

# MUSCULOSKELETAL INJURIES IN ATHLETES OF THE 2006 SEASON'S BRAZILIAN WOMEN'S SPEED CANOEING TEAM

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## SUMMARY

**Objective:** This study aimed to assess the incidence, kind, etiology and anatomical site of musculoskeletal injuries of athletes of the Brazilian Women's Speed Canoeing Team for the 2006 season. **Methodology:** All eight athletes of the main team participated on the study. Their mean age was 19.50 years ( $\pm 3.78$ ); mean body mass of 58.67 kg ( $\pm 5.44$ ) and mean height of 162.00 cm ( $\pm 4.00$ ). **Results:** After the analysis of data, a rate of 5.06 injuries/ athlete/ 1000 hours of sports practice was found. We also found that 87.50% of the athletes experienced injuries, totaling 82.05% of recurrences. –The most common injuries seen were: muscle contraction (48.72%)

and tendonitis (23.08%). The trunk (56.41%), particularly the thoracic and thoracolumbar region, and the UULL (41.03%), particularly the shoulder, were the areas that were shown to be most frequently affected. **Conclusion:** As a result of the sportive gesture, the etiology of injuries was non-traumatic especially due to overload of anatomical structures. We believe that with the characterization of injuries in this sport activity, it will be possible for sportive physical therapy to develop a preventive work focused to the specific injuries found with the purpose of reducing their incidence and recurrence rates.

**Keywords:** *Epidemiology; Trauma in athletes/ prevention & control; Women.*

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## INTRODUCTION

Speed canoeing is a sport modality practiced in rivers or quiet waters, using kayak-like boats, where the oarsman is called canoeman. The boats are divided into K1, K2 and K4, and support, respectively, one, two or four crew members.<sup>(1,2)</sup>

On kayaks, rowing is performed using the upper limbs (UULL), to move a double-bladed paddle, with which the athlete rows on both sides of the kayak, in a symmetric pathway. It is regarded as a quite repetitive movement, and is performed for a long period of time, and an inappropriate rowing mechanics and the repeated overload imposed to some regions of the body may predispose athletes to injuries.<sup>(3-5)</sup>

Sports injuries usually cause changes to athletes' performance, potentially leading to withdraws from training sessions and competitions. Thus, sports physiotherapy faces the challenge of providing an accurate diagnosis of sport injuries, with an early and effective rehabilitation, re-establishing an athlete's function as soon as possible.<sup>(6)</sup> In addition, it plays an important role in reducing its incidence and minimizing its severity, thus improving athletes' performance.<sup>(7-9)</sup>

Therefore, the identification, classification and characterization of the profile of these athletes at risk is required in order to provide the necessary preventive measures in reducing the occurrence rate of such injuries.<sup>(10, 11)</sup>

In Brazil, canoeing is growing, achieving good results on a global basis, although it has been relatively recently structured.<sup>(12)</sup> However, even with fast development, few studies have been conducted on this area. Currently available studies tried to characterize the anthropometric profile of the Brazilian national canoeing team<sup>(13)</sup>,

estimate the aerobic power and contributions of the different metabolic paths in speed canoeing<sup>(2)</sup> as well as to monitor canoemen's heart rate.<sup>(12)</sup>

Concerning international literature, the available studies investigated the incidence of injuries in different modalities of canoeing<sup>(4,10,11)</sup>, but none of those comprised data for speed canoeing athletes.

In speed canoeing, there are no current studies addressing musculoskeletal injuries, but the quantification of most common injuries and the identification of its characteristics could help on planning and preparing a specific physiotherapeutic, medical and multidisciplinary preventive intervention, thus reducing athletes' exposure to injury hazards.

Therefore, the present study intended to assess the incidence, kind, etiology and anatomical site of musculoskeletal injuries among athletes of the Brazilian Women's National Speed Canoeing Team during 2006's season.

## METHODOLOGY

A prospective longitudinal study was conducted with all eight athletes composing the Brazilian Women's National Canoeing Team. The athletes row on kayaks and compete in Junior and Senior classes. The group had a mean age of 19.50 years ( $\pm 3.78$ ), mean body mass of 58.67 kg ( $\pm 5.44$ ), mean height of 162.0 cm ( $\pm 4.0$ ), BMI of 22.37 ( $\pm 2.12$ ), and mean time of sports practice of 5.78 years ( $\pm 2.79$ ).

For conducting the research, two main instruments were used: an ID file as well as a specific injuries follow-up form. The ID file reported personal data of each athlete, and the specific form comprised aspects such as: athlete's name, injury date, injury recurrence, kind

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of injury, anatomical region and segment affected, etiology, need and period of sports timeout.

First, the researchers made a verbal and explanatory contact with the athletes and their coach about the objectives of the research and to ask if they were available to participate of the study. Then, each athlete filled an ID file, after which a longitudinal follow-up was made with the team between January and November 2006, for acquiring information about injuries.

In this study, we regarded as musculoskeletal all injuries affecting the athletes' locomotive apparatus, being diagnosed by physiotherapists and doctors accompanying the Brazilian Women's National Canoeing Team over the period of the research.

Injuries were classified as mild (injuries not requiring timeoff from training sessions or competitions), moderate (injuries that led to 1-day timeoff from training sessions or competitions), and severe (injuries leading to > 1 day timeoff fro training sessions and competitions).<sup>(14)</sup>

Diagnosis was exclusively clinical <sup>(15)</sup>, as per the anamnesis, where signs and symptoms were investigated as well as the background of the referred injury and physical examination with palpation, muscular function tests and special tests. Supplementary examinations were used for diagnostic purposes in cases when an accurate diagnosis could not be provided by anamnesis and physical examinations, or in cases of more severe injuries. Data were collected and classified according to pre-established criteria on the specific form. This procedure was based on the study by Moreira et al<sup>(14)</sup>.

All athletes signed a free and informed consent term, and the study was submitted to and approved by the Committee of Ethics in Research (CEP) of the University of Caxias do Sul protocol nr. 43/2006, as determined by resolution 196/96 of the National Health Council (CNS).

The analysis of data was quantitatively made, by means of descriptive statistical analysis.

## RESULTS

All injuries occurred within the period of study were of non-traumatic nature (100%). During that period, the athletes were exposed to 964 hours of sports activities, including training sessions and competition games, leading to an incidence of 39 injuries. Thus, a rate of 4.88 injuries was found for each athlete during the study period, and therefore, 5.06 injuries per athlete at each 1000 hours of sports practice.

After data acquisition and analysis, we noticed that a total of 87.5% of the athletes were affected by musculoskeletal injuries during the study period. The most common injuries are shown on Figure 1.

Of the 39 injuries diagnosed, 22 occurred on the trunk, 16 on upper limbs (UULL) and only one on lower limbs (LLLL). Figure 2 shows the percentages of involvement for each anatomical site.

Concerning anatomical segments affected by injuries, thoracic and lumbar spine, as well as shoulders, were the structures most frequently impacted. Table 1 shows the results for each segment.

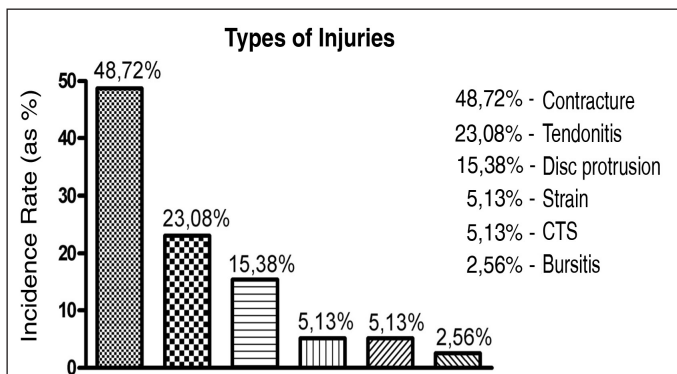


Figure 1 – Types of injuries.

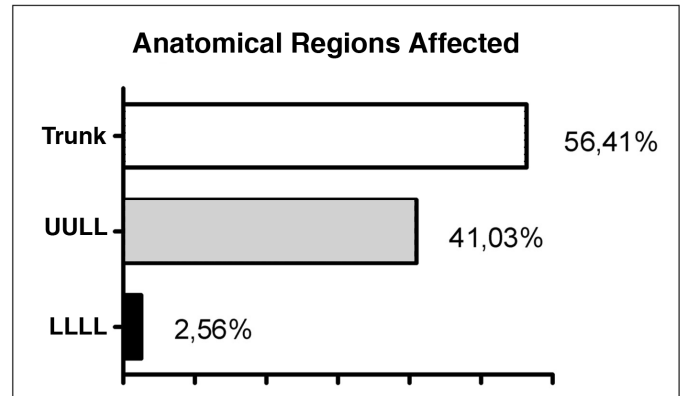


Figure 2 – Anatomical regions affected by musculoskeletal injuries.

| Segment                          | Frequency | %     |
|----------------------------------|-----------|-------|
| Thoracic and thoracolumbar spine | 14        | 35.90 |
| Lumbar and lumbossacral spine    | 08        | 20.51 |
| Shoulder                         | 07        | 17.95 |
| Forearm                          | 06        | 15.39 |
| Wrist                            | 02        | 5.13  |
| Leg                              | 01        | 2.56  |
| Arm                              | 01        | 2.56  |

Table 1 – Anatomical segments affected by injuries.

Concerning the degree of injuries severity, most of the episodes were regarded as mild, as illustrated by Figure 3.

Of the 39 injury episodes, 82.05% were recurrent, while only 17.95% constituted new cases.

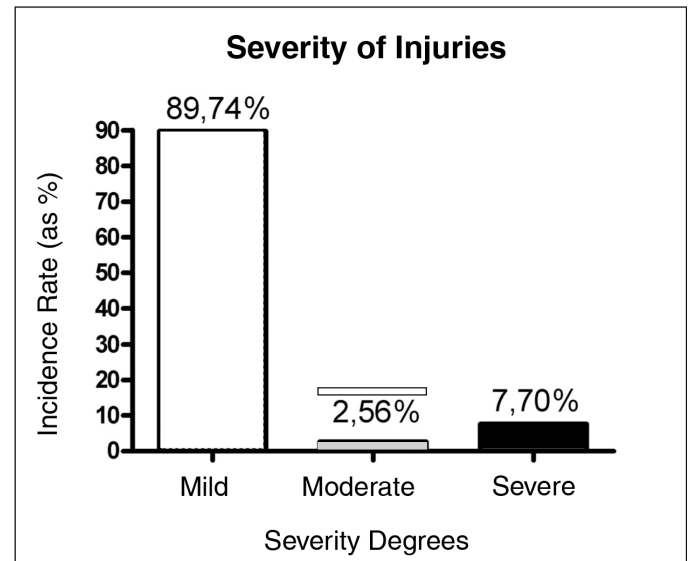


Figure 3 – Injuries severity degrees.

## DISCUSSION

Canoeing lacks research on the injuries associated to its practice, specifically the speed canoeing, the modality chosen by this study. As a result, for comparing data obtained in this study to those available in literature, researches on different canoeing modalities

and with different sportive gesture characteristics, competitions and equipment have been used.

During the study period, 87.50% of the athletes experienced musculoskeletal injuries, in an average of 4.88 injuries/ athlete. Values above those have been found in other studies for different canoeing modalities, with 54.9% to 83% of injured athletes and averages ranging from 1.81 to 2.11 injuries/ athlete.<sup>(4,10, and 16)</sup>

In speed canoeing, rowing is a movement regarded as repetitive and performed for a long period of time.<sup>(4)</sup> The authors Saran et al<sup>(17)</sup> report that an athlete's exposure to repeated forces and to excessive drills lead to overuse injuries, accounting for about 30%-50% of all sports-related injuries.

Thus, it is suggested that the root cause that triggered the injuries found in this study were overload and overuse, caused by the characteristics of sports gesture associated to the extenuating need of training high-performance teams.<sup>(11,18,19)</sup>

The present study found 48.72% of muscle contractures, being the kind of injury most frequently diagnosed. In canoeing, no study was found correlating muscular contracture as the most frequent injury on these athletes.

Some authors mention that muscle contractures would be a muscular dysfunction, without anatomical fiber injury, particularly associated to muscle fatigue<sup>(20)</sup>.

Garrett<sup>(21)</sup> reports that muscular contracture is the mildest form of muscle injury and that it occurs as a result of dehydration and minimal fiber rupture.

Kisner and Colby<sup>(22)</sup> define muscular contracture as being a shortening or retraction of the muscle, restricting its normal mobility or flexibility.

Scapular girdle muscles, on the thoracic region, were the structures presenting the highest number of muscle contractures, and we believe that this is a result of overload and of the strong demand on these muscles on UULL movements during rowing. Another aspect that may have led to overload on this region is the sedestation posture adopted by athletes on the kayak, supported by ischios and with the pelvis in anteversion. This factor may cause stronger physiological curves on the spine, making scapular girdle muscles to be excessively demanded to keep vertebral statics<sup>(23)</sup>.

As the second most frequent injury, tendonitis showed an incidence rate of 23.08%. The same rate was reported by other studies, which sorted tendonitis among the most frequent injury types among canoeing athletes<sup>(10,16)</sup>.

In the present study, of the nine tendonitis cases, 66.66% occurred on the shoulder region, more specifically on the region of the long portion of the biceps, with other 33.33% on the region of the forearm, on wrist extensor muscles.

It is suggested that one of the tendonitis causes on the shoulder region is due to a deficiency of the scapular-humeral rhythm, changing the glenoumeral joint mechanics and leading to injuries.

<sup>(22)</sup> Another factor that may be associated is the tendon of the long portion of the biceps' trend to rub against humeral intertubercular groove surface, where it lies, predisposing to overuse and, as a result, to a potential injury<sup>(24, 25)</sup>.

In addition, Pelham, Holt and Stalker<sup>(24)</sup>, report that excessive hypertrophy of the supraspinal muscle and anatomical abnormalities are risk factors to the occurrence of overuse injuries on subacromial space structures due to its reduction, this being another factor suggested for explaining tendonitis episodes on the tendon of the long portion of the biceps, since, for being a high-performance team, intensive work out is required applying maximum strength to UULL.

Tendonitis on the forearm region, on wrist extensor muscles, may be a result of the overuse of these muscles for the apprehension function<sup>(17)</sup>.

The study by du Toit et al<sup>(26)</sup> investigated the incidence of acute tenosynovitis of the forearm in 510 long-distance canoeists, with 23% of injury reports. The authors concluded that the tenosynovitis of the wrist extensors is caused by a biomechanical change of the

sports gesture, especially by repeated wrist hyperextension during the stroke phase.

This fact may be worsened by the analysis of wrist extensors' stabilizing action during apprehension, where the strength applied is directly proportional to the strength of this musculature<sup>(25)</sup>.

The cases of lumbar and lumbo-sacral disc protrusion found here refer to new acute injuries processes that occurred prior to this study period. Nachemson<sup>(27)</sup> and Hamill and Knutzen<sup>(28)</sup> report that sedestation without support associated to UULL loads, such as those adopted by canoeists, increase the overload on lumbar intervertebral discs to values equivalent to four times the body mass, this being a predisposing factor to disc changes and injuries. These factors associated to trunk's rotational movement at rowing, may have been responsible for the injuries occurred, due to an excessive use and load on lumbar spine<sup>(28)</sup>.

The following have also occurred in the present study, while less frequently: muscular stains, carpal tunnel syndrome (CTS) and bursitis. Muscular strains, according to Cohen and Abdalla<sup>(6)</sup>, may be caused by an eccentric or sudden concentric contraction, or by muscular fibers elongation beyond its physiological state. The strain cases observed in this study were believed to occur during maximum acceleration of the movement in competitions or speed drills, or, still, at maximum force trainings or during runs out of the water.

According to Cohen and Abdalla<sup>(6)</sup>, among the most common injuries on the wrist and forearm region of canoeists is CTS. Drinkwater,<sup>(3)</sup> reports that these episodes occur in sports requiring wrist flexion with strong apprehension. During strike and traction phases, wrist flexion is regarded as an inappropriate movement, causing technique changes and overloading the forearm region<sup>(29)</sup>. Therefore, the CTS diagnosed in this study are believed to have occurred due to an incorrect technique employed during rowing movements.

The least frequent injury occurred here was deltoid/ subacromial bursitis. Pelham et al<sup>(24)</sup>, report that subacromial bursitis occurs as a result of the abduction and internal rotation of the shoulder at rowing recovery phase. In this movement, there is a reduced subacromial space, causing an increased rubbing mechanism and resultant subacromial bursa irritation, leading to inflammation.

Another hypothesis could be the existence of intrinsic factors, such as changes on anatomical structures of the shoulder. These changes, associated to the cyclic movement of that sport may have caused microtrauma as a result of repetitive rubbing to the bursa, ultimately leading to inflammation and pain<sup>(30)</sup>.

The anatomical region most frequently affected by injuries was the posterior trunk region (back), accounting for 56.41% of all injuries. On the trunk, the anatomical segments affected were the thoracic and thoracolumbar spine (35.90%) followed by lumbar and lumbosacral spine (20.51%). On these sites, the most common kinds of injuries were muscular contractures and new acute disc protrusion processes.

According to Cohen and Abdalla<sup>(6)</sup>, the most common injuries on the spine are thoracic and lumbar muscle contractures, and lumbar disc hernias, which is consistent to the results of the present study. Some authors explain that the potential for spinal injuries increases due to canoeists' stance on the kayak, remaining seated with the LLLL extended and with minimal back support, leading to muscle fatigue and ligament tension<sup>(3,28)</sup>.

The regions of the shoulder and forearm also presented a high incidence of injuries, with the UULL accounting for a total of 41.03% of the episodes. The results found in other studies show the UULL as the most frequently affected site by injuries; however, the present study denies these results, with the site most commonly involved by musculoskeletal injuries the posterior trunk region.

Fiore and Huston<sup>(10)</sup>, found 61% of the injuries on UULL, with half of these involving the shoulder region, and report that such a high incidence of injuries can be explained when we analyze the sports gesture, where this region is largely exposed and contains

most of the muscles used for rowing, leaving them susceptible to excessive use, trauma stress and impact injuries.

Shoen and Stano<sup>(16)</sup>, also reported that the UULL and particularly the shoulder, were the most affected by acute and chronic injuries; however, they do not mention numbers for each region. Hagemann, Rijke and Mars<sup>(11)</sup>, studied the prevalence of shoulder injuries in 52 canoemen of the endurance modality, by means of clinical tests and magnetic resonance, and concluded that injuries caused by overuse of these athletes' shoulders are more common than trauma injuries. In this study, the authors reported that understanding injuries on canoemen's shoulders is achieved by observing kinesiological, biomechanical and physiological demands of the sport gesture.

David and Fiore<sup>(19)</sup>, in their study, provide a review of the demographic data and kinds of injuries in *Whitewater* modalities with kayak and rafting types of boats and concluded that chronic injuries in canoeing are common and usually occur on UULL, especially on wrist and shoulder regions.

This large majority of UULLL injuries may be explained by the fact that the forearm, wrist and hand regions are responsible for transferring the power produced by hip, trunk and shoulders to the paddle. As previously mentioned, a deviation of the wrist angle, exaggerated apprehension or wrong technique may cause an ineffective power transfer to the paddle and inappropriate effort of the UULL, thus increasing the risk of injuries<sup>(3)</sup>.

Considering that this study sample is exclusively composed by female athletes, it is important to highlight that some authors report that females are more likely to experience shoulder injuries because of their relatively weaker musculature of the scapular girdle in comparison to males<sup>(3, 6)</sup> and also because of hormonal effects that could lead to increased joint lassitude, which can be a predisposing factor to injuries<sup>(3)</sup>.

These data cannot be compared either with other studies addressing canoeing. The severity variable was considered only in the retrospective research by Fiore and Huston<sup>(10)</sup>, who presented sports timeoff as a severity marker. They graded the timeoff only as: none, less than one week, less than one month, and more than one month. However, we could not compare their results to ours due to the lack of information and standardization of the analyzed variables.

The injuries found in this study were of non-traumatic nature, as expected, considering that speed canoeing is a non-contact sport, and also because of the requirements of this activity, where drills and competitions are based on the performance of repeated movements with cyclical load application.

These injuries result mainly from microtrauma mechanisms, probably caused by overuse, rubbing or cyclical loads applied to certain regions of the body. Microtrauma injuries are known to present a potential of spontaneous resolution. However, due to the strong demand of high-performance sports, an abusive load is continuously imposed, generating a chronic inflammatory response that ultimately becomes symptomatic for the athlete. Only when the injury becomes symptomatic or when function is reduced or lost an athlete seeks medical care<sup>(17, 30)</sup>.

As mentioned, high-performance sports require high performance from athletes, and this results on the need of a swift rehabilitation. However, in most of the cases, the reduced treatment time prevents an optimal recovery, despite of the normal function return and symptoms relief<sup>(17, 30)</sup>. According to Enoka<sup>(30)</sup>, if drills continue during rehabilitation, this may lead to an inappropriate treatment, increasing the risks of new injuries. Since in the present study 89.74% of the injuries were regarded as mild, meaning that they did not cause athletes' timeoff from drills, we suggest that this could have been one of the factors accounting for the high rate of recurrence cases observed (82.05%).

This high incidence rate can be attributed to the continuous extenuating drills required by high-performance sports. As in speed canoeing the sport gesture is cyclical, always involving the same regions of the body, that is, imposing an overload on and overusing them, recurrent injuries are expected.

Furthermore, other risk factors to injuries contribute to the physical overload of these athletes, such as, for example, individual, physical and psycho-social characteristics (muscular unbalances, fatigue, lack of flexibility, and muscular weakness) known as intrinsic and extrinsic factors such as sport activity characteristics, different environmental aspects exposed during competitions in different countries, incorrect rowing technique and training peculiarities<sup>(30)</sup>. Data concerning severity and recurrence of injuries could not be compared to other studies with canoemen, because those did not assess these variables.

It is believed that the reduced amount of new injury cases is due to a preventive treatment that has been provided to athletes for two years, including the study period. Preventive treatment stresses muscle flexibility exercises (especially posterior chain ones on LLLL and trunk), sensorimotor training, muscular control and strengthening of specific regions (such as abdominal, paravertebral muscles and the LLLL), coordination and balance exercises associated to sports gesture, and stance exercises. In addition to exercises, guidance is provided on: maintaining preventive exercises for scapular girdle and shoulder, pre- and post-drills elongation, and ice therapy after training sessions on overloaded and/ or painful joints.

Drinkwater<sup>(3)</sup>, mentions that providing guidance to athletes on risk factors is the best approach to prevent overuse injuries. Safran et al<sup>(17)</sup>, reinforce the importance of preventive programs, reporting that all oarsmen, regardless of the modality or type of boat may be benefited by an exercises program that includes muscular rebalance, scapular stabilization, and postural readjustment. Furthermore, they reinforce that an increased flexibility of the ischiotibial muscles and the strengthening of abdominal muscles are extremely important for maintaining optimal physical status for sports practice in these athletes.

Even counting on a limited sample, the audience studied here reflects the elite of national women's speed canoeing athletes, and, thus, we believe that, with the present study, a preventive program will be focused on the specific injuries found, aiming to control, mitigate and prevent them, thus reducing their incidence and recurrence rates and improving athletes' performance and health.

We also hope that the present study can help filling the knowledge gap existing about injuries in this sport, and that other studies are developed, thus contributing to a better understanding and development of this sports modality.

## CONCLUSION

We found that most of the athletes were affected by injuries, and that most of these injuries were recurrences of previous injuries.

The thoracic and thoracolumbar regions, as well as the shoulder, were the sites most affected by injuries in women's speed canoeing.

As a result of the sports gesture and characteristics, the etiology of injuries was of non-traumatic nature in 100% of the cases.

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