

Implications of tendinopathy on the sports career: Epidemiological and clinical profile of high-performance athletes

Lucas Rafael Lopes^{a,b}, Daniel Escorsim Machado^a, Rodrigo Araújo Goes^{c,d},
 Marcus Vinícius Galvão Amaral^c, Francisca Dias^e, Valéria Tavares^{e,f,g,h,i}, Rui Medeiros^{e,f,g,h,i},
 Jamila Alessandra Perini^{a,*}

^a Research Laboratory of Pharmaceutical Sciences (LAPESF), State University of Rio de Janeiro (UERJ), Rio de Janeiro, RJ, Brazil

^b Program of Post-graduation in Public Health and Environment, National School of Public Health, Oswald Cruz Foundation, Rio de Janeiro, Brazil

^c Research Division, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil

^d Lisbon Medical University, Lisbon, Portugal

^e Molecular Oncology and Viral Pathology Group, Research Center of IPO Porto (CI-IPOP)/ Pathology and Laboratory Medicine Dep., Clinical Pathology SV/ RISE@CI-IPOP (Health Research Network), Portuguese Oncology Institute of Porto (IPO Porto) / Porto Comprehensive Cancer Centre (Porto.CCC), 4200-072, Porto, Portugal

^f Faculty of Medicine of University of Porto (FMUP), 4200-072, Porto, Portugal

^g Abel Salazar Institute for the Biomedical Sciences (ICBAS), 4050-313, Porto, Portugal

^h Research Department, Portuguese League Against Cancer (NRNorte), 4200-172, Porto, Portugal

ⁱ Faculty of Health Sciences, Fernando Pessoa University, 4200-150, Porto, Portugal

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ABSTRACT

Objective: To identify the prevalence of tendinopathy and describe the predictive factors of condition and chronic tendon pain in high-performance athletes.

Design: Cross-sectional observational study.

Setting: Sports training centers and competitions.

Participants: Federated high-performance athletes.

Main outcome measures: Tendinopathy and chronic tendon pain.

Results: Out of all recruited athletes, 30.6% had a confirmed diagnosis of tendinopathy. Tendinopathy prevalence was 36.5% in athletes with extremely high training exposure index (TEI), compared to 21.9% in those with low TEI ($p = 0.03$). There was a significant difference in the prevalence of tendinopathy sites between the sport modalities, TEI classification and sex. Almost 60% had chronic tendon pain, 48% had required a break from training, and 19% reported that the condition affected two or more tendons. Being older than 25 years (OR = 3.5; 95%CI = 2.0–6.2), female sex (OR:0.5; 95%CI:0.3–0.9) and receiving nutritional guidance (OR:1.7; 95%CI:1.3–2.4) were identified as factors associated with tendinopathy. Protection from chronic tendon pain was associated with male sex (OR:0.6; 95%CI:0.3–0.9) and nutritional guidance (OR:0.5; 95%CI:0.3–0.9).

Conclusion: This study reports the difference of tendinopathy prevalence according to sexes stratified by TEI classification. Chronic tendon pain was associated with female sex, lack of nutritional guidance, and more than three episodes of condition manifestation.

1. Introduction

Tendinopathy is a multifactorial condition that affects individuals exposed to ergonomic risks and represents a serious occupational public health problem worldwide (Hopkins et al., 2016; Millar et al., 2021). The prevalence of the condition ranges from 1 to 6% in the general population (Millar et al., 2021), and from 10 to 50% in

high-performance athletes (Goes et al., 2020). This discrepancy can be explained by the intense workload throughout an athlete's career, with the duration, intensity, frequency, and volume of training regimens imposing a mechanical overload on the tendon (Abat et al., 2017).

The recognition of athletes as individuals vulnerable to occupational risks is not pragmatic and equitable, leading them to exceed their physical and mental limits, making them more susceptible to

* Corresponding author. State University of Rio de Janeiro (UERJ), Avenida Manuel Caldeira de Alvarenga, 1.203, 23070-200, Rio de Janeiro, RJ, Brazil.

E-mail addresses: jamila.machado@uerj.br, jamilaperini@yahoo.com.br (J.A. Perini).

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$$\text{TEI (MET-years)} = \frac{\text{WTH} \times \text{WNY} \times \text{YSP} \times \text{MET}}{\text{NHY}}$$

Legend:

TEI = Training exposure index

WTH = Weekly training hours (informed by the athlete on the questionnaire)

WNY = Week number in the year (constant = 52.143)

YSP = Years of sports practice (informed by the athlete on the questionnaire)

MET = Metabolic equivalent of task (constant by sport, according to 2011 Compendium of Physical Activities)

NHY = Number of hours in the year (constant = 8760)

Fig. 1. – Formula developed to estimate the training exposure index.

musculoskeletal injuries (Mann et al., 2020). This scenario is further exacerbated in times of crisis, such as the COVID-19 pandemic, when athletes performed adapted training regimens at home to maintain their athletic performance. Though, 20% suffered injuries during social isolation, with 17% being due to tendinopathy (Lopes et al., 2021). Inclusive, depression acquired during this period was associated with a higher risk of musculoskeletal injuries in a study of 474 Brazilian athletes from different sports modalities (Lopes, de Souza, et al., 2023), highlighting the influence of mental health on the athlete's athletic and physical performance.

Regarding the condition pathogenesis, intrinsic and extrinsic factors are recognized as contributing to the phenotype of tendinopathy in athletes (Millar et al., 2021). The former include age, sex, genetic factors, body mass index (BMI), metabolic disorders (such as diabetes mellitus, hypertension, dyslipidemia, and hyperuricemia), flexibility, excessive or limited joint mobility, muscle weakness, and tendon anatomic changes. Meanwhile, extrinsic determinants encompass overuse of the tendon, smoking, training errors, hormonal influences, medications (for instance, fluoroquinolones and excessive corticosteroids), occupational, ergonomic, environmental, and psychological risks, and, most importantly, excessive sports activities (Millar et al., 2021; Hopkins et al., 2016; Ribbans & Collins, 2013).

The signs and symptoms of tendinopathy include pain and limited range of motion during occupational activities. Of note, patients may be asymptomatic in the preclinical stage (Lowerens et al., 2015). In advanced stages, in addition to chronic pain, there is stiffness in the tendon in the morning or after prolonged rest (Morton et al., 2015). For athletes, the physical and psychosocial limitations of the condition have a direct impact on their quality of life, causing loss of productivity and potentially leading to their early retirement due to disability (Oliveira et al., 2022). Tendinopathy is also a major burden on the healthcare system due to the high costs associated with diagnosis, rehabilitation, and chronic treatment with medications, physical therapy, and even surgery (Hopkins et al., 2016).

Given the implications, it is crucial to gain a better understanding of the athlete's susceptibility to musculoskeletal injuries such as

tendinopathy, which could lead to early career termination. This could allow the creation of complex risk assessment models (RAMs) that include modifiable and non-modifiable factors that could help prevent and manage tendinopathy in the sports environment (Corsini et al., 2020). Thus, this study aims to identify the prevalence of tendinopathy and describe the sociodemographic, lifestyle, athletic, and clinical profiles of a cohort of high-performance athletes with the condition and chronic tendon pain, hypothesizing the relationship between the condition and its contributing factors within their sporting context.

2. Methods

2.1. Study design and population

A cross-sectional observational study was conducted with 831 Brazilian high-performance athletes recruited between February 2018 and June 2023 at sports training centers or competitions in the city of Rio de Janeiro. The participants provided written consent for the research and answered to the questionnaire validated by experts in the field, titled "Report on Musculoskeletal Injuries in Brazilian Athletes", which was previously published (Goes et al., 2020). All questionnaires were checked and stored in an Excel spreadsheet by a qualified researcher, and the data was reviewed by two other researchers at different times. This study was approved by the institutional Research Ethics Committee (protocol 2.455.630/2017).

The inclusion criteria for the study were active high-performance athletes who self-declared themselves as professionals in a sport at federated sports training centers and who actively participated in national and/or international competitions. They were aged between 18 and 45 years and represented a diverse range of sports modalities. Noteworthy, high-performance athletes can be defined by a complexity of factors such as receiving a salary for sports, having high levels of oxygen volume at anaerobic and aerobic thresholds, with running economy, anthropometric characteristics, participation in high-level competitions, and training characteristics (intensity, frequency, and duration) being also important determinants (Lorenz et al., 2013).

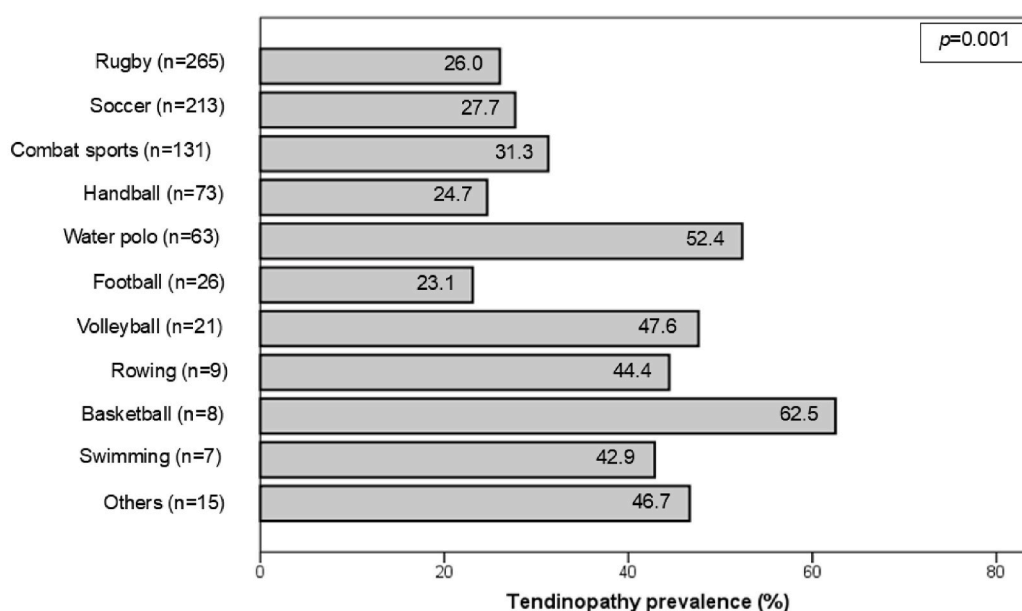
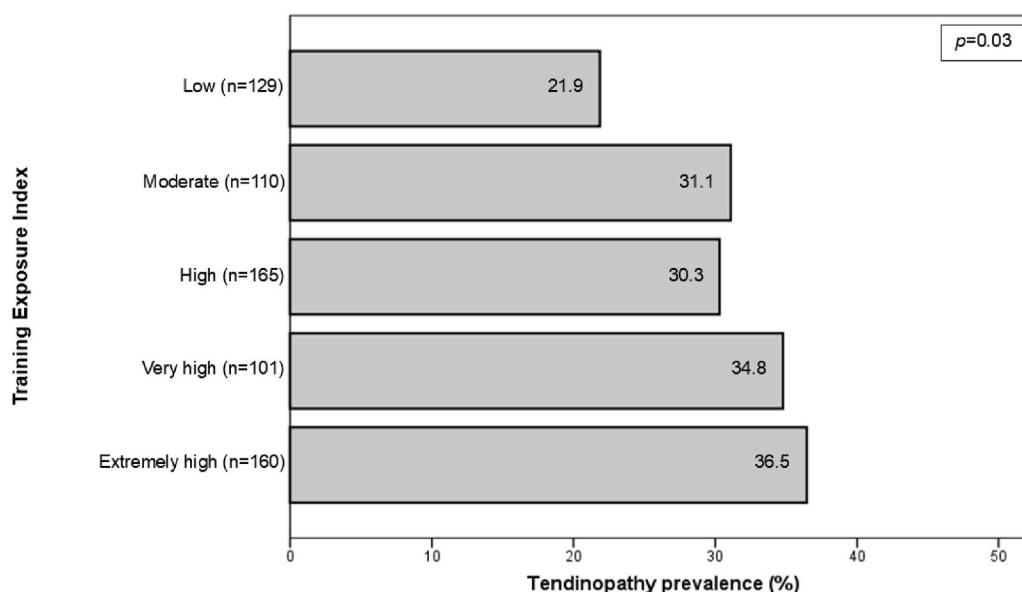
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Fig. 2. – Tendinopathy prevalence in the eligible athletes according to sports modality (A) and training exposure index classification (B). p -Value was obtained by the Chi-square test.

Therefore, athletes who did not provide information on their level of competition (national and/or international) or who had a history of musculoskeletal injuries (MSIs) not related to sports practice, including injuries that occurred before the start of their sports career, were excluded from the study.

2.2. Data collection and analysis

Sociodemographic (age, sex, skin color, body weight, height, education, and family income), lifestyle (alcohol consumption, smoking, nutritional guidance, and continuous medication use), sports (sports

modality, competition level, training location, years of sports practice, and weekly training hours), and clinical information related to tendinopathy (affected tendon, episodes of tendinopathy manifestation, chronic tendon pain, training break, clinical, and treatment of the condition) were collected.

Length of exposure to sports training was estimated by developing a formula (Fig. 1). Namely, Training Exposure Index (TEI), in MET-years, which represented the amount of time an athlete engaged in physical activity related to sports. It was calculated according to the metabolic equivalent of task (MET) values defined by the sports modality outlined in the 2011 Compendium of Physical Activities (Ainsworth et al., 2011).

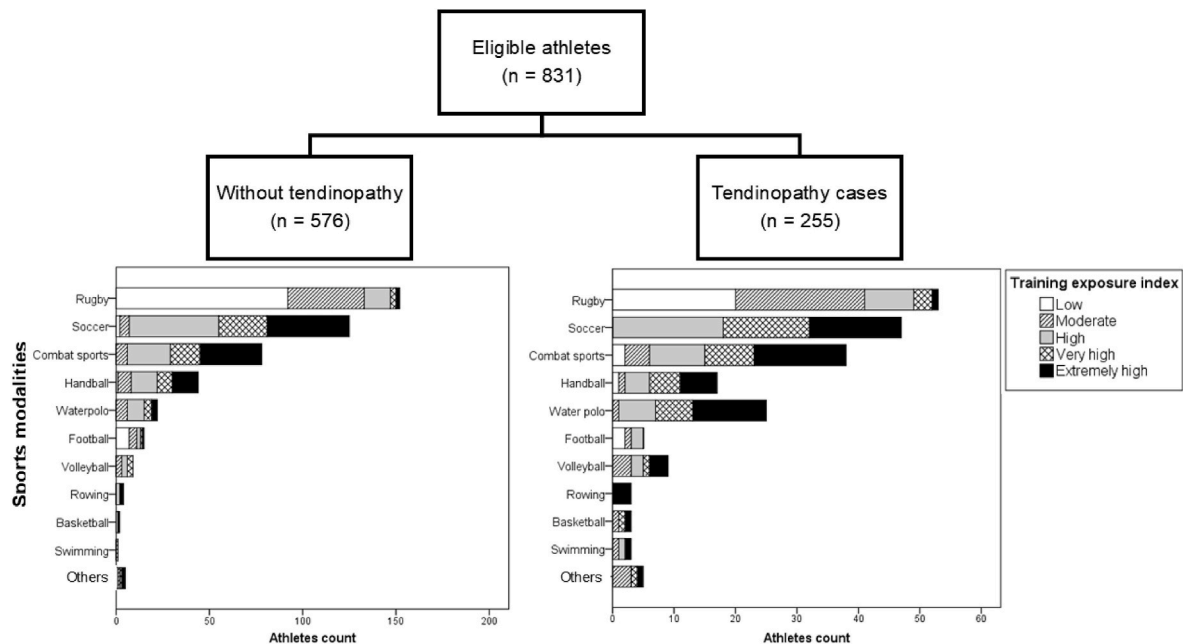


Fig. 3. – Flowchart of eligible athletes for the study categorized into case groups and those without a diagnosis of tendinopathy. In each group, athletes were categorized by sport modality and by training exposure index according to the MET-years score.

Specifically, TEI was defined as the sum of weekly training hours throughout each athlete's entire sports career equated to the MET-years of the athlete's exposure to sports training.

Athletes who reported clinically diagnosed tendinopathies by specialized orthopedists (confirmed via physical exam and/or imaging) comprised the case group for this study. They were the focus of investigation regarding the type, location, episodes of condition manifestation, and presence of chronic tendon pain.

The prevalence of tendinopathy was calculated as the total number of athletes diagnosed with tendinopathy divided by the total number of athletes recruited in each selected sport modality and categorized according to the TEI based on MET values.

Athletes without evidence and who did not self-report MSK-i during their lifetime were considered the comparison group, enabling an exploration of the contributing factors for tendinopathy in high-performance athletes. Those who were not diagnosed with tendinopathy but had a history of muscle or joint injury were not considered for the association analysis. Subsequently, the case group was analyzed for predictors of chronic tendon pain.

The associations found in this study were systematically linked through the qualitative exploratory method, based on the risk factors previously described in the literature for tendinopathy (Goes et al., 2020; Millar et al., 2021; Ribbans & Collins, 2013).

2.3. Statistical analysis

The normality of continuous variables was assessed using the Kolmogorov Smirnov test. Continuous variables were presented as mean $\pm$ standard deviation (SD). However, according to their distribution and clinical significance, for the association analysis, the age and years of sports practice were divided into quartiles. The body mass index (BMI) was categorized according to the National Institute of Health (NIH) in normal weight (<25.0 kg/m²), overweight (25.0–29.9 kg/m²), and obesity (≥ 30 kg/m²) (Weir and Jan, 2023). In turn, the TEI was classified as low (<3.0 MET-years), moderate (3.0–5.9 MET-years), high (6.0–9.9 MET-years), very high (10.0–14.9 MET-years), and extremely high (≥ 15.0 MET-years). Categorical data was expressed as a percentage. In the analysis of the prevalence, athletes participating in sports with an index distribution lower than 5% of the entire studied

population were grouped as "others". Differences between means of continuous variables were assessed using the independent samples *t*-test or ANOVA, while differences in proportions of categorical variables were evaluated using the Chi-square test (χ^2).

The Odds Ratios (OR) were estimated using the method of unconditional logistic regression to determine the influence of each variable under study. For the construction of a final model, the biological importance of each variable and the level of statistical significance in the univariate analyses were considered, with an entry $p = 0.20$ and an exit $p = 0.05$. All statistical analyses were performed using the SPSS statistical package, version 20.0, and a $p < 0.05$ was considered statistically significant.

3. Results

Out of the 831 eligible athletes, 30.6% ($n = 255$) had a confirmed diagnosis of tendinopathy, and 22.5% ($n = 187$) were free of MSK-I during their athletic career. Although the 46.8% ($n = 389$) of athletes who had self-reported a history of other sports injuries were not part of the comparison group in this study, they contributed to the estimation of the prevalence of tendinopathy in each sport modality (Fig. 2A) and according to the athletes' TEI (Fig. 2B), which showed significant differences in two comparative analyses.

The distribution of eligible athletes based on sport modality and TEI purpose classification is shown in Fig. 3. The recruited athletes had a mean age of 24.6 ± 5.5 years, a BMI of 24.9 ± 3.7 kg/m², a training time of 10.5 ± 6.4 years, and a TEI of 9.9 ± 8.9 MET-years. It was observed that age (25.7 ± 5.8 vs. 22.7 ± 4.5 years, $p < 0.001$), BMI (25.3 ± 3.6 vs. 24.5 ± 3.3 kg/m², $p = 0.02$), duration of sport practice (11.6 ± 6.4 vs. 8.6 ± 6.0 years, $p < 0.001$), and TEI (11.1 ± 8.6 vs. 7.4 ± 6.5 MET-years, $p < 0.001$) differed significantly between athletes with tendinopathy and those without MSK-I, respectively. The association analysis of the sociodemographic profile, lifestyle, and sport characteristics between tendinopathy cases and those non-MSK-I athletes is described in Table 1.

Of 483 athletes with a TEI of 6.0 MET-years (higher), 67.8% ($n = 367$) were male, whereas 59.9% ($n = 173$) of athletes with low or moderate TEI were female. The prevalence of tendinopathy was higher in female athletes with low and moderate TEI classification; however,

Table 1

Association analyses of sociodemographic, lifestyle, sport, and clinical characteristics between tendinopathy cases and athletes without musculoskeletal injuries.

Characteristics	Controls (n = 187)	Tendinopathy (n = 255)	p-Value ^a and ^b	Adjusted OR(95% CI) ^b
Sociodemographic	n (%)			
Age (years)				
≤20	83 (44.4)	58 (22.7)	<0.01	1 ^c
21–24	50 (26.7)	57 (22.4)		1.97 (1.15–3.38)
25–28	29 (15.5)	68 (26.7)		3.49 (1.96–6.21)
>28	25 (13.4)	72 (28.2)		3.53 (1.92–6.48)
Male sex	127 (67.9)	156 (61.2)	0.03	0.62 (0.39–0.96)
BMI (Kg/m ²)				
<25	121 (64.7)	133 (52.2)	0.09	1 ^c
25–29.9	55 (29.4)	101 (39.6)		1.44 (0.92–2.26)
≥30	11 (5.9)	21 (8.2)		2.18 (0.93–5.12)
Income family ≤ \$2017,88 ^d	139 (76.4)	166 (66.1)	0.21	0.74 (0.46–1.18)
Lifestyle				
Alcohol consumption ^e	102 (54.5)	157 (62.1)	0.21	1.31 (0.86–1.98)
Nutritional guidance	86 (46.0)	175 (68.6)	<0.01	2.02 (1.32–3.09)
Continuous medication use ^f	17 (9.3)	41 (16.2)	0.38	1.35 (0.69–2.66)
Chronic disease ^g	3 (1.6)	10 (4.0)	0.59	1.47 (0.36–6.02)
Training				
Years of sports practice ^g				
≤20	67 (35.8)	49 (19.2)	0.67	1 ^c
21–24	60 (32.1)	75 (29.4)		1.41 (0.80–2.49)
25–28	39 (20.9)	60 (23.5)		1.39 (0.66–2.94)
>28	21 (11.2)	71 (27.8)		1.63 (0.60–4.46)
TEI (MET-years) ^g				
Low	59 (31.6)	40 (15.7)	0.51	1 ^c
Moderate	37 (19.8)	51 (20.0)		1.42 (0.75–2.70)
High	44 (23.5)	50 (19.6)		1.20 (0.64–2.27)
Very high	22 (11.8)	48 (18.8)		1.77 (0.88–3.59)
Extremely high	25 (13.4)	66 (25.9)		1.61 (0.80–3.24)

BMI: body mass index, CI: confidence interval, OR: Odds ratios, TEI: Training Exposure Index.

^a $p < 0.05$ was obtained through the Chi-square test (Pearson's p -value).^b OR adjusted by age, sport, nutritional guidance, and TEI.^c Reference group for variables with more than two categories.^d Information obtained from 433 athletes.^e Information obtained from 440 athletes.^f Information obtained from 436 athletes, and the value was divided according to median.^g Information obtained from 442 athletes.

the condition was more frequent among male athletes with high intensity TEI, presenting a significant difference in prevalence by sex according to TEI classification (Fig. 4A). The most affected sites in self-reported cases of tendinopathy were the patellar (41.6%; $n = 106$), rotator cuff (33.3%; $n = 85$), epicondyles (27.8%; $n = 71$), and Achilles tendons (14.5%; $n = 37$). In addition, there was a significant difference in the prevalence of epicondylitis, patellar tendinopathy, and rotator cuff tendinopathy between the sexes (Fig. 4B).

Regarding the clinical data of the tendinopathy cases ($n = 255$), 18.8% ($n = 48$) of the athletes reported the condition affecting two or more tendons, and 21.2% ($n = 54$) reported three or more episodes of the condition manifestation during their sports careers. Approximately 58.9% ($n = 149$) of athletes reported chronic tendon pain and 46.2% ($n = 117$) had required a break from training, with 23.2% ($n = 26$) having a break longer than 30 days. The main treatments for tendinopathy were physical therapy (71.4%; $n = 177$) and the use of anti-inflammatory drugs (37.1%; $n = 92$).

Comparing the sociodemographic profile, lifestyle, and sports characteristics according to the sex of the tendinopathy cases, it was observed that BMI ≥ 25.0 kg/m² ($p < 0.01$), family income $\geq \$2017.88$ (R \$10,000.00) ($p = 0.01$), training time > 10 years ($p = 0.01$), and TEI > 6.0 MET-years ($p < 0.01$) were predominant in males compared to their counterparts. Conversely, women were more likely to have a college education ($p < 0.01$) and to be on continuous medication ($p = 0.02$), with 50% using oral contraceptives.

In order to investigate the factors associated with chronic tendon pain (Table 2), the quality of the model was assessed by the Hosmer-Lemeshow test ($p = 0.30$), the variables sex, type of sport, nutritional

guidance, and episodes of condition manifestation were considered as confounding variables ($p = 0.02$).

In addition, the use of anti-inflammatory medications for tendinopathy treatment was associated with loss of training (OR: 2.1, 95% CI: 1.2–3.6) as well as the condition manifestation in more than three episodes (OR: 3.1, 95% CI: 1.6–5.8) (Fig. 5A and B, respectively).

4. Discussion

To our knowledge, this is the first study to explore a sample of high-performance Brazilian athletes to investigate the implications of tendinopathy on their athletic careers. Due to the chronic nature of the condition, prevalence is the appropriate risk measure to assess the proportion of cases present, whether in remission or exacerbation, at a given point in time (Bahr, 2009). High-performance athletes have a 10-fold higher prevalence of tendinopathy than the general population (Hopkins et al., 2016; Millar et al., 2021). In Brazil, tendinopathy was reported as the most common overuse injury in approximately 92% of cases in a prospective cohort study of elite handball players from teams participating in the São Paulo State Adult and National League Championships (Giroto et al., 2017). In a previous study by our group, a condition prevalence of 30% was observed in a cohort of 627 athletes participating in rugby, soccer, combat sports, handball, and water polo. This prevalence ranged from 20% in handball players to 50% in water polo players (Goes et al., 2020). In addition, one additional match per week was found to increase the odds of tendinopathy by 1.3 times in high-performance handball players (Giroto et al., 2017), which is consistent with our findings that the prevalence of tendinopathy was

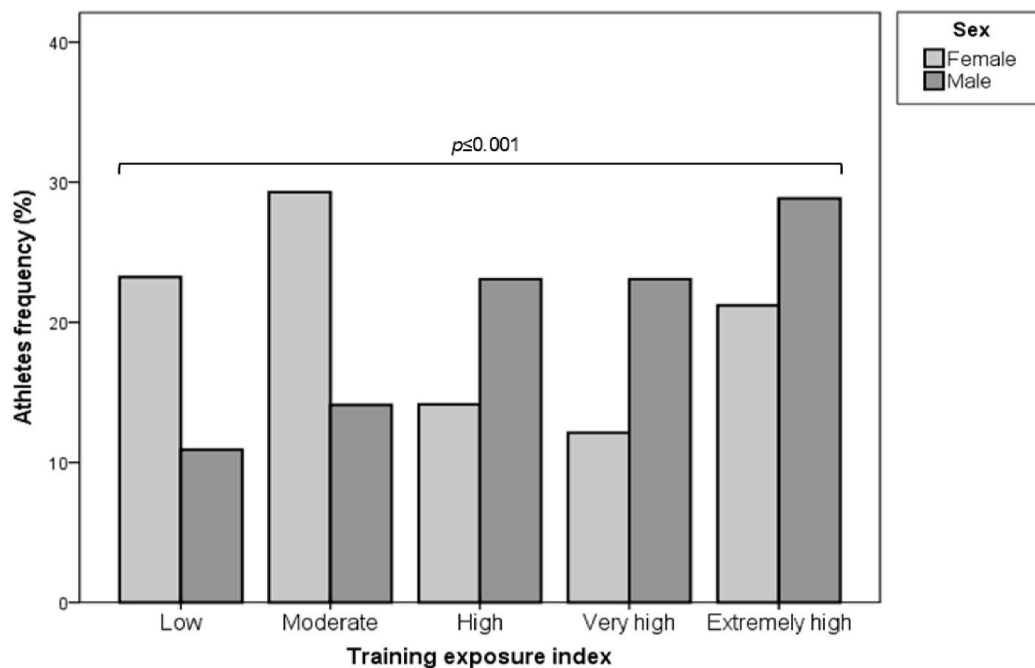
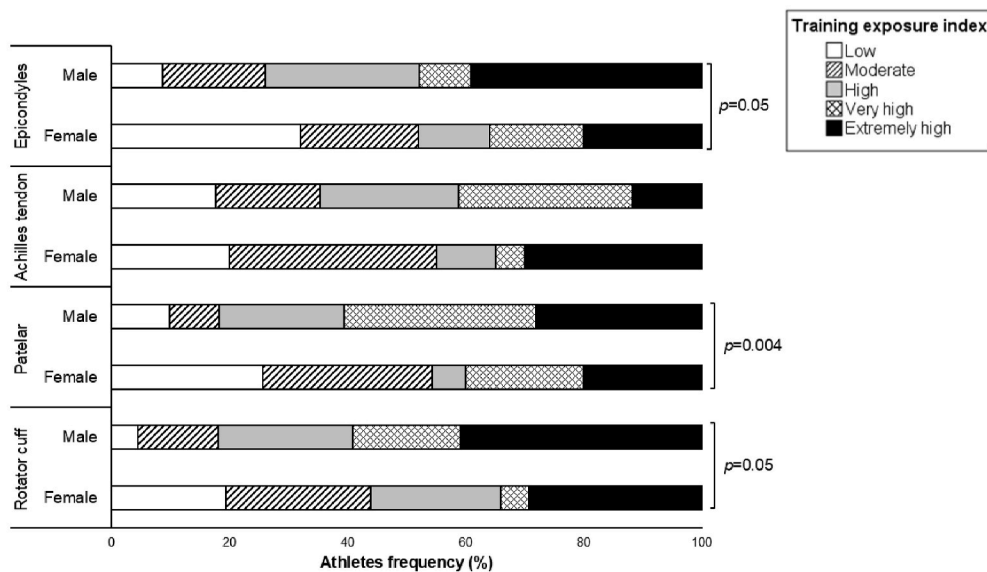
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Fig. 4. – Tendinopathy prevalence stratified by sex, according to training exposure index (TEI) classification (A) and affected tendon (B). *p*-Value was obtained by the Chi-square test.

Table 2

Association analyses of sociodemographic, lifestyle, sport, and clinical characteristics of the tendinopathy cases among athletes with chronic tendon pain.

Characteristics	Tendon pain		p-Value ^a and ^b	Adjusted OR ^b (95% CI)
	No (n = 105)	Yes (n = 149)		
Sociodemographic	n (%)			
Age (years)				
≤20	22 (21.0)	36 (24.2)	0.73	1 ^c
21–24	26 (24.8)	30 (20.1)		0.64 (0.28–1.42)
25–28	28 (26.7)	41 (27.5)		0.88 (0.41–1.89)
>28	29 (27.6)	42 (28.2)		0.82 (0.38–1.76)
Male sex	74 (70.5)	83 (55.7)	0.03	0.55 (0.32–0.95)
BMI (Kg/m ²)				
<25	52 (49.5)	79 (53.0)	0.78	1 ^c
25–29.9	46 (43.8)	56 (37.6)		0.88 (0.50–1.55)
≥30	7 (6.7)	14 (9.4)		1.22 (0.44–3.44)
Income family ≤ \$2017,88 ^d	60 (58.8)	106 (71.6)	0.12	1.59 (0.89–2.85)
Lifestyle				
Alcohol consumption ^e	61 (58.7)	95 (63.8)	0.41	1.26 (0.73–2.17)
Nutritional guidance	81 (77.1)	93 (62.4)	0.02	0.51 (0.28–0.92)
Continuous medication use	15 (14.3)	26 (17.4)	0.54	1.26 (0.60–2.64)
Chronic disease	5 (4.8)	5 (3.4)	0.57	0.67 (0.17–2.68)
Training				
Years of sports practice				
≤20	21 (20.0)	28 (18.8)	0.45	1 ^c
21–24	31 (29.5)	45 (30.2)		1.70 (0.76–3.80)
25–28	25 (23.8)	33 (22.1)		1.96 (0.82–4.70)
>28	28 (26.7)	43 (28.9)		1.72 (0.76–3.92)
TEI (MET-years)				
Low	16 (15.2)	24 (16.1)	0.44	1 ^c
Moderate	21 (20.0)	31 (20.8)		1.50 (0.59–3.84)
High	23 (21.9)	27 (18.1)		1.26 (0.50–3.19)
Very high	17 (16.2)	31 (20.8)		1.91 (0.72–5.06)
Extremely high	28 (26.7)	36 (24.2)		1.44 (0.57–3.62)
Clinics				
>3 episodes of condition ^f	11 (10.6)	40 (27.6)	0.001	3.43 (1.63–7.18)
Training break	44 (41.9)	73 (49.0)	0.29	1.33 (0.78–2.26)
>30 days of break ^g	8 (19.5)	18 (25.4)	0.48	1.45 (0.52–4.03)
Physiotherapy treatment ^h	69 (67.6)	108 (74.0)	0.24	1.42 (0.79–2.55)
Anti-inflammatory treatment ^h	33 (32.4)	59 (40.4)	0.81	1.07 (0.60–1.90)

BMI: body mass index, CI: confidence interval, OR: Odds ratios, TEI: Training Exposure Index.

^a $p \leq 0.05$ was obtained through the Chi-square test (Pearson's p -value).^b OR adjusted by sex, sport, nutritional guidance, and episodes of condition manifestation.^c Reference group for variables with more than two categories.^d Information obtained from 250 athletes.^e Information obtained from 253 athletes.^f Information obtained from 249 athletes, and the value was divided according to the median.^g Information obtained from 112 athletes.^h Information obtained from 248 athletes.

higher in athletes with extremely high TEI and varied by sport modality.

The pioneering initiative of this study in estimating the influence of the absolute amount of time an athlete has been exposed to active physical work during his or her athletic career was crucial in elucidating the significant difference in the prevalence of the condition according to sex, sport modality, and the affected tendon location among the athletes analyzed. Workload complexity includes both external load (the athlete's exposure to training activities) and internal load (the athlete's perceived response to the external loads) (Drew & Finch, 2016).

The variation in the areas affected by the condition may be a consequence of specific training overload for each sport discipline or between different training centers within the same sport. In the present study, patellar, rotator cuff, and epicondyle tendinopathies were observed between the sexes stratified by TEI classification. Epicondylitis and patellar tendinopathy were more common in males with TEI classification above high. The muscle endurance ratio of the wrist extensors was twice lower in females, suggesting that females need to exert more effort to maintain the wrist extension position under resistance (Ikeda et al., 2023). Similarly, basketball players were twice as likely to develop patellar tendinopathy during a competitive season (Owoeye et al., 2021). However, women are 1.5-fold higher chance to have

symptomatic calcific tendinopathy of the rotator cuff (Louwerens et al., 2015), corroborating our findings of a higher prevalence of condition at this site.

Athletes over the age of 25 and those with more than 10 years of experience had a higher risk of developing tendinopathy (about 5 and 11 times, respectively) (Lopes, de Souza, et al., 2023). With advancing age, tendon aging is associated with structural changes at the tissue, cellular, and molecular levels that make these connective tissues more susceptible to degeneration and subsequent injury (Graça et al., 2023). Regarding the duration of sports practice, a systematic review study found that of 31 eligible studies, 28 demonstrated a significant association between increased workload and a higher incidence of overuse injuries in athletes (Drew & Finch, 2016).

Interestingly, a negative association was found between nutritional guidance and chronic tendon pain (approximately 0.5-fold lower) in this cohort. This can be explained by the prescription of foods and supplements rich in collagen, which promote regeneration, reduce pain, and positively regulate metabolic pathways associated with muscle and tendon growth (Kviatkovsky et al., 2022). In addition, nutritional guidance can serve as a predictor for BMI in the present study. According to a systematic review, three out of four studies found that higher BMI

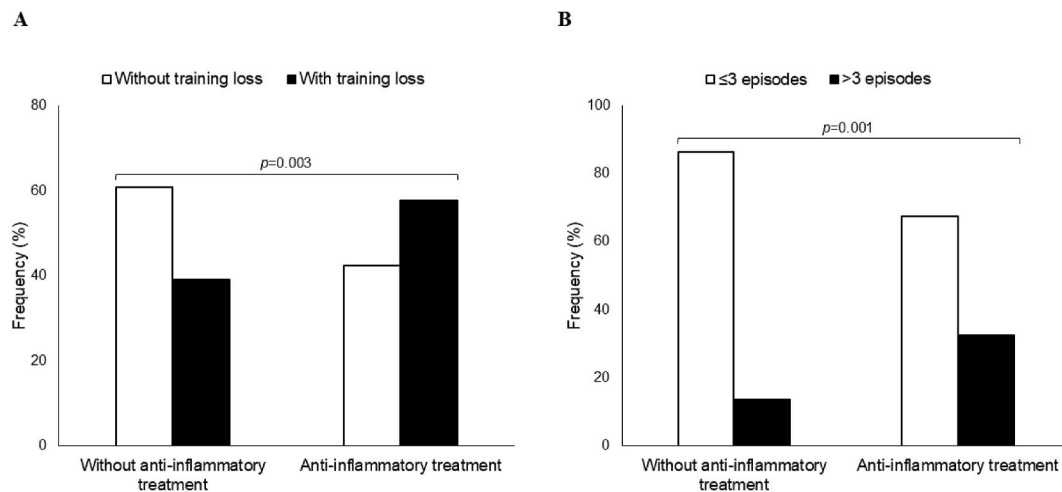


Fig. 5. – Distribution of athletes who received anti-inflammatory treatment in relation to loss of training (A) and episodes of tendinopathy exacerbation during their athletic career (B). p -value was obtained by the Chi-square test.

was associated with the development of tendinopathy in elite basketball and volleyball players (Deng & Mansfield, 2022).

Finally, pharmacologic treatment of chronic tendinopathy is controversial because histologically, tendon tissue shows few or no inflammatory cells (Theodorou et al., 2023). The analgesic effect may cause patients to ignore early symptoms, increasing the risk of further damage to the affected tendon and delaying tissue regeneration (Tsai et al., 2007). This could explain the association found between the higher frequency of anti-inflammatory use among athletes who experienced training loss and the increased number of condition manifestations, which may have been recommended in the more chronic stages of the condition.

Based on the associations found in the present study (variables: sex, nutritional guidance, and episodes of condition manifestation are associated with chronic tendon pain, whereas anti-inflammatory treatment for tendinopathy was associated with training break and episodes of condition manifestation, respectively) and the predictors of tendinopathy described in the literature (Goes et al., 2020; Millar et al., 2021; Ribbans & Collins, 2013) (age, sex, BMI, genetic variants, metabolic disease, smoking, anatomical changes, psychological risk, fluoroquinolones, corticosteroids, and workload), a hypothesis was developed to describe the impact of the condition on the quality of life of athletes, which may lead to an interruption of their athletic career, which subsequently affects their financial income and leads to early retirement (Fig. 6).

The high performance of the athlete is associated with the same predictors (age, sex, BMI, and genetic variants) of tendinopathy (Silva et al., 2022), creating a fine line between performance and sports-related injury. In the present study, almost 50% of the athletes experienced a break in training due to tendinopathy exacerbation, with 17% having a break in training lasting more than 30 days. The clinical features of tendinopathy, including chronic pain and tendon dysfunction (Millar et al., 2021), may be limiting factors leading to the early retirement from their athletic careers. It is also essential to recognize and understand the complex social systems in which athletes are embedded as human beings, rather than viewing them solely as commodities (Tomlinson & Young, 2006).

This study has some limitations. First, because this study relied on a self-report questionnaire, athletes may not have accurately recalled some important information about their lifestyle, especially those without musculoskeletal injuries that did not require medical care. This could introduce potential biases related to both information accuracy and recall. Second, as a cross-sectional study, it is not possible to determine whether the exposure occurred before or after the observed

outcome. In addition, it was not possible to conduct a more robust subgroup analysis by sport modality due to the disparity in the number of eligible athletes across different sport modalities. Despite these limitations, the exploratory qualitative analysis of the associations between predictors and tendinopathy may serve as a basis for the development of theoretical models for the prevention and management of the condition in high-performance athletes. This includes relevant information observed in the relationships, such as condition severity, the presence of a concurrent occupation that may affect the prevalence of the condition, the use of anti-inflammatory drugs for other conditions, anti-inflammatory use for other diseases, the level of reported chronic tendon pain, and periods of tendinopathy remission or exacerbation that were not measured in this study. Furthermore, all questionnaires were reviewed and entered a database by a trained researcher, with double-checking by two other researchers at different times, which strengthens the findings of this study.

5. Conclusion

In the present study, the distribution of TEI differed by sport discipline. There was a higher prevalence of patellar tendinopathy in male athletes, whereas the frequency of Achilles tendinopathy, rotator cuff, and epicondyle tendinopathy was similar between the sexes. Chronic tendon pain was associated with female sex, nutritional guidance, and episodes of tendinopathy manifestation. Additionally, the use of anti-inflammatory treatment for tendinopathy management showed a positive association with episodes of condition manifestation and exercise cessation.

CRedit authorship contribution statement

Lucas Rafael Lopes: Writing – original draft, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Daniel Escorsim Machado:** Writing – review & editing, Visualization, Methodology, Conceptualization. **Rodrigo Araújo Goes:** Writing – review & editing, Visualization, Data curation, Conceptualization. **Marcus Vinícius Galvão Amaral:** Writing – review & editing, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Francisca Dias:** Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Valéria Tavares:** Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Rui Medeiros:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Jamila Alessandra Perini:** Writing – review & editing, Supervision,

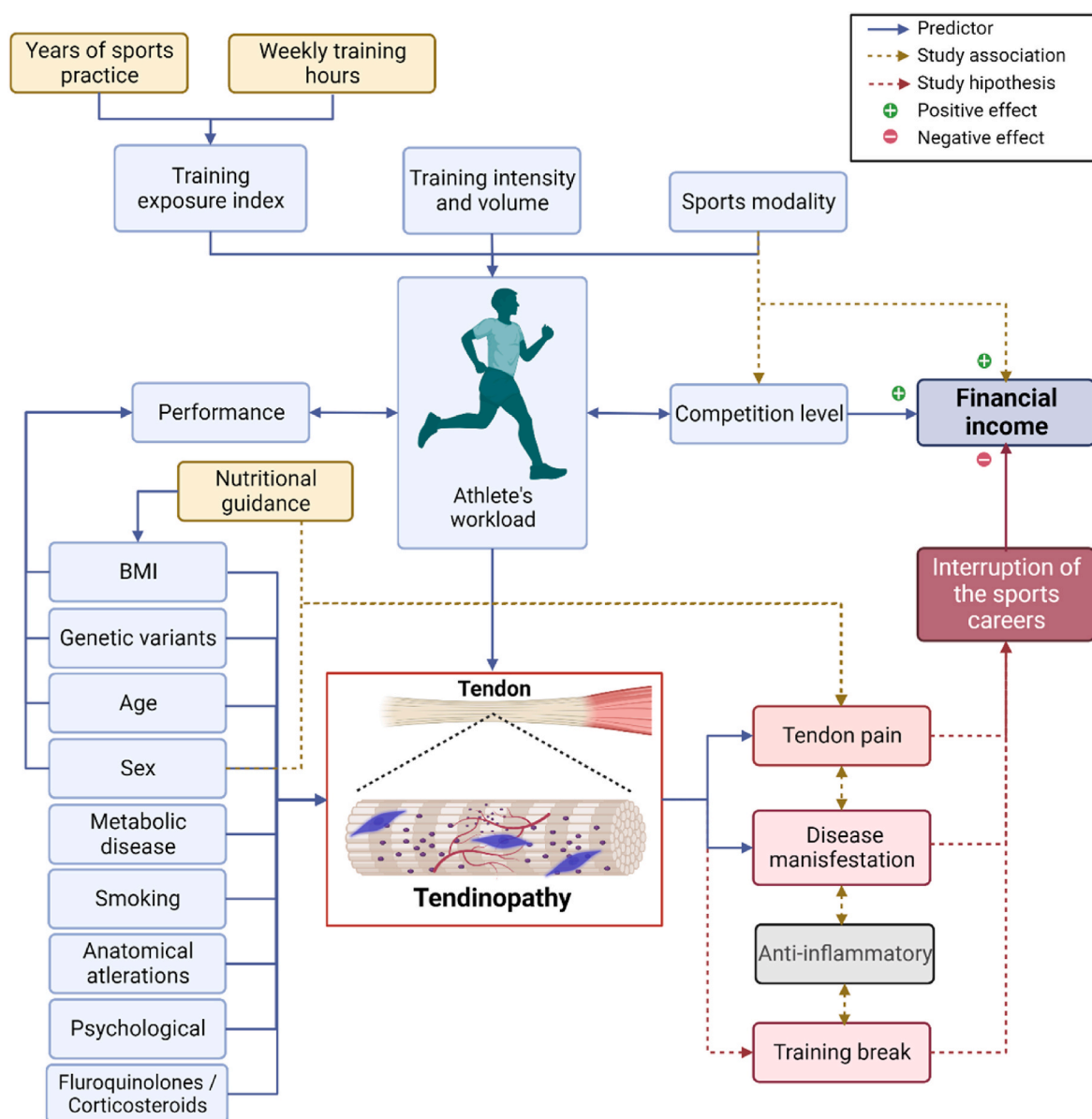


Fig. 6. – The hypothesis that tendinopathy has an impact on the quality of life of athletes, potentially leading to the interruption of their athletic careers, with subsequent impact on financial income and early retirement. The relationships between the condition and its associated factors were visualized using Bio-render software.

Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Ethical statement

Ethical approval was granted by the Instituto Nacional de Traumatologia e Ortopedia Research Ethics Committee (reference number: [2.455.630/2017]). Participants provided informed consent to have their data included in this research study.

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Declaration of competing interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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