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Injury Incidence in Traineras: Analysis of Traditional Rowing by Competitive Level and Gender

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Abstract: The growing interest in "Traineras", a traditional competitive rowing modality prevalent in Northern Spain, underscores the need for a comprehensive analysis of the injury incidence associated with this sporting practice. Despite rowing's significance in the international sports arena and its inclusion since the beginnings of the modern Olympic Games, research into injuries in this sport, especially in traditional modalities such as Traineras, has been limited. This study aimed to identify and describe the predominant injuries among Traineras rowers, analyzing their epidemiology, characteristics, affected body regions, and diagnoses, further differentiated by competitive level and gender. A retrospective survey completed by 773 rowers (24% women, 76% men) participating in various leagues (ACT, ARC1, ARC2, LGT1, LGT2, ETE, and LGT-F) during the season revealed that 68.2% suffered from at least one injury, predominantly due to overuse (91.1% in men, 83.1% in women). The most affected regions were the lower back and shoulders, with the main diagnoses being muscle cramps and tendinitis, showing statistically significant differences between sexes. The findings of this study not only provide a deeper understanding of the etiology and origin of injuries in this sport but also lay the groundwork for developing specific injury prevention plans, thereby contributing to the safety and optimal performance of athletes.

Keywords: sports injuries; low back; injury incidence; overuse; performance level

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1. Introduction

Rowing sports are categorized into three main disciplines: outdoor flat-water rowing, open water disciplines [1], and indoor variants. Traditional rowing can be considered an open water discipline and often employs a fixed seat, in contrast to the more widespread Olympic sliding-seat rowing, which consequently has been subject to more extensive research [2–4]. Given their similarities as sports in relation to the phases and paddling cycle, comparisons between traditional and Olympic rowing have been common in the literature [1,2,5].

Traditional rowing typically involves athletes using a single oar gripped with both hands and oriented either to the port (right) or starboard (left) side. The Olympic category includes events such as the eight (a boat for eight sweep rowers with a coxswain for direction), the four (for four sweep rowers), and the pair (for two sweep rowers), with options for coxed or coxless boats [6]. Despite the diversity of disciplines, all rowing forms require a cyclical movement pattern where the synchronization of leg and arm work is essential for maximizing stroke efficiency and achieving peak performance [7]. Although fixed-seat rowing modalities are widespread throughout the Spanish peninsula [8], Traineras rowing can be considered the modality that has acquired most importance in recent years [9].

In Olympic rowing, all athletes need to perform over 2000 m, women and men, while in Traineras rowing, 5556 m, or three sea miles, must be completed in the shortest possible time during a regatta for males [1–4,10], and half of this distance, or 2778 m, needs to be completed by women [11]. Moreover, approximately between 5′30″–7′ effort time (200–240 strokes) is required in Olympic rowing depending on the boat type and weather conditions, while 19′–20′ (700–800 strokes) are needed in a Traineras male rowing competition [1,2,10], and 11′–12′ (350–450 strokes) in women regattas, time that can be extended when the sea conditions become rough. Another characteristic that makes traditional rowing different from Olympic rowing is the *ciaboga* maneuver, in which male Traineras turn around three times and women once in each regatta, which means that the boat loses speed that need to be recovered after each *ciaboga* [2], instead, in Olympic rowing boats go straight from the beginning to the finish line. Strength-endurance capacity becomes crucial for performance in both, Olympic rowing [12] and traditional rowing [1]. Among the differences while Olympic rowing takes place in calm waters such as rivers or lakes, traditional rowing modalities such as Traineras are mostly played on the sea [1,2,10], and their main characteristic is that the seat is fixed, so rowers do not use a sliding seat to propel on the sea, and instead a more pronounced flex-extension of the trunk is required [1,10].

Among all rowing modalities, Olympic rowing is the most researched worldwide [13], and it can be considered the main reference for many fixed-sit rowing modalities. In Olympic rowing research, different aspects have been analyzed e.g., physiological variables [6,7,14], physical training [6,15–18], nutrition [17,19,20], anthropometry [21–23], psychology [24,25], coaching [24,26], or technical and biomechanical aspects [27,28], seeking to improve athletes' performance. Likewise, we find how fixed-sit rowing has also been analyzed from different perspectives to seek athletes' performance [1,8,29]. e.g., form perspectives such as physiology [1,2,5,30–32], physical training [33–35], nutrition [2,36–38], anthropometry [2,3,39,40], leadership and behavioral based investigations [41], psychology [42,43] or biomechanical aspects [2,4].

Despite the investigations carried out to improve athletes' performance, everything changes when a sports injury occurs, and injuries across sports have been consistently reported [44]. For this reason, sports injuries and their prevention have become a crucial subject of study [45]. The early specialization and the high demand to improve athletes' performance have contributed to a significant increase in chronic and overuse injuries suffered by different level athletes [46].

Even though a recent investigation shows that team sports have a higher injury rate in Olympic sports than individual sports [47], for example, Olympic rowing is not considered a very harmful sport since it belongs to the group with the lowest incidence of injuries [48–53]. Moreover, due to their importance to athletes' performance and health, the epidemiology of injuries in rowing has been widely analyzed [52], and several investigations have described the incidence of injuries in Olympic rowing [49,54–56]. These main injuries are shown in an updated systematic review of injury epidemiology in Olympic rowing [57]. Within the scientific literature related to injuries in rowing, many articles have focused on athletes' injuries according to rowers' competitive level or age, with several investigations gathering the main injuries in elite rowing [51,55,58–61] and many others describing the main injuries age-wise [62], junior [63], collegiate rowers [64,65], or amateur rowers [66]. Likewise, high school rowers [65] and master rowers' injuries [50] also haven been analyzed. Several investigations show female rowers' injuries [57,67], while some compared these sport injuries between men and women rowers [59,68], showing a wide map of the main injuries in Olympic rowing.

Among the characteristics or types of injuries of Olympic rowers, mainly overuse, acute (traumatic), and chronic (overuse) injuries have been described [50,51,56,57,62]. Apart from the type, the injury region in the body has also been studied, showing that the highest injury incidence described are low back [56,68–80] and rib stress [67,81,82]. However, other injuries, such as wrist and forearm, knee, iliotibial band, shoulder, hip, and skin conditions [54,56,60] are common in rowing. Among the main injury diagnoses, tenosynovitis, spondylolysis, disk injuries, or stress fractures have been described [49,56,60,62], thus completing the specific injury pattern in this sport. Beyond the characteristics of the cyclic movement in rowing, biomechanics and rowers' injuries have also been associated in different publications, since the biomechanical analysis of the technique of each sport is connected to the aetiology of the injuries and therefore crucial to be able to subsequently prevent or reduce the effects of these injuries [56,60,69,83]. Moreover, due to the importance of not being injured during an athletic season, injury prevention plans have been released for team sports [45] and in rowing [60,83] to try to reduce the injury rate.

Despite the number of studies that analyze the etiology and injury incidence in Olympic rowing, fixed-sit rowing injuries have been scarcely analyzed [84,85]. A recent investigation in Maltese fixed-sit rowing, compared the musculoskeletal injuries in this rowing modality with a group of Olympic rowers, and results showed that for both, the low back and shoulder were the body regions with the highest injury incidence [84]. In the Spanish context, Mediterranean fixed-sit rowers' incidence of injury was described, and ankle, low back, and shoulder were the main injured body regions, while sprains and tendinitis were the highest described diagnoses, and overuse injuries occurred the most during, especially during the training period [85]. However, there is currently no research that analyzes the injuries in Traineras rowing. Therefore, due to its importance to athletes' performance and health, the main objectives of this research will be to describe the characteristics, body region, and incidence of injuries in traditional rowing, creating thus specific injury incidence patterns in Traineras rowing related to gender and competitive level of rowers.

2. Materials and Methods

2.1. Participants

A retrospective cohort study was carried out with Traineras rowers competing in different competitive leagues: elite (ACT-Eusko Label in men and Euskotren in women) and non-elite (ARC1, ARC2, LGT1, LGT2 in men and ETE, LGT-F in women). The survey was completed by 714 athletes, 389 men and 107 women suffered one or more injuries, while 166 men and 51 women suffered no injuries. The 389 men had a total of 597 injuries, 122 were from elite rowers and 475 were from non-elite rowers. The 107 women had a total of 178 injuries, 49 were from elite rowers and 129 from non-elite rowers. The participants were selected by convenience, and the only inclusion criteria was that they needed to be competing in any of the Traineras leagues during that season. Approval was obtained from the University of Alicante's Ethics Committee (protocol code UA-2023-06-14_1), and the study was conducted following the ethical principles of the Declaration of Helsinki.

2.2. Questionnaire

The online survey was adapted from a previously validated questionnaire [85], and the tool was readapted with some general and specific questions related to Traineras discipline and divided into different sections. In the first section there is an introduction to the study and informed consent. The second section details demographics and questions in relation to the trajectory of the sportsmen and sportswomen, such as years of experience, competitive level, or Traineras league in which they were competing at that season. In the third section, questions regarding rowers' injuries, answering first whether they had suffered or not from an injury, are discussed with the option to describe and specify in detail the suffered injuries.

2.3. Procedure

Different rowing clubs and coaches were contacted via email and phone during the competitive season and were provided with detailed information about the study, the objective, and the justification of the investigation. Through direct contact with the coaches, they explained and administered the questionnaire to their rowers. The survey was created using Google Docs technology [86], and it was tested before being released. Athletes received the necessary information about the study before completing the survey and provided written informed consent at the beginning of it. The participating rowers were provided with an email address to be able to ask any questions that they might have while filling out the questionnaire.

2.4. Statistical Analysis

In the current study, the Z-test for the comparison of proportions was employed to analyze the difference between two proportions or percentages in a sample. It will calculate the test statistic for the difference in proportions by approximating the normal distribution. The Z-test is a robust statistical tool that allows us to determine whether the observed differences between proportions are statistically significant or merely a result of chance. The null hypothesis is that the two proportions are equal, while the alternative hypothesis can be two-tailed, left-tailed, or right-tailed. The formula to calculate the Z-test statistic is:

$$Z = \frac{p_1 - p_2}{SEDP} = \frac{p_1 - p_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$$

This test is based on the normal approximation of the binomial distribution. We aim to compare two proportions, p_1 and p_2, observed in two different groups of sizes, n_1 and n_2, respectively. The Z-statistic follows a normal distribution. The confidence interval is obtained using the formula, where SEDP corresponds to the standard error of the difference in proportions as calculated in the previous formula. If the p-value corresponding to the Z-test statistic is less than the chosen significance level (0.05 for a 95% confidence level), then the null hypothesis can be rejected.

3. Results

A total of 775 injuries were described, 597 by men and 178 by women rowers. Within men rowers, 122 injuries were described by elite athletes, while 475 injuries were reported by non-elite athletes. Among women athletes, 49 injuries were reported by elite athletes, while 129 were reported by non-elite athletes (Table 1).

3.1. Characteristics of Injuries According to Competitive Level and Sex

Table 1 shows a list with characteristics of injuries and different comparisons: the differences for the total sample of injuries between men and women, the differences according to the competitive level, among elite and non-elite rowers, and the differences within each group in injury characteristics. Within the first comparison group among men and women injuries, statistically significant differences were found in high volume and competitive periods ($p < 0.01$), in the mode, with traumatism and overuse injuries ($p < 0.01$), at the severity, in 4–7 days and < 21 days ($p < 0.05$), and for starboard rowers ($p < 0.05$).

According to competitive level, men showed statistical differences ($p < 0.05$) in eight characteristics (high volume and competitive period, new injury or recurrent, in the injury severity 8–21 days, in athletes that row at bow and with those rowing in starboard and both sides), while elite and non-elite women's injuries showed statistical differences ($p < 0.05$) in the injury mode, traumatism, and overuse ($p < 0.05$).

Within each analyzed group (period, moment, type, mode, severity, rower position, and boat side), Table 1 shows how there are statistically significant differences within period, timing, type, and mode of injury in the overall male and female samples and at the elite and sub-elite levels for both men and women. However, injury severity does not show any significance for any of the groups, and rowing position only shows significant differences for men, showing a higher number of injuries for rowers rowing in the middle of the boat, in the total men's sample, and in the men's non-elite group. Finally, in relation to the side of the boat on which they row, a higher number of injuries is shown for rowers rowing on the port side in non-elite male rowers and elite female rowers, compared to starboard and those rowers that row on both sides.

Table 1. Characteristics of injuries in elite and non-elite male and female rowers.

	Male Rowers				Female Rowers				
	All (n = 597)	Elite (n = 122)	Non-Elite (n = 475)	p	All (n = 178)	Elite (n = 49)	Non-Elite (n = 129)	p	p
	% (n)	% (n)	% (n)		% (n)	% (n)	% (n)		
Period									
High volumes	78.9 (471) †	88.5 (108) †	76.4 (363) †	0.003 #	68.0 (121) †	63.3 (31) †	69.8 (90) †	0.406	0.003 *
Competitive period	21.1 (126)	11.5 (14)	23.6 (112)	0.003 #	32.0 (57)	36.7 (18)	30.2 (39)	0.406	0.003 *
Moment									
Training	90.5 (540) †	91.0 (111) †	90.3 (429) †	0.823	87.1 (155) †	81.6 (40) †	89.1 (115) †	0.182	0.194
Competition	9.5 (57)	9.0 (11)	9.7 (46)	0.823	12.9 (23)	18.4 (9)	10.9 (14)	0.182	0.194
Type									
New injury	73.9 (441) †	82.0 (100) †	71.8 (341) †	0.022 #	67.4 (120) †	61.2 (30) †	69.8 (90) †	0.277	0.091
Recurrent	26.1 (156)	18.0 (22)	28.2 (134)	0.022 #	32.6 (58)	38.8 (19)	30.2 (39)	0.277	0.091
Mode									
Traumatism	8.9 (53)	9.8 (12)	8.6 (41)	0.677	16.9 (30)	6.1 (3)	20.9 (27)	0.018 #	0.003 *
Overuse	91.1 (544) †	90.2 (110) †	91.4 (434) †	0.677	83.1 (148) †	93.9 (46) †	79.1 (102) †	0.018 #	0.003 *
Severity									
1–3 days	48.6 (290)	41.0 (50)	50.5 (240)	0.060	47.8 (85)	51.0 (25)	46.5 (60)	0.591	0.847
4–7 days	21.9 (131)	18.9 (23)	22.7 (108)	0.355	14.0 (25)	14.3 (7)	14.0 (18)	0.955	0.021 *
8–21 days	17.3 (103)	24.6 (30)	15.4 (73)	0.016 #	18.5 (33)	18.4 (9)	18.6 (24)	0.971	0.692
>21 days	12.2 (73)	15.6 (19)	11.4 (54)	0.206	19.7 (35)	16.3 (8)	20.9 (27)	0.490	0.012 *
Rower position									
Stern	20.9 (125)	23.0 (28)	20.4 (97)	0.540	21.3 (38)	16.3 (8)	23.3 (30)	0.314	0.906
Middle	33.7 (201) †	35.2 (43)	33.3 (158) †	0.679	34.3 (61)	40.8 (20)	31.8 (41)	0.257	0.882
Bow	20.3 (121)	13.1 (16)	22.1 (105)	0.028 #	17.4 (31)	18.4 (9)	17.1 (22)	0.837	0.400
Versatile	25.1 (150)	28.7 (35)	24.2 (115)	0.309	27.0 (48)	24.5 (12)	27.9 (36)	0.646	0.621
Boat side									
Port	39.4 (235)	41.0 (50)	38.9 (185) †	0.681	43.8 (78) †	53.1 (26) †	40.3 (52)	0.126	0.288
Starboard	35.7 (213)	43.4 (53)	33.7 (160)	0.045 #	27.5 (49)	26.5 (13)	27.9 (36)	0.854	0.044 *
Both	25.0 (149) †	15.6 (19) †	27.4 (130)	0.007 #	28.7 (51)	20.4 (10)	31.8 (41)	0.134	0.323

Note: * Significant differences between male and female rowers ($p < 0.050$); # significant difference between elite and non-elite rowers ($p < 0.050$); † significant differences in each group ($p < 0.050$).

3.2. Body Region of Injuries

Table 2 shows the different body regions of injuries for men and women rowers at elite and non-elite competitive levels. Among all the body regions, lower back ($p < 0.01$), shoulder ($p < 0.05$), and ankle ($p < 0.01$) injuries showed statistical differences between the total sample of men and women rowers, while the rest of the body regions showed no such significance. When it comes to the differences between elite and non-elite rowers, back ($p < 0.05$), ribs ($p < 0.01$), and leg ($p < 0.05$) injuries were statistically different for men, and pyramidal injuries ($p < 0.05$) resulted in being higher for elite women rowers. Finally, the lower back was found to be the most significantly recurrent injury in male rowers for their total sample, as well as for the elite and non-elite groups.

Table 2. Body region of injuries in elite and non-elite male and female rowers.

	Male Rowers				Female Rowers				
	All (n = 597)	Elite (n = 122)	Non-Elite (n = 475)	p	All (n = 178)	Elite (n = 49)	Non-Elite (n = 129)	p	p
	% (n)	% (n)	% (n)		% (n)	% (n)	% (n)		
Lower back	35.2 (210) †	36.1 (440) †	34.9 (166) †	0.818	19.1 (340)	20.4 (100)	18.6 (240)	0.785	<0.001 *
Shoulder	11.2 (67)	10.7 (13)	11.4 (54)	0.824	16.9 (30)	22.4 (11)	14.7 (19)	0.219	0.046 *
Back	8.7 (52)	4.1 (5)	9.9 (47)	0.043 #	7.3 (13)	10.2 (5)	6.2 (8)	0.359	0.552
Knee	5.7 (34)	6.6 (8)	5.5 (26)	0.645	9.6 (17)	4.1 (2)	11.6 (15)	0.126	0.069
Ribs	5.4 (32)	12.3 (15)	3.6 (17)	<0.001 #	6.2 (11)	6.1 (3)	6.2 (8)	0.984	0.675
Pelvis	3.7 (22)	0.8 (1)	4.4 (21)	0.060	3.4 (6)	0.0 (0)	4.7 (6)	0.125	0.844
Forearm	3.5 (21)	4.1 (5)	3.4 (16)	0.696	3.9 (7)	6.1 (3)	3.1 (4)	0.354	0.795
Wrist	3.5 (21)	5.7 (7)	2.9 (14)	0.136	1.1 (2)	2.0 (1)	0.8 (1)	0.474	0.099
Neck	2.8 (17)	0.8 (1)	3.4 (16)	0.131	1.7 (3)	0.0 (0)	2.3 (3)	0.282	0.391
Leg	2.8 (17)	0.0 (0)	3.6 (17)	0.034 #	0.6 (1)	0.0 (0)	0.8 (1)	0.537	0.076
Elbow	2.3 (14)	3.3 (4)	2.1 (10)	0.445	2.2 (4)	2.0 (1)	2.3 (3)	0.909	0.939
Arm	2.2 (13)	4.1 (5)	1.7 (8)	0.103	4.5 (8)	6.1 (3)	3.9 (5)	0.518	0.095
Hip	2.2 (13)	1.6 (2)	2.3 (11)	0.648	2.8 (5)	2.0 (1)	3.1 (4)	0.702	0.623
Hand	2.0 (12)	3.3 (4)	1.7 (8)	0.263	1.7 (3)	0.0 (0)	2.3 (3)	0.282	0.783
Psoas	2.0 (12)	0.8 (1)	2.3 (11)	0.294	3.9 (7)	4.1 (2)	3.9 (5)	0.950	0.145
Thigh	1.7 (10)	0.0 (0)	2.1 (10)	0.106	1.7 (3)	2.0 (1)	1.6 (2)	0.820	0.992
Abdomen	1.2 (7)	0.8 (1)	1.3 (6)	0.685	2.8 (5)	2.0 (1)	3.1 (4)	0.702	0.121
Ankle	1.0 (6)	2.5 (3)	0.6 (3)	0.071	3.9 (7)	2.0 (1)	4.7 (6)	0.424	0.008 *
Foot	0.8 (5)	0.8 (1)	0.8 (4)	0.981	1.1 (2)	2.0 (1)	0.8 (1)	0.474	0.723
Abductor	0.7 (4)	0.8 (1)	0.6 (3)	0.820	0.6 (1)	0.0 (0)	0.8 (1)	0.537	0.874
Clavicle	0.5 (3)	0.8 (1)	0.4 (2)	0.579	0.6 (1)	0.0 (0)	0.0 (0)	-	0.923
Pyramidal	0.3 (2)	0.0 (0)	0.4 (2)	0.473	1.1 (2)	4.1 (2)	0.0 (0)	0.021 #	0.198
Fingers	0.2 (1)	0.0 (0)	0.2 (1)	0.612	2.2 (4)	0.0 (0)	3.1 (4)	0.213	0.002
Twin	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.6 (1)	0.0 (0)	0.8 (1)	0.537	0.363
Chest	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.6 (1)	2.0 (1)	0.8 (1)	0.474	0.363

Note: * Significant differences between male and female rowers ($p < 0.050$); # significant difference between elite and non-elite rowers ($p < 0.050$); † significant differences in each group ($p < 0.050$).

3.3. Diagnosis of Injuries

Table 3 shows the diagnosis of the suffered injuries, with muscular cramps ($p < 0.01$) and tendinitis ($p < 0.01$) being the highest diagnosed injuries for the total sample of men and women and being higher in female rowers, while sciatica ($p < 0.05$) was higher diagnosed for male rowers. In relation to the competitive level, significant differences were found in muscular cramps, Tendinitis, Sprain, fissure, and vertebral displacement for male's rowers. Muscle micro-tears were significantly higher in elite women than in non-elite women ($p < 0.05$). Finally, in the comparison of different diagnoses, muscle cramps and tendinitis were statistically significant and higher than the rest of the diagnoses for the total sample of men and women rowers ($p < 0.05$). Likewise, when it comes to the different groups, women and men who are non-elite rowers showed that muscle cramps and tendinitis were higher statistically ($p < 0.05$). On the other hand, in elite rowers, even though the number of diagnoses was also higher, only muscle cramps were found to show significant differences ($p < 0.05$). While this significance was not found for elite male rowers, a diagnosis of tendinitis was not significantly higher for both elite men and women.

Table 3. Diagnosis of injuries in elite and non-elite male and female rowers.

	Male Rowers				Female Rowers				
	All (n = 597)	Elite (n = 122)	Non-Elite (n = 475)	p	All (n = 178)	Elite (n = 49)	Non-Elite (n = 129)	p	p
	% (n)	% (n)	% (n)		% (n)	% (n)	% (n)		
Muscle Cramp	48.2 (288) †	32.8 (40)	52.2 (248) †	<0.001 #	73.0 (41) †	51.0 (25) †	37.2 (48) †	0.094	<0.001 *
Tendinitis	19.1 (114) †	27.9 (34)	16.8 (80) †	0.006 #	30.0 (17) †	14.3 (7)	17.8 (23) †	0.573	0.003 *
Muscle Tear	5.5 (33)	4.9 (6)	5.7 (27)	0.741	10.0 (6)	4.1 (2)	6.2 (8)	0.583	0.202
Muscle micro-tears	3.7 (22)	5.7 (7)	3.2 (15)	0.177	4.0 (2)	6.1 (3)	0.8 (1)	0.032 #	0.103
Overload	3.2 (19)	3.3 (4)	3.2 (15)	0.946	11.0 (6)	2.0 (1)	7.8 (10)	0.158	0.849
Sprain	3.0 (18)	5.7 (7)	2.3 (11)	0.049 #	5.0 (3)	0.0 (0)	3.9 (5)	0.162	0.298
Sciatica	2.5 (15)	2.5 (3)	2.5 (12)	0.966	0.0 (0)	0.0 (0)	0.0 (0)	-	0.033 *
Fracture	1.8 (11)	0.8 (1)	2.1 (10)	0.346	4.0 (2)	0.0 (0)	3.1 (4)	0.213	0.600
Contusion	1.3 (8)	1.6 (2)	1.3 (6)	0.747	3.0 (2)	4.1 (2)	0.8 (1)	0.126	0.679
Fissure	1.3 (8)	4.1 (5)	0.6 (3)	0.003 #	5.0 (3)	2.0 (1)	3.1 (4)	0.702	0.812
Herniated disc	1.3 (8)	1.6 (2)	1.3 (6)	0.747	1.0 (1)	0.0 (0)	0.8 (1)	0.537	0.251
Displacement	1.2 (7)	0.0 (0)	1.5 (7)	0.177	7.0 (4)	2.0 (1)	4.7 (6)	0.424	0.303
Dislocation	1.2 (7)	1.6 (2)	1.1 (5)	0.591	7.0 (4)	6.1 (3)	3.1 (4)	0.354	0.303
Vertebral displacement	1.0 (6)	3.3 (4)	0.4 (2)	0.005 #	0.0 (0)	0.0 (0)	0.0 (0)	-	0.179
Inflammation	0.7 (4)	0.8 (1)	0.6 (3)	0.820	1.0 (1)	0.0 (0)	0.8 (1)	0.537	0.587
Meniscus wear	0.5 (3)	0.0 (0)	0.6 (3)	0.379	2.0 (1)	2.0 (1)	0.8 (1)	0.474	0.836
Superficial injury	0.5 (3)	0.8 (1)	0.4 (2)	0.579	3.0 (2)	0.0 (0)	2.3 (3)	0.282	0.502
Protrusion	0.5 (3)	0.8 (1)	0.4 (2)	0.579	0.0 (0)	0.0 (0)	0.0 (0)	-	0.343
Joint impingement	0.3 (2)	0.0 (0)	0.4 (2)	0.473	3.0 (2)	0.0 (0)	2.3 (3)	0.282	0.298
Bursitis	0.3 (2)	0.8 (1)	0.2 (1)	0.299	1.0 (1)	0.0 (0)	0.8 (1)	0.537	0.968
Irritation	0.3 (2)	0.0 (0)	0.4 (2)	0.473	2.0 (1)	0.0 (0)	1.6 (2)	0.381	0.584
Low back pain	0.3 (2)	0.0 (0)	0.4 (2)	0.473	0.0 (0)	0.0 (0)	0.0 (0)	-	0.439
Meniscus tear	0.0 (0)	0.0 (0)	0.0 (0)	-	2.0 (1)	2.0 (1)	0.8 (1)	0.474	0.052
Femoroacetabular impingement	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Muscle strain	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Spondylitis	0.2 (1)	0.0 (0)	0.2 (1)	0.612	1.0 (1)	0.0 (0)	0.8 (1)	0.537	0.699
Plantar fasciitis	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Pilonidal fistula	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Tendon impingement	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Burns	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Rheumatism	0.2 (1)	0.0 (0)	0.2 (1)	0.612	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Sacralgia	0.2 (1)	0.8 (1)	0.0 (0)	0.048	0.0 (0)	0.0 (0)	0.0 (0)	-	0.585
Calcifying myositis	0.0 (0)	0.0 (0)	0.0 (0)	-	1.0 (1)	2.0 (1)	0.0 (0)	0.104	0.170
Other	0.5 (3)	0.0 (0)	0.6 (3)	0.379	2.0 (1)	2.0 (1)	0.8 (1)	0.474	0.836

Note: * Significant differences between male and female rowers ($p < 0.050$); # significant difference between elite and non-elite rowers ($p < 0.050$); † significant differences in each group ($p < 0.050$).

4. Discussion

The main objective of this study was to analyze and describe the incidence of injury patterns in Traineras rowing. The main finding of this research was that the majority of injuries occurred during high-volume training periods. Most of them are new injuries for men and women. The most injured body regions in this rowing modality were the low back and shoulders, while the main diagnoses were muscle cramps and tendinitis for most of the rowers.

To our knowledge, investigations carried out on fixed-seat rowing injuries are practically non-existent in the scientific literature about Traineras. However, due to their similarity, research about Traineras has been compared to the Olympic rowing modality [1–3,5]. Therefore, despite the substantial heterogeneity of injury-reported methodologies in Olympic rowing research [57], our results will be compared to the existing literature related to injuries in Olympic rowing and also to the existing literature about injuries in other fixed-seat rowing modalities.

The results obtained showed that, irrespective of competitive level and gender, overuse injuries were much higher than those caused by trauma ($p < 0.01$) in Traineras rowing, results that are in line with previous research that described injuries in Olympic rowing in general [56]. In elite rowers [50,63] junior, senior, and master rowers [62], and female rowers [57]. Likewise, the result of this study fits well with Mediterranean fixed-sit rowing injuries [85]. These results make sense since, given the cyclic character of these rowing modalities and not physical contact, most injuries are the result of chronic overuse [56]. Within injury characteristics, our results showed that training periods and high-volume periods were statistically associated with a higher incidence of injury, in accordance with a previous investigation [85], and in the same line, new injuries were significantly higher than recurrent injuries.

The body region has been the most analyzed variable when trying to understand the prevalence of injuries in sports in general and also in rowing. The results described that the main injured body region was the low back, a similar result with previous investigations in Olympic rowing [64,66,69,71] and with an investigation carried out in Maltese traditional fixed-sit rowing [84]. However, the results were only partially in line with previous research carried out in Spanish Mediterranean rowers since the main injured body region was the ankle due to sprains over low back pain injuries, which were in second position [85]. The results showed that the second injured body region in Traineras rowing were the shoulders, only partially in line with results in previous investigations in Olympic rowing, since the following injured regions after the low back were the knee [51] and chest [49,60]. Related to rib stress fractures [55,58,67,82], and then shoulders were described in less number. In fact, the shoulder is considered a less common injury in Olympic rowing [60]. However, the results are in line with previous investigations in other fixed-seat rowing modalities, such as Mediterranean rowing [85] and Maltese traditional rowing [84], since shoulders were described as the most injured body regions. From these results, it could be interpreted that the fact that the flexion-extension of the trunk is more pronounced than in Olympic rowing and trunk rotation is needed significantly in the last part of the stroke influences the injury to the shoulders.

Within injuries per body region, the results showed that there were statistical differences between men and women in low back ($p < 0.01$). showing a higher incidence for male rowers. in the total sample and in both. elite and non-elite rowers. Our results showed that injuries in the low back were about 35% of the total for men, while in women, being the highest injured body region as well, they did not reach 20%. These results are in line with previous investigations in Olympic rowing, since the low back was the body region that showed the most injuries in elite [50,63], subelite [51,70], and international master rowers [51]. On the other hand, our results showed that the second body region with the most injuries was the shoulder, being statistically higher for women than men ($p < 0.05$). While almost 17% of the injuries were in the shoulders for women, in men, this body region collected 11.2% of the total injuries. Previous literature showed differences among men and women in Olympic rowing., e.g., comparing lightweight and open-weight rowers, and have demonstrated conflicting results [59] but no investigation in fixed-seat rowing have shown such a comparation.

Lastly, when it comes to the diagnosis of injuries, it should be noted the importance of the right diagnosis since it helps with better treatment and prevention [87]. Our results showed that muscle cramps were the most commonly diagnosed in Traineras rowing, showing statistical differences between men and women ($p < 0.01$), which was not in line with previous investigations in Olympic rowing [54]. On the other hand, our results showed that the second-ranked diagnosis for men and women rowers was tendinitis, being statistically higher in women and according to competitive level in men ($p < 0.05$). These results partially coincide with previous research in senior international Olympic rowers [50], since tendinitis was one of the main diagnoses of injury [62]. Other than that, our results are partially in line with the previous research about Mediterranean traditional rowing injuries, since tendinitis was one of the main diagnoses, after sprains and fractures [85]. Our results showed that sciatica diagnosis was statistically higher for men Traineras rowers than for women ($p < 0.05$), despite the low number of this type of diagnosis that were found. However, these results should be treated with caution since the heterogeneity of injury reported methodologies in rowing sport research is a fact [57], and further investigation would be needed taking into account the previously used methodologies.

Based on this first approach, the main injuries, their characteristics, and affected body regions are described, making this useful information for athletes, coaches, and physiotherapists. In addition, different professionals are involved in the performance of this sport. Future studies are needed to better understand the incidence of injuries in Traineras rowing, e.g., the training and biomechanical aspects that influence those injuries.

5. Conclusions

In conclusion, this study shows that the low back is the main body region affected by an injury in this sport, and shoulders are highly injured, finding differences between men and women. Moreover, most of the injuries are due to overuse and related to muscle cramps and tendinitis, partially in line with previous investigations carried out in different rowing modalities. This information will be helpful in creating a specific injury prevention plan to help athletes and coaches decrease the incidence of injuries, therefore helping them to improve continuity and reach their highest performance.

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