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# *THE RUNNING CLUB EFFECT: A SOCIAL AND BEHAVIORAL MODULATOR FOR THE RUNNING-RELATED INJURIES IN AMATEUR BRAZILIAN RUNNERS*

# O EFEITO DO CLUBE DE CORRIDA: UM MODULADOR SOCIAL E COMPORTAMENTAL PARA LESÕES RELACIONADAS À CORRIDA EM CORREDORES AMADORES BRASILEIROS

# *EL EFECTO DEL CLUB DE CORREDORES: UN MODULADOR SOCIAL Y CONDUCTUAL DE LAS LESIONES RELACIONADAS CON LA CARRERA EN CORREDORES AFICIONADOS BRASILEÑOS*

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***ABSTRACT***

*Musculoskeletal injuries are prevalent among amateur runners, and although traditionally attributed to external training overload, evidence suggests that social, behavioral, and organizational factors may influence actual exposure to exertion. This study investigated the association between participation in running clubs and injury risk, considering traditional training load variables and systemic interactions between training components. This cross-sectional study included 97 runners, from whom sociodemographic data, training characteristics, and self-reported injury history in the previous year were collected. Running club participation showed the largest magnitude of association with injury occurrence (OR = 3.09; 95% CI 0.99–9.68), with borderline statistical significance (p = 0.053), while traditional load variables were not independently associated with the outcome. Mediation analysis indicated that training load did not mediate the relationship between club participation and injury occurrence. Network analysis revealed greater structural instability among variables related to load, competition participation, and age in the injured group, with participation in running clubs emerging as a central node in the network. Participation in running clubs showed an association with injury occurrence in recreational runners, while training load variables were not independently related to the outcome. These results should be interpreted cautiously due to the cross-sectional design.*

***KEYWORDS:*** *Running. Athletic injuries. Sports physiotherapy. Social support.*

**RESUMO**

Lesões musculoesqueléticas são prevalentes entre corredores amadores e, apesar de historicamente atribuídas ao excesso de carga externa, evidências sugerem que fatores sociais, comportamentais e organizacionais podem modular a exposição real ao esforço. Este estudo investigou a associação entre a participação em clubes de corrida e o risco de lesões, considerando variáveis tradicionais de carga de treinamento e interações sistêmicas entre os

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componentes do treinamento. Este estudo transversal incluiu 97 corredores, dos quais foram coletados dados sociodemográficos, características de treinamento e histórico de lesões autorrelatadas no ano anterior. A participação em clubes de corrida apresentou a maior magnitude de associação com a ocorrência de lesões (OR = 3,09; IC 95% 0,99–9,68), com significância estatística limítrofe (p = 0,053), enquanto as variáveis tradicionais de carga não foram associadas independentemente ao desfecho. A análise de mediação indicou que a carga de treinamento não mediou a relação entre a participação em clubes e a ocorrência de lesões. A análise de rede revelou maior instabilidade estrutural entre as variáveis relacionadas à carga, participação em competições e idade no grupo lesionado, com a participação em clubes de corrida emergindo como um nó central na rede. A participação em clubes de corrida mostrou associação com a ocorrência de lesões em corredores recreativos, enquanto as variáveis de carga de treinamento não se relacionaram independentemente com o desfecho. Esses resultados devem ser interpretados com cautela devido ao delineamento transversal do estudo.

**PALAVRAS-CHAVE**: Corrida. Lesões esportivas. Fisioterapia esportiva. Suporte social.

***RESUMEN***

*Las lesiones musculoesqueléticas son frecuentes entre corredores aficionados y, aunque tradicionalmente se han atribuido a la sobrecarga externa del entrenamiento, la evidencia sugiere que factores sociales, conductuales y organizativos pueden influir en la exposición real al esfuerzo. Investigar la asociación entre la participación en clubes de corredores y el riesgo de lesión, considerando variables tradicionales de carga de entrenamiento y las interacciones sistémicas entre los componentes del entrenamiento. Estudio transversal que incluyó a 97 corredores. Se recopilaron datos sociodemográficos, características del entrenamiento y antecedentes de lesiones autorreportadas durante el año previo. La participación en clubes de corredores presentó la mayor magnitud de asociación con la ocurrencia de lesiones (OR = 3,09; IC del 95%: 0,99–9,68), con significación estadística limítrofe (p = 0,053), mientras que las variables tradicionales de carga de entrenamiento no se asociaron de manera independiente con el desenlace. El análisis de mediación indicó que la carga de entrenamiento no medió la relación entre la participación en clubes y la ocurrencia de lesiones. El análisis de redes reveló una mayor inestabilidad estructural entre las variables relacionadas con la carga, la participación en competiciones y la edad en el grupo lesionado, emergiendo la participación en clubes de corredores como un nodo central en la red. La participación en clubes de corredores mostró asociación con la ocurrencia de lesiones en corredores recreativos, mientras que las variables de carga de entrenamiento no se relacionaron de manera independiente con el desenlace. Estos resultados deben interpretarse con cautela debido al diseño transversal del estudio.*

***PALABRAS CLAVE**: Carrera. Traumatismos en atletas. Fisioterapia desportiva. Apoyo social.*

## 1. INTRODUCTION

Participation in road running has increased substantially and is now one of the most widely practiced physical activities worldwide [1]. In general, this growth has been attributed to the well-established physical and mental health benefits associated with running [2]. Despite these benefits, road running remains one of the sports with the highest incidence of musculoskeletal injuries, with annual rates ranging from 20% to 80% among recreational runners [3,4].

The most common running-related injuries include patellofemoral pain syndrome, medial tibial stress syndrome, plantar fasciitis, iliotibial band syndrome, tendinopathies, and patellar chondromalacia [5,6]. These conditions directly affect functional capacity, athletic performance, and long-term adherence to running, in addition to generating substantial treatment-related costs [7]. Consequently, they represent a major concern for sports physiotherapy and for rehabilitation and injury prevention programs [8].

Traditionally, injury risk in running has been attributed to the accumulation of external training load, particularly weekly volume, intensity, and training frequency, within a dose–response framework in which progressive increases in load are beneficial up to a threshold, beyond which tissue damage and injury risk increase [9]. However, contemporary evidence rejects this simplified view, indicating that runners can tolerate high training volumes when load progression is appropriately managed, with abrupt increases, rather than absolute volume, being the main factors associated with injury risk [10,11]. Thus, injuries are not caused solely by excessive load but rather emerge from non-linear interactions between applied load and the adaptive capacity of the biological system [12], reflecting a multifactorial and dynamic process involving multiple physiological, biomechanical, and psychosocial determinants [13].

Within this context, social aspects of training, particularly participation in running clubs and coaching groups, have received increasing attention in the literature [14]. Evidence suggests that collective training environments modify both motor and decision-making behaviors: runners tend to involuntarily increase their pace due to “social pacing,” adopt externally oriented attentional strategies, reduce perceived fatigue, and intensify competitive responses in the presence of others [15,16]. These mechanisms can be understood as part of the process of self-regulation of internal load and effort, which are central components of injury prevention in sports physiotherapy.

Moreover, complex systems–based models indicate that running-related injuries are emergent phenomena arising from multivariate interactions and are more sensitive to the temporal organization of training load, abrupt fluctuations, social context, and behavioral stability than to isolated metrics such as training volume or running pace alone [17,18]. In parallel, factors such as competition participation and total training experience have also been shown to influence injury occurrence [19]. Nevertheless, empirical investigations specifically examining the impact of the structured social environment of running clubs as a determinant of injury risk in amateur runners remain scarce.

Therefore, understanding how running clubs modulate training load behavior, both external load, including volume, intensity, and frequency, and internal load, encompassing physiological and perceptual responses, and how these processes influence injury risk is

essential for advancing prevention, monitoring, and educational strategies in Sports Physiotherapy. The aim of this study was to investigate the association between participation in running clubs and the risk of musculoskeletal injuries in amateur runners, examining whether this effect is independent of traditional training load variables (weekly volume, training frequency, session duration, and average running pace) and exploring the role of behavioral and organizational factors through multivariable analysis, mediation modeling, and network analysis.

Therefore, our hypothesis is that participation in running clubs is associated with the risk of musculoskeletal injuries in amateur runners regardless of traditional training load, influenced by behavioral and organizational factors.

## 2. METHODS

### 2.1. Study design, eligibility criteria, and ethical aspects

This cross-sectional study is part of the InTrack project and included 97 Brazilian amateur runners of both sexes. Amateur runners were defined as non-professional individuals who engage in running without a primary competitive purpose. Eligibility criteria comprised being at least 18 years old, agreeing to participate, and completing the questionnaire used for data collection. Runners residing outside Brazil and those who did not answer the mandatory questions of the instrument were excluded. All participants received detailed information about the study aims and procedures and provided informed consent prior to participation. The study was approved by the Brazilian ethics committee (Federal University of Sergipe; protocol no. 5.286.914).

### 2.2. Data collection procedures

Data were collected between April 2022 and January 2023 using an online questionnaire administered via Google Forms. A convenience sampling strategy was adopted, and the survey link was widely disseminated through social media, educational institutions, and sports federations to reach amateur runners. Participation was voluntary and unpaid, with an estimated completion time of approximately 15 minutes. The system required completion of mandatory questions (e.g., anthropometric data, country of residence, and running pace) to allow submission, and participants were able to review their responses before finalizing the questionnaire.

The questionnaire collected the following information:

- **Sociodemographic data:** age, sex, body mass (kg), and body height (m). Body mass and height were used to calculate body mass index (BMI) [kg/m²].

- **Training characteristics:** average weekly running volume, training frequency, session duration, running pace (time in minutes to cover one kilometer), participation in a running club (yes/no), and average number of running competitions per year.

- **Running-related injury:** self-reported musculoskeletal injury within the previous year, defined as any pain or dysfunction that limited training continuity or required interruption of running for a period of at least seven days, in accordance with epidemiological recommendations for running-related injuries [20].

### 2.3. Statistical analysis

Descriptive statistics were presented as means, standard deviations, and frequencies. Multivariable logistic regression was performed to estimate odds ratios (ORs), adjusting for age, sex, BMI, and training load variables. Subsequently, mediation analysis was conducted to assess whether weekly volume, training frequency, session duration, or running pace mediated the relationship between participation in running clubs and injury occurrence. Indirect effects were estimated using the product-of-coefficients approach (a·b), and statistical significance was evaluated using Sobel tests as an exploratory procedure, acknowledging its limitations, particularly in smaller samples.

Finally, network analysis based on Spearman correlations was used to identify interdependent patterns among variables in injured and non-injured runners. Betweenness centrality was calculated to identify variables that acted as key connectors within the athlete–training–environment system. All analyses were performed using Python (pandas, statsmodels, scipy) and JASP, with a 95% confidence interval. Network analysis was conducted as an exploratory tool to visualize interrelationships among variables and does not imply causal or directional effects.

Given the sample size and the number of covariates included in the regression models, estimates should be interpreted with caution. The analyses were designed to be exploratory, aiming to identify potential associations rather than to establish definitive causal inferences.

Although the number of covariates included in the regression model slightly exceeds conventional events-per-variable recommendations, the model was specified based on theoretical relevance and prior evidence. Therefore, the regression results should be interpreted as exploratory, and the estimates may be subject to instability.

## 3. RESULTS

The final analysis included complete data from 82 runners for the selected variables (Table 1). Participants of both sexes (51% men) had a mean age of 39.7 (±11.2) years and a mean body mass index (BMI) of 24.25 (±4.27) kg/m². Regarding training characteristics, the sample presented a mean weekly running volume of 32.17 km, distributed across an average training frequency of 3.57 sessions per week, with a mean session duration of 60.5 minutes and an average running pace of 5.44 min/km. Notably, there was a high level of participation in organized running programs, with 72% of runners affiliated with running clubs, and an overall prevalence of musculoskeletal injuries of 65%.

**Table 1.** Descriptive statistics of clinical, sociodemographic, and training variables in amateur runners

| Variable | Count | Mean | Std | Min | P25 | Median | P75 | Max |
|---|---|---|---|---|---|---|---|---|
| **Injury** | 82 | 0,65 | 0,48 | 0 | 0 | 1 | 1 | 1 |
| **Running club participation** | 82 | 0,72 | 0,45 | 0 | 0 | 1 | 1 | 1 |
| **Volume/week (km)** | 82 | 32,17 | 17,78 | 6 | 20 | 30 | 40 | 100 |
| **Frequency/ week** | 82 | 3,57 | 1,16 | 2 | 3 | 3 | 4 | 7 |
| **Training duration (min)** | 82 | 60,5 | 33,66 | 20 | 41 | 60 | 60 | 280 |
| **Running pace (min/km)** | 82 | 5,44 | 1,01 | 3 | 5 | 5,3 | 6 | 9 |
| **BMI (kg/m²)** | 82 | 24,25 | 4,27 | 17 | 21,7 | 24,3 | 26,5 | 35,2 |
| **Age (years)** | 82 | 39,72 | 11,2 | 18 | 33 | 41 | 46 | 61 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sex (M=1)** | 82 | 0,5 | 0,5 | 0 | 0 | 1 | 1 | 1 |
| **Numcomp (competitions/year)** | 82 | 8,02 | 8,02 | 0 | 4 | 6 | 10 | 50 |

Std: Standard Deviation.
Source: Prepared by the authors, 2026.

In the adjusted analysis (Table 2), participation in running clubs showed the greatest magnitude of association with injury (OR = 3.09; 95% CI: 0.99–9.68; p = 0.053). None of the training load variables—weekly volume (p = 0.607), weekly frequency (p = 0.450), session duration (p = 0.338), or average running pace (p = 0.365) - showed a statistically significant independent effect on the outcome.

**Table 2.** Multiple logistic regression for the prediction of musculoskeletal injuries in amateur runners

| Variable | Coef | OR | CI_low | CI_high | p |
|---|---|---|---|---|---|
| **Const** | -2.485 | 0.083 | 0.001 | 8.066 | 0.287 |
| **Running club participation** | 1.128 | 3.091 | 0.987 | 9.679 | 0.053 |
| **Volume/week((km)** | 0.010 | 1.010 | 0.973 | 1.048 | 0.607 |
| **Frequency/week** | 0.203 | 1.225 | 0.724 | 2.070 | 0.450 |
| **Training duration (min)** | -0.008 | 0.992 | 0.977 | 1.008 | 0.338 |
| **Running pace (min/km)** | 0.309 | 1.363 | 0.698 | 2.661 | 0.365 |
| **BMI (kg/m²)** | -0.036 | 0.964 | 0.830 | 1.120 | 0.633 |
| **Age (years)** | 0.019 | 1.019 | 0.969 | 1.073 | 0.462 |
| **Sex** | 0.379 | 1.461 | 0.439 | 4.861 | 0.536 |

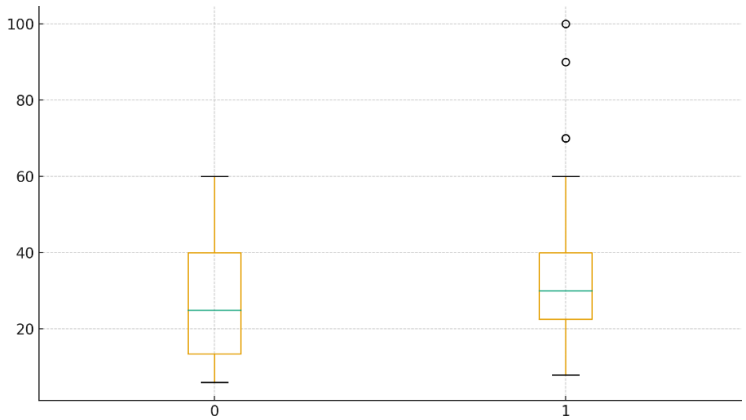
OR: Odds ratio; CI: Confidence interval; p: p-value.
Source: Prepared by the authors, 2026.

Graphical analyses reinforced the absence of marked differences in training load distributions between groups. The boxplot of weekly training volume according to running club participation (Figure 1) showed substantial overlap between distributions, suggesting no systematic difference in weekly training volumes according to club affiliation. Similarly, the boxplot

of running pace stratified by injury status (Figure 2) demonstrated comparable variability between injured and non-injured runners. The scatter plot depicting the relationship between weekly training volume and running pace (Figure 3) revealed a weak linear correlation, suggesting limited combined explanatory capacity of training intensity and volume for injury occurrence.

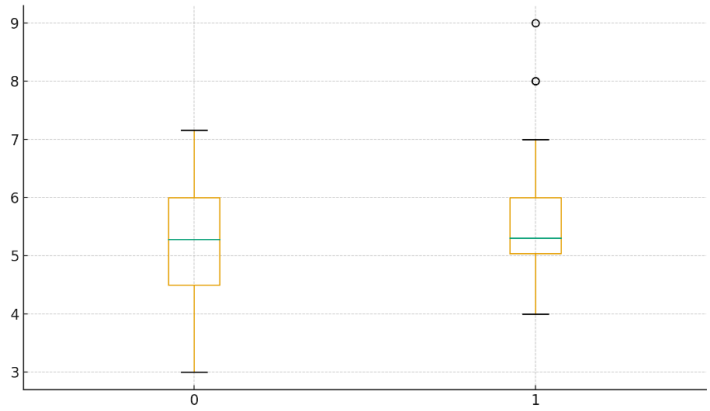
In the mediation analysis, none of the training load variables showed a statistically significant indirect effect on the relationship between running club participation and injury occurrence. Network analysis revealed distinct structural patterns between groups: injured runners exhibited greater centrality of training load variables, particularly weekly mileage and training frequency, suggesting a network structure more dependent on load organization. In contrast, non-injured runners displayed a more distributed pattern of centrality, with weekly mileage and session duration emerging as the main nodes, alongside relevant contributions from age, BMI, and running club participation, suggesting a more balanced network structure, with less apparent dependence on a single factor.

**Figure 1.** Distribution of weekly training volume (km) among runners affiliated and not affiliated with running clubs



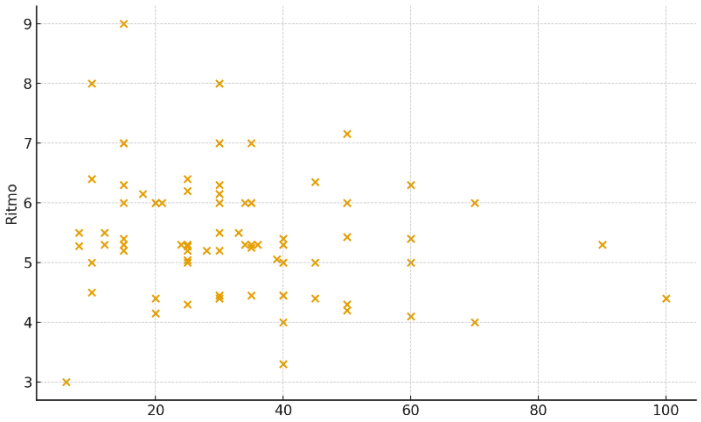

Source: Prepared by the authors, 2026.

**Figure 2.** Comparison of average running pace (min/km) between runners with and without musculoskeletal injuries




Source: Prepared by the authors, 2026.

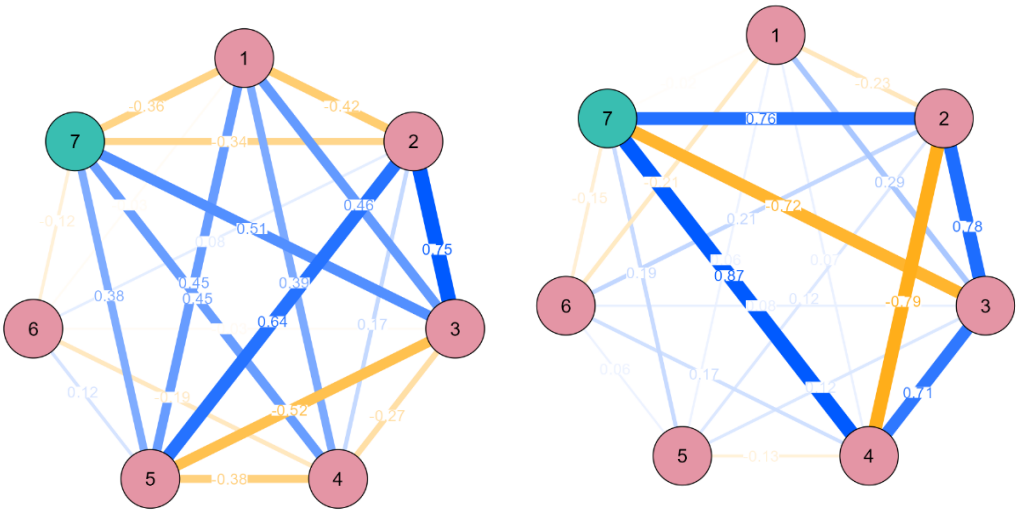
**Figure 3.** Relationship Between Weekly Training Volume (km) and Running Pace (min/km)




Source: Prepared by the authors, 2026.

Figure 4 presents the results of the network analysis. Based on the centrality parameters, for the injured group (right network), the participation in running clubs was the variable with the highest values of betweenness (1.65), connecting with training volume and running pace. For those without injuries (left network), the running pace presented the highest values for centrality, acting as a regulator within the system, and presenting a connection with BMI and participation in running clubs.

**Figure 4.** Network results for groups without injuries (left) and with injuries (right). Legend= 1: BMI; 2: Volume/week; 3: Duration/week; 4: Pace; 5: Frequency/week; 6: number of competitions; 7: Running club




Source: Prepared by the authors, 2026.

## 4. DISCUSSION

This study identified relevant associations between training environment, psychosocial factors, and injury occurrence in recreational runners. Notably, participation in running clubs showed the largest effect size among the analyzed variables, although statistical significance was borderline. The sample was predominantly composed of middle-aged runners (mean age 39.7 years) with body composition within normal ranges (mean BMI 24.25 kg/m²). Although the average weekly training volume of ~32 km and a frequency of three to four sessions per week characterize a typical recreational running profile, the high prevalence of running club participation (72%) reflects substantial engagement in organized training environments.

It is also plausible that runners with previous injuries are more likely to seek structured environments such as running clubs, which may partially explain the observed association. Therefore, reverse causality cannot be ruled out.

In this context, the present findings reinforce the understanding that running-related injuries do not result exclusively from the magnitude of external training load, but rather from complex interactions among organizational, behavioral, and adaptive factors within the athlete–training system. Although variables such as running volume, training frequency, duration of training sessions, and running pace have historically been considered primary predictors of injury, the multivariable analysis demonstrated that none of these factors were independently associated

with injury occurrence. In the mediation analysis, training load variables did not show significant indirect effects, and these findings should be interpreted as hypothesis-generating rather than definitive. These findings align with studies showing that abrupt increases in training load, rather than absolute volume, are more strongly associated with injury risk in runners [10,11].

Participation in running clubs, in contrast, showed the largest magnitude of association with injury occurrence, although this finding should be interpreted as exploratory rather than confirmatory. This result may reflect the influence of social and organizational factors on how exposure to effort is structured. The literature indicates that group-based training can alter pace self-regulation, reduce perceived fatigue, and enhance competitive responses, phenomena described as ‘social pacing’ and ‘motivational contagion’ [15,16]. These mechanisms may influence internal load, a core construct in physiotherapy, by modifying the relationship between physiological stress and tissue adaptive capacity [12]. Consequently, injury occurrence may be better understood not solely in terms of higher training volume, but in relation to how social behavior shapes the organization of the training system.

Network analysis further supported this interpretation by demonstrating greater structural instability among training load variables, age, and competition participation in injured runners, with running club participation emerging as a critical node. This pattern aligns with the dynamic systems vulnerability model, which posits that injuries emerge when systemic stability is reduced by behavioral, organizational, or physiological perturbations [12, 17]. The network analysis should be interpreted as a hypothesis-generating approach, as centrality metrics, particularly betweenness, are sensitive to sample size and network density and should not be interpreted as measures of causal influence. The absence of formal network stability analysis further limits the interpretation of these findings.

From a sports physiotherapy perspective, these findings highlight the need to broaden the focus of injury prevention strategies. Beyond monitoring training volume and intensity, it is essential to consider the social context of practice, pacing decisions, load variability, psychological profile, and adaptive progression, since individual perceptions and contextual factors influence how runners manage and adjust their training [21]. Educational interventions targeting effort self-regulation, perceived exertion, pace modulation during group training, and internal load monitoring may be particularly effective in reducing injury risk among runners affiliated with clubs.

Within this framework, sports physiotherapy emerges as a strategic tool for risk mitigation, not only through rehabilitation but, fundamentally, through structured and personalized prevention [22]. Reducing injury risk in runners requires individualized and multifactorial approaches supported by qualified professionals. Evidence suggests that preventive strategies should be

initiated early, including among younger runners, and that coach supervision contributes to positive behavioral changes. Moreover, there is clear acceptance of prevention programs led by specialists such as physiotherapists [8].

## 5. LIMITATIONS AND STRENGTHS

This study provides relevant contributions to understanding the role of running clubs in musculoskeletal injury risk among amateur runners; however, some limitations should be acknowledged. The cross-sectional design precludes causal inference, as exposure and outcome were assessed simultaneously. Thus, it is not possible to determine whether participation in running clubs increases injury risk or whether previously injured runners are more likely to seek organized training environments for additional support.

In addition, data collection relied on self-report, which may introduce recall and perception biases, particularly regarding injury history, training volume, and session characteristics. Similarly, anthropometric data were obtained through an online questionnaire and are subject to systematic bias, which may compromise the accuracy of body mass index estimates. Previous evidence indicates that, although such errors tend to be smaller in physically active populations, such as recreational runners, compared to the general population, self-reported anthropometric data are not fully reliable and should be interpreted with caution [23].

The use of convenience sampling, while appropriate for exploratory research, limits the generalizability of the findings, as participants may not fully represent the broader population of Brazilian recreational runners. Another limitation is the absence of detailed information on psychosocial factors, attentional strategies, load variability, and specific training structures within running clubs, which could have provided deeper insight into the mechanisms linking social environments to injury risk. Additional limitations include the cross-sectional design, the relatively small sample size, and the use of exploratory analytical techniques, which may limit the generalizability of the findings.

Despite these limitations, the study has notable strengths. It addresses an important gap in the literature by empirically examining participation in running clubs as a potential determinant of injury risk, a concept often discussed but rarely tested quantitatively. The use of complementary analytical approaches enhances the depth of the findings by moving beyond direct associations, and the application of contemporary methods represents a methodological advance that supports understanding injury as a multifactorial phenomenon.

Taken together, these results provide initial evidence that behavioral and organizational factors related to collective training contexts may play a meaningful role in injury risk, contributing to the development of more integrated and context-sensitive prevention strategies aligned with

the current demands of sports physiotherapy. Additionally, the number of covariates relative to the number of events may have affected the stability of the regression estimates, increasing uncertainty in the observed associations.

## 6. FINAL CONSIDERATIONS

Participation in running clubs showed an exploratory association with musculoskeletal injury occurrence. In contrast, traditional training load variables were not independently associated with the outcome. These findings suggest that social and organizational factors may influence how training behaviors are structured and regulated, contributing to injury occurrence within a complex systems framework.

For sports physiotherapy, it is essential to consider the context of practice and the social dynamics of running clubs when designing preventive strategies and educational interventions aimed at effort self-regulation. Approaches that integrate internal load monitoring, adaptive progression, controlled training variability, and guidance on pacing decisions during group training may help reduce injury risk in amateur runners.

## DECLARATION OF CONFLICT OF INTERESTS

The authors have no competing interests to declare that are relevant to the content of this article.

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