation, elevation and posterior tilt, which acts to maximise the subacromial space (Wassinger et al., 2011). If the scapula upward rotation and posterior tilt are decreased, this position could predispose for impingement of the subacromial structures (Hagemann et al., 2004; Kibler & Sciascia, 2010; Lukasiewicz, McClure, Michener, Pratt, & Sennett, 1999). In the exit phase of the stroke (Figure 4), the humerus has a low angle of elevation, is near the frontal plane, horizontally abducted with maximal scapular external rotation and posterior tilt. The exit of the paddle starts through abduction and external rotation in the shoulder joint (Wassinger et al., 2011). These positions can predispose for increased risk of internal impingement in the shoulder joint, if conditions that limit the scapular motion and/or posterior shoulder tightness are present (Castagna et al., 2010). A sitting posture with a slouched position in the upper back can decrease the flexion range of motion compared to erect posture (Bullock, Foster, & Wright, 2005). This might predispose for a more anteriorly tilted scapula position, with decreased posterior tilt of the scapula in arm elevation, which has been linked to shoulder impingement (Lukasiewicz et al., 1999). The relationship between scapular and humeral kinematics during elevation has been studied extensively in patients with shoulder pain, and in comparison to healthy participants with no shoulder pain (Kibler et al., 2013; Lukasiewicz et al., 1999; Park et al., 2013; Sahrmann, 2001). Several shoulder pathologies such as impingement, rotator cuff pathologies and labral tears have demonstrated altered scapular kinematics patterns (Kibler et al., 2013; Struyf, Nijs, Baeyens, Mottram, & Meeusen, 2011; Worsley et al., 2013). Changes in scapular kinematics can be attributed to altered muscle recruitment patterns or muscle function, pain or pathologies, but the flexibility deficits in the soft tissues surrounding the scapula may also restrict normal humeroscapular motion in sport-specific movements (Cools et al., 2014; Kibler & Sciascia, 2010; Kibler et al., 2013). Scapular dyskinesis has been associated with shoulder pain in athletes in the earlier studies (Kawasaki, Yamakawa, Kaketa, Kobayashi, & Kaneko, 2012; Kibler et al., 2013; Lukasiewicz et al., 1999; Struyf et al., 2011), but until now there have been no studies on scapular dyskinesis in kayakers.

A decreased range of rotational motion in the shoulder joint, especially decreased internal rotation has been correlated to shoulder injuries in other athletes (Maenhout, Van Eessel, Van Dyck, Vanraes, & Cools, 2012; Myklebust, Hasslan, Bahr, & Steffen, 2013; Tyler, Nicholas, Lee, Mullaney, & McHugh, 2010; Wilk et al., 2011). A posterior tightness of the shoulder muscles and capsule with limited internal rotation could also predispose for an internal impingement where the more dorsal part of the rotator cuff gets impinged against the superior-dorsal part of the labrum, (Castagna et al., 2010; Kibler et al., 2013; Tyler et al., 2010).

McKean and Burkett (2010) tested upper body strength and joint range of motion for shoulders and hips in flatwater kayakers and investigated the relationship of strength and joint range of motion to performance on the water. The kayakers in McKean and Burkett´s (2010) study showed a decreased range of motion in internal and external rotation of the shoulder, when compared to the earlier findings of shoulder joint range of motion in strength training individuals and bodybuilders. McKean and Burkett (2010) concluded that it might be the kayak training and not the strength training that decreases the shoulder joint range of motion in kayakers. No strong correlations were found between joint range of motion, strength test results and on water performance (McKean & Burkett, 2010).

There are few studies on kayakers and shoulder problems in relation to the reported incidence of shoulder pain/injuries in kayakers (Fiore & Houston, 2001; Hagemann et al., 2004). Few studies have looked at the shoulder biomechanics and injury risks in kayaking (Trevithick et al., 2007; Wassinger et al., 2011). The relationship between scapular dyskinesis with decreased range of motion and risk of injury at the shoulder joint found in other athletes (Maenhout et al., 2012; Merolla et al., 2010; Wilk et al., 2011) has not been studied in kayakers. More research is needed on kayakers with shoulder problems in order to implement preventive measurements and treatment.

Therefore, the purpose of this study was to evaluate the prevalence of shoulder pain in Swedish flatwater kayakers and to investigate any differences in joint range of motion or findings of scapula dyskinesis between kayakers who had experienced shoulder pain and kayakers with no reported shoulder pain.

Methods

Participants

Thirty-one competitive flatwater kayakers from five different canoe clubs, 11 females and 20 males had agreed to participate in the study (Table 1). The only exclusion criteria were earlier shoulder surgery. None of the volunteered kayakers had undergone surgery. Participation was voluntary, and the tests and questionnaires were administered in agreement with the clubs and kayakers at one of the clubs training events. All participants were informed about the study and they gave their written informed consent to participate. Ethical approval was obtained from the Ethical Advisory Board in South East Sweden (Dnr EPK 194-2013), and the study was conducted in accordance with the Declaration of Helsinki for human studies.

Table 1. Characteristics of the kayakers, (n = 31) data presented as mean and standard deviation (SD).

	Female n = 11 Mean (SD)	Male n = 20 Mean (SD)
Age (years)	16.6 (1.4)	18.2 (3.0)
Length (cm)	169 (6.8)	185.8 (10.9)
Weight (kg)	61 (5.8)	80.5 (11.2)
Paddling training hours/week	6.8 (2.8)	8.2 (3.5)
Other training hours/week	3.2 (1.6)	4.0 (1.4)
Years paddling	6.0 (4.3)	6.7 (3.6)

Questionnaire

A modified version of a shoulder questionnaire by Fahlström, Yeap, Alfredson, and Söderman (2006) that was originally used on badminton players (Fahlström & Söderman, 2007; Fahlström et al., 2006) and later modified and used on handball players (Myklebust et al., 2013) was used for background information on the participating kayakers. The questionnaire by Fahlström et al. (2006) was modified to apply to kayakers.

Age, gender, years of paddling, weekly training hours, incidence and duration of shoulder pain and its effect on training and competition were investigated in the questionnaire.

Since the investigations took place after the end of the competitive season, two questions needed to be clarified. The questions were related to weekly hours spent kayaking and other training and were confirmed to apply to the competitive season as the training hours in kayaking can differ from competitive season to off-season.

Scapula dyskinesis

The kayakers were screened for scapula dyskinesis by observation of the scapula in the humeroscapular rhythm of flexion and abduction. They were rated as having dyskinesis if any of following findings, in accordance with Kibler and Sciasca (2010), were observed:

Prominence of the inferior angle of scapula, which indicates an anterior tilt of the scapula. Medial winging, where the complete medial border is prominent from the thorax. Excessive superior translation of the scapula and prominent superior angle during elevation. Excessive downward rotation of the scapula, which is more likely seen during the eccentric phase of the flexion and abduction movement.

The movements of flexion and abduction were done for five repetitions each at a rate of approximately 3 s up and 3 s down.

Observation of scapular dyskinesis in flexion and abduction is a reliable and validity tested screening instrument of shoulder dyskinesis (Kibler et al., 2013; McClure, Tate, Kareha, Irwin, & Zlupko, 2009; Mottram, 1997; Park et al., 2013; Uhl, Kibler, Gecewich, & Tripp, 2009)

Range of motion of shoulder joint

Shoulder joint range of motion was measured with a Myrin OB Goniometer (Lic Rehab AB, Linköping Sweden) that measures rotation and flexion with a weighted pointer controlled by gravity and axial rotation with a compass needle. The Myrin Goniometer was placed with Velcro strapping proximal to the styloideus process of ulna.

(1) Internal rotation (IR) and external rotation (ER) were measured in supine position with the shoulder in 90 degrees of abduction, 10 degrees of horizontal adduction and elbow in 90 degrees of flexion and forearm in pronation. A wedge with a 10 degree inclination was placed under the humerus with the edge in line with the acromion to support the arm. The examiner stabilised the scapula by control of the processus coracoideus and the spine of the scapula in accordance with Wilk et al. (2009) and Morrissey, Morrissey, Driver, King, and Woledge (2008).

(2) Flexion in the shoulder joint was measured in supine position with control for thoracal or lumbar movement.

The Myrin OB Goniometer has been tested and found to have good intra-tester reliability for passive shoulder joint range of motion with an intra-class correlation coefficient (ICC) value of 0.97 and standard error of measurement (SEM) value of 2.6 degrees (Janwantanakul, Magarey, Jones, & Dansie, 2001). The Myrin OB Goniometer has also been tested on knee joint movements with good intra-tester reliability, ICC value of 0.94 and SEM value of 1.84 degrees (Sullivan, Murray, & Sainsbury, 2009).

Normal values for flexion have previously been described as 180 degrees, IR in 90 degrees of abduction as 70 degrees and ER in 90 degrees of abduction as 90 degrees (Kendall, McCreary, Provance, Rodgers, & Romani, 2005; Norkin & Levangie, 1992).

One examiner/physiotherapist conducted all the range of motion measurements and screening tests for scapula dyskinesis.

Statistical analysis

Descriptive statistics were used for background data, presented as mean and standard deviation (SD) and analysed for normality with Shapiro–Wilkins test. All data passed the test for normality. Data were then analysed for significant differences between groups with independent T-test with a 2-tailed significance testing, and the Chi^2 tests were used for categorical data, with Fisher's exact test for small samples, two sided. In all cases, *P*-value was set at 5% ($P < 0.05$). The 95% confidence interval was calculated and presented, and for effect size, Cohen's *d* value was used.

Results

Shoulder pain

Of the 31 participating kayakers, 45.2% ($n = 14$) had shoulder pain during the last season/year, of which four kayakers had ongoing pain. Three kayakers had experienced previous shoulder pain, ranging 1-3 years ago. A total of 54.8% ($n = 17$) of the kayakers had experienced shoulder pain. No significant differences were found between kayakers with pain last season, previous pain or no pain ever concerning, age, years of kayaking, or training hours per week. Male kayakers reported a significantly higher frequency of shoulder pain compared to female kayakers ($P = 0.031$), with 3 of 11 female kayakers reported shoulder pain and 14 of 20 male kayakers reported pain. Of the kayakers who had experienced shoulder pain, 9 reported bilateral pain, 3 reported only pain in right shoulder and 5 reported only pain in left shoulder. Of the kayakers who had experienced shoulder pain, 53% ($n = 9$) had sought medical care, 70.6% ($n = 12$) had been forced to change or reduce training and/or competitive participation due to pain. The kayakers who had experienced shoulder pain had problems related to pain for a duration of 0.5 weeks to 2 years, with a mean of 14.4 weeks and a median of 3.5 weeks of pain. For 41% ($n = 7$) of the kayakers, the pain had a sudden onset and for 59% ($n = 10$) of the kayakers, a more gradual onset was noted. Of the 17 kayakers who had experienced pain in the shoulder, 13 reported pain during training/kayaking, 4 reported pain independently of activity and 3 reported pain after activity. The kayakers who had experienced shoulder pain reported a mean intensity of pain on the visual analogue scale (VAS) between 10 and 88 mm, with a mean value of 48 mm and a median value of 56 mm. Three of the kayakers were left-handed, however, there were no significant differences in pain frequency in dominant and non-dominant arm.

Shoulder range of motion

Kayakers who reported shoulder pain during the last season were found to have significantly lower range of motion in internal rotation (IR) in the shoulder joint compared to kayakers who did not have shoulder pain during the last season. IR for right arm was 47.7° and 59.4° ($P = 0.009$) respectively for the group reporting pain during the last season and the group reporting no pain during last season. Corresponding values for the left arm were 50.4° and 64.8° respectively ($P = 0.0001$). There were no significant differences in shoulder joint range of motion for external rotation (ER) or flexion (F) for kayakers who had pain during the last season versus kayakers without shoulder pain in the last season. When those kayakers who reported pain earlier than last season where included in the pain group ($n = 17$), there were also significant differences ($P = 0.017$) with lower values in IR in the shoulder joint in the kayakers who had experienced pain versus the kayakers that had never experienced shoulder pain reporting 49.3° vs 60° for the right arm and 51.9° vs 66.0° for the left arm (Table 2). When comparing shoulder IR between kayakers who had experienced pain in the right shoulder versus kayakers who had not experienced pain in the right shoulder, there was a significantly lower IR for the right arm in the pain group with a mean of 47.4° vs 58.4° ($P = 0.017$). Comparing shoulder IR in the left shoulder, for kayakers who had experienced pain in the left shoulder joint versus kayakers who had not experienced pain in the left shoulder, there was a significantly lower IR in the pain group with a mean of 52.2° vs 63.3° ($P = 0.006$).

Table 2. Shoulder joint range of motion presented as mean and standard deviation (SD) for internal rotation (IR), external rotation (ER), flexion (F), total rotational range of motion (IR + ER), mean difference, 95% confidence interval (CI) and Cohen's (*d*) for effect size in kayakers who had experienced shoulder pain and kayakers who had not experienced shoulder pain.

Range of motion	Kayakers who had not experienced pain n = 14 Mean (SD)	Kayakers who had experienced pain n = 17 Mean (SD)	Mean difference (95% CI)	P-value	Effect size (d)
IR right	60.0 (10.9)	49.3 (12.4)*	10.7 (2.0, 19.4)	0.017	0.92
IR left	66.0 (8.7)	51.9 (10.0)*	14.1 (7.1, 21,0)	0.000	1.54
ER right	90.2 (10.5)	85.9 (10.5)	4.3 (−3.4, 12.1)	0.262	0.41
ER left	87.9 (10.0)	83.1 (10.3)	4.8 (−2.7, 12.3)	0.200	0.47
F right	185.5 (8.5)	183.8 (8.8)	1.7 (−4.7, 8.1)	0.582	0.20
F left	186.1 (9.1)	183.8 (6.1)	2.3 (−3.6, 8.2)	0.436	0.30
Total right (IR + ER)	150.2 (13.3)	135.2 (15.8)*	15.0 (4.3, 25.8)	0.008	1.03
Total left (IR + ER)	153.9 (13.1)	135.1 (13.6)*	18.9 (9.0, 28.7)	0.001	1.41

Note: Degrees mean (SD). * significantly lower at $P < 0.05$.

Kayakers who had experienced shoulder pain had a lower mean value of ER than kayakers who had not experienced shoulder pain, 85.9° vs 90.2° in the right shoulder, and 83.1° vs 87.9° in the left shoulder, though not statistically significant.

The kayakers who had experienced shoulder pain showed a significantly lower total range of motion (IR + ER) than kayakers who had not experienced shoulder pain with a mean of 135.2° vs 150.2° (P = 0.008) for the right shoulder and 135.1° vs 153.9° for the left shoulder (P = 0.001) (Table 2).

There were no significant differences in shoulder joint range of motion between male and female kayakers.

Scapula dyskinesis

When comparing the results for observation of scapula dyskinesis between kayakers who had experienced shoulder pain, and kayakers who had not experienced pain, there was a significantly higher frequency (P = 0.001) with a risk ratio of 3.1 (CI 1.3–7.2) of finding dyskinesis in the kayakers who had experienced shoulder pain (Figure 5). Of the 17 kayakers who had experienced shoulder pain, 88% (n = 15) were observed with scapular dyskinesis, 3 had scapula dyskinesis in the left shoulder, 1 in the right shoulder and 11 in both shoulders. Of the 14 kayakers who did not reported shoulder pain, 29% (n = 4) were found to have scapular dyskinesis, 1 in left shoulder and 3 in both shoulders. Of all the participating kayakers, 61% (n = 19) were observed as having one or more of the four signs of scapular dyskinesis. The female kayakers were observed with a scapular dyskinesis with a significantly lower frequency than male kayakers (P = 0.007), with 3 of 11 female kayakers vs 16 of 20 male kayakers observed as having scapular dyskinesis. When comparing the kayakers observed as having a scapula dyskinesis in right shoulder with kayakers with no dyskinesis in right shoulder, the kayakers with dyskinesis had a significantly lower IR with a mean value of 47.9° vs 59.9° (P = 0.007) (d = 1.37; CI 0.58–2.15). When comparing the kayakers observed as having a scapula dyskinesis in the left shoulder with the kayakers with no scapula dyskinesis in left shoulder, a significantly lower IR was observed with a mean value of 54.6° vs 63.5° (P = 0.034) (d = 1.15; CI 0.38–1.91).

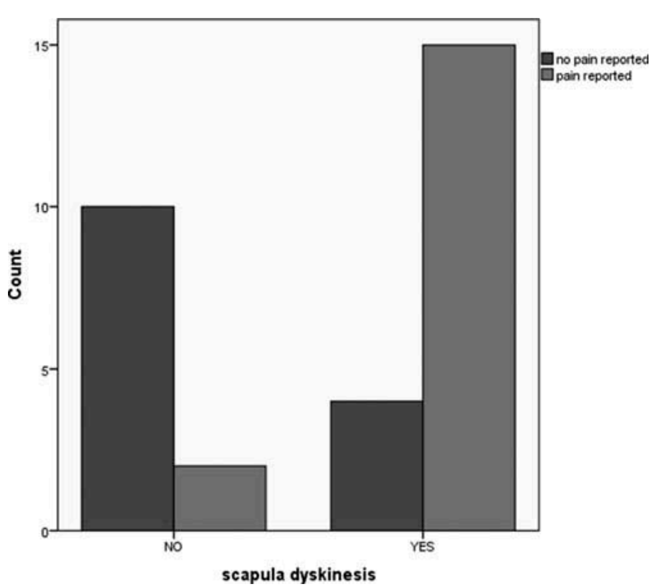

Figure 5. Observed scapula dyskinesis (yes or no) in kayakers who had reported shoulder pain and kayakers who had not experienced shoulder pain.

Discussion

The main finding in the present study was that a majority of the kayakers had experienced shoulder pain. Kayakers who had experienced shoulder pain were found to have less internal rotational range of motion and higher incidence of scapular dyskinesis compared to kayakers with no history of pain.

Almost half of the participating kayakers had experienced shoulder pain during the last season. Similar results were found in the study by Hagemann et al. (2004) where 48% of the participating kayakers had experienced shoulder pain and 35% had ongoing shoulder pain. In the present study, there were significant differences between male and female kayakers in reported pain frequency, but due to a small number of kayakers in the study being female, this might not be representative in a larger group of competitive kayakers. The present study found a significantly decreased shoulder IR in the kayakers who had experienced shoulder pain in comparison to kayakers with no reported pain.

Earlier studies on shoulder problems in athletes with a high degree of shoulder involvement in their sport also found a decreased internal rotation in athletes with shoulder pain (Maenhout et al., 2012; Merolla et al., 2010; Wilk et al., 2011).

Of the kayakers who had experienced pain in the present study, 52.9% reported having experienced pain in both shoulders, 29.4% in only the left shoulder and 17.6% in only the right shoulder. When compared to kayakers who did not report any pain, they showed a lower degree of IR in both shoulders, suggesting that kayakers who experience pain in one or both shoulders might be stiffer in soft tissues, dorsal capsule and muscles around the glenohumeral joint.

There have been several studies on glenohumeral internal rotation deficit (GIRD) and its correlation to shoulder pain in athletes (Maenhout et al., 2012; Merolla et al., 2010; Wilk et al., 2011), however, not many prospective studies have been performed. Wilk et al. (2011) performed a prospective study looking at shoulder joint range of motion and its correlation to shoulder pain in baseball pitchers during a season and found an increased risk of shoulder injuries in pitchers who had a deficit of 5 degrees or more in total ROM (ER + IR) in their throwing shoulder compared to the other shoulder. In kayaking, the movement and load are the same on both sides and there are no findings of increased ER as in throwing shoulders. When both shoulders are involved to the same degree, it might not be meaningful to compare the painful shoulder with the pain-free shoulder for a normal value of rotational range of motion. The kayakers who reported ongoing pain or pain during the last season in one or both shoulders in this study had a mean decreased internal rotation in the right shoulder of 11.7 degrees and left shoulder of 14.4 degrees in comparison with kayakers with no pain last season. There were no significant differences in shoulder range of motion between male and female kayakers in the present study, which is similar to the findings in the study by McKean and Burkett (2010). The kayakers in McKean and Burkett's (2010) study had a lower mean degree of IR than the kayakers in the present study. The kayakers in the present study had a normal range of motion for flexion in the shoulder joint compared to the participating kayakers in McKean and Burkett (2010) study that had a decreased range of motion for flexion. The participating kayakers in McKean and Burkett (2010) study had a mean age of 25.4 years for male kayakers and 23.9 years for female kayakers, while the participating kayakers in the present study were younger with a mean age of 18.2 years for male kayakers and 16.6 years for female kayakers. The difference in range of internal rotation and flexion might suggest that the shoulder range of motion, especially internal rotation and flexion, has a tendency to decrease with age in elite kayakers. McKean and Burkett (2010) did not present total training hours for the kayakers, which also might differ from the kayakers in the present study and might affect the range of motion. Several studies that have addressed the decrease in IR had a good effect on pain and function in athletes with shoulder pain (Maenhout et al., 2012; Tyler et al., 2010). Maenhout et al. (2012) found that a 6 week stretching programme for dorsal capsule and shoulder muscles had a significant effect on IR in athletes with GIRD and shoulder pain. Maenhout et al. (2012) also examined the distance between acromion and the humeral head (subacromial space) in resisted abduction and found this to be significantly smaller in the shoulder with GIRD before the 6 week stretching programme, but which improved after the intervention.

The present study revealed a significantly higher incidence of scapular dyskinesis in the kayakers who had experienced shoulder pain versus kayakers reporting no pain.

This is in line with findings of altered scapular movement pattern in studies on patients and athletes with pain or pathologies in the shoulder compared to non-injured shoulders (Kawasaki et al., 2012; Kibler et al., 2013; Lukasiewicz et al., 1999; Struyf et al., 2011).

Kawasaki et al. (2012) tested rugby players for scapular dyskinesis and found that players with asymptomatic scapular dyskinesis preseason had a high incident of shoulder pain during regular season. The scapular dyskinesis was also associated with findings of shoulder pathology such as impingement, instability and muscle weakness (Kawasaki et al., 2012).

Studies that have focused on retraining scapular stability, scapular movement patterns and scapular muscle activation pattern found a good effect in relieving symptoms in patients with shoulder pain (Struyf et al., 2013; Worsley et al., 2013). Struyf et al. (2013), compared to scapular focused retraining and stretching, with eccentric training of external rotators of the glenohumeral joint and stretching, and found a significantly better result of the scapular focused intervention in patients with impingement syndrome. Merolla et al. (2010) found a significant correlation between scapular dyskinesis and decreased strength in infraspinatus in volleyball players. A 6 month training programme focused on scapular stability and shoulder mobility significantly increased infraspinatus strength and reduced shoulder pain. Tsai, McClure, and Karduna (2003) found a change in scapula position and movement pattern with an increase in anterior tilt and decreased upward rotation during arm elevation due to fatigue of external rotator cuff muscles.

Taking into account the highly repetitive movement of the kayak stroke, the fatigue effect might influence the kayakers' shoulders and make the scapula more susceptible to dyskinesis or increase a scapula dyskinesis. The present study chose not to separate the scapular dyskinesis findings into the four different subgroups as described by Kibler and Sciascia (2010). Rather, we just classified the findings as having a scapular dyskinesis, yes or no. This procedure was chosen due to the higher intra- and inter-reliability of this procedure in comparison with the subgrouping method (Uhl et al., 2009). The examiner in this study is an experienced physiotherapist in movement analysis.

In measurements of shoulder joint range of motion, intrarater reliability has been found to be higher than inter-rater reliability (Van de Pol, van Trijffel, & Lucas, 2010; Walker, Gabbe, Wajswelner, Blanch, & Bennell, 2012). The present study standardised the measurements by one performing and testing physiotherapist. There are always risks for measurement errors when measuring joint range of motion and standardisation is important to decrease this risk. This study chose to standardise so that the measurements for internal and external rotation in the glenohumeral joint were done in the scapula plane, thus, a wedge was used to get nearest exact 10 degrees of horizontal adduction to reach the scapula plane. This procedure and the use of the Myrin OB goniometer instead of the more commonly used universal plastic goniometer or handheld gravity-based inclinometer in shoulder range of motion testing had the advantage that a single examiner could position and stabilise the scapula and move the arm during the measurements as well as read the results. Stabilisation of the scapula during IR measurements led to a higher intra-tester reliability and minimises movement errors due to scapular movement (Wilk et al., 2009). The studies that have tested the Myrin OB Goniometer have found good intra-tester reliability and SEM value of 1.8–2.6 degrees. The differences in IR in this study between the kayakers who had experienced shoulder pain versus kayakers with no history of shoulder pain were small but significant.

Conclusion

This study revealed a high incidence of shoulder pain in the participating competitive flatwater kayakers, a decreased internal rotation in the shoulder and a higher incidence of scapular dyskinesis in the kayakers who had experienced shoulder pain. These findings suggest that kayakers might need to incorporate stability training of the scapula and more mobility training of the shoulder at an early age to prevent shoulder injuries, though more research is needed to verify whether the decreased internal rotation or scapular dyskinesis is the cause or the result of the pain.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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