

# PREVALENCE OF INJURIES IN BRAZILIAN RECREATIONAL STREET RUNNERS: META-ANALYSIS



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PREVALÊNCIA DE LESÕES EM CORREDORES DE RUA AMADORES BRASILEIROS: METANÁLISE

PREVALENCIA DE LESIONES EN CORREDORES DE CALLE AFICIONADOS BRASILEÑOS: META-ANÁLISIS

Wyngrid Porfirio Borel<sup>1</sup>  
(Physiotherapist)

José Elias Filho<sup>1</sup>  
(Physiotherapist)

Juliano Bergamaschine Mata Diz<sup>1</sup>  
(Physiotherapist)

Poliana Fernandes Moreira<sup>1</sup>  
(Physiotherapist)

Priscila Monteiro Veras<sup>1</sup>  
(Physiotherapist)

Leonardo Lacerda Catharino<sup>1</sup>  
(Physiotherapist)

Bárbara Palmeira Rossi<sup>1</sup>  
(Physiotherapist)

Diogo Carvalho Felício<sup>1</sup>  
(Physiotherapist)

1. Universidade Federal de Juiz de Fora, Post-Graduate Degree Program in Rehabilitation Sciences and Physical Functional Performance, Juiz de Fora, MG, Brazil.

## Correspondence

Wyngrid Porfirio Borel. Master's Program in Rehabilitation Sciences UFJF, Faculdade de Fisioterapia. Av. Eugênio do Nascimento, s/n, Bairro Dom Bosco, Juiz de Fora, MG, Brazil. 36038-330  
wyn\_fisio@yahoo.com.br

## ABSTRACT

Street running is an accessible, low-cost form of exercise. However, the occurrence of musculoskeletal injuries may hinder regular practice. This study aimed at estimating the prevalence of injuries in Brazilian street runners and the associated factors. A meta-analysis of Brazilian studies was performed to investigate the prevalence and risk factors of injuries in male and female recreational street runners aged  $\geq 18$  years. We excluded systematic review studies, research conducted on professional athletes or triathletes, and duplicate articles. The following databases were used: SciELO, LILACS, PubMed, Web of Science, and Google Scholar. Keywords such as "prevalence," "injury," "recreational street runners," and "Brazil" were used. Prevalence analysis was performed using the random effect model, and a funnel plot was used to assess publication bias. Then the Begg-Mazumdar and Egger tests were applied to quantify the graph results. The Prevalence Critical Appraisal Instrument was used to evaluate the methodological quality of the studies. Associated factors were analyzed with meta-regression analysis. Twenty-three studies with 3,786 runners were included in the review. The prevalence of injury was 36.5% (95% confidence interval [CI] 30.8-42.5%), and a running distance per week greater than 20 km was a predictive variable of injuries. A higher prevalence of injuries was observed in men than in women (28.3%, 95% CI 22.5-35.0%), the knee was the most affected site of injury (32.9%, 95% CI 26.7-39.6%), and muscle injuries were the most frequent type of injury (27.9%, 95% CI 18.2-40.1%). This is the first national meta-analysis conducted to investigate the prevalence of injuries in recreational street runners. Although the prevalence of injuries was moderate, caution is required in terms of the weekly duration of running. Male runners are more susceptible, and muscle and knee injuries are the most common. **Level of evidence II, Systematic review<sup>b</sup> of Level II Studies.**

**Keywords:** Prevalence; Injury; Running.

## RESUMO

A corrida de rua é uma forma de exercício acessível e de baixo custo. No entanto, a ocorrência de lesões musculoesqueléticas pode dificultar a prática regular. O objetivo deste estudo foi estimar a prevalência de lesões em corredores de rua brasileiros e os fatores associados. Foi realizada uma metanálise de estudos brasileiros para investigar a prevalência e os fatores de risco de lesão em corredores de rua amadores, de ambos os sexos, com idade  $\geq 18$  anos. Foram excluídos estudos de revisão sistemática, pesquisas com atletas profissionais ou triatletas e os artigos duplicados. As buscas eletrônicas foram feitas nos seguintes bancos de dados: SciELO, LILACS, PubMed, Web of Science e Google Acadêmico. Foram usados descritores como "prevalência", "lesão", "corredores de rua amadores" e "Brasil". A análise de prevalência foi realizada com o modelo de efeito aleatório, e um gráfico de funil foi usado para avaliar o viés de publicação. Em seguida, os testes Begg-Mazumdar e Egger foram aplicados para quantificar os resultados do gráfico. O Prevalence Critical Appraisal Instrument foi usado para avaliar a qualidade metodológica dos estudos. Os fatores associados foram analisados com análise de metarregressão. Vinte e três estudos, totalizando 3.786 corredores foram incluídos na revisão. A prevalência de lesões foi de 36,5% (intervalo de confiança [IC] de 95% 30,8-42,5%), e a distância percorrida por semana superior a 20 km foi uma variável preditiva de lesões. Observou-se maior prevalência de lesões em homens do que em mulheres (28,3%, IC de 95% 22,5-35,0%). O joelho foi o local mais acometido (32,9%, IC de 95% 26,7-39,6%) e as lesões musculares foram as mais frequentes (27,9%, IC de 95% 18,2-40,1%). Esta é a primeira metanálise nacional a investigar a prevalência de lesões em corredores de rua amadores. Embora a prevalência de lesões tenha sido moderada, é preciso ter cautela em termos da duração semanal da corrida. Os corredores do sexo masculino são mais suscetíveis, e as lesões musculares e do joelho são as mais comuns. **Nível de evidência II, Revisão sistemática<sup>b</sup> de Estudos de Nível II.**

**Descritores:** Prevalência; Lesão; Corrida.

## RESUMEN

La carrera de calle es una modalidad de accesible y de bajo costo. Sin embargo, la aparición de lesiones musculoesqueléticas puede dificultar la práctica regular. El objetivo de este estudio fue estimar la prevalencia de lesiones en corredores de calle brasileños y los factores asociados. Se realizó un meta-análisis de estudios brasileños que investigaron la prevalencia y los factores de riesgo de lesión en corredores de calle aficionados, de ambos sexos, con edad  $\geq 18$  años. Se excluyeron estudios de revisión sistemática, investigaciones con atletas profesionales o triatletas y los artículos duplicados. Las búsquedas electrónicas se realizaron en las siguientes bases de datos: SciELO, LILACS, PubMed, Web of



Science y Google Académico. Se utilizaron descriptores como “prevalencia”, “lesión”, “corredores de calle aficionados” y “Brasil”. El análisis de prevalencia se realizó con el modelo de efecto aleatorio, y un gráfico de embudo se utilizó para evaluar el sesgo de publicación. A continuación, se aplicaron las pruebas Begg-Mazumdar y Egger para cuantificar los resultados del gráfico. El Prevalence Critical Appraisal Instrument se utilizó para evaluar la calidad metodológica de los estudios. Los factores asociados fueron analizados con análisis de meta-regresión. Se incluyeron 23 estudios en la revisión, totalizando 3.786 corredores, con prevalencia de lesiones del 36,5% (intervalo de confianza [IC] del 95% 30,8-42,5%), y la distancia recorrida por semana superior a 20 Km fue una variable predictiva de lesiones. Se observó mayor prevalencia de lesiones en hombres que en mujeres (28,3%, IC del 95% 22,5-35,0%). La rodilla fue el local más afectado (32,9%, IC del 95% 26,7-39,6%) y las lesiones musculares fueron las más frecuentes (27,9%, IC del 95% 18,2-40,1%). Este es el primer meta-análisis nacional en investigar la prevalencia de lesiones en corredores aficionados. Aunque la prevalencia de lesiones ha sido moderada, se requiere precaución en cuanto a la duración semanal de la carrera. Los corredores del sexo masculino son más susceptibles, y las lesiones musculares y de la rodilla son las más comunes. **Nivel de evidencia II, Revisión sistemática<sup>b</sup> de Estudios de Nivel II.**

**Descriptores:** Prevalencia; Lesión; Carrera.

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## INTRODUCTION

Street running is an accessible, low-cost, simple form of exercise, and it is a contemporary social phenomenon.<sup>1,2</sup> A regular running practice provides several health benefits. However, when performed improperly or unguided, it might cause injury.<sup>3,4</sup> Injuries in street runners lead to work absenteeism, increased demand for health services, and discontinuity in training or competitions.<sup>5</sup>

In a recent study, Smits et al<sup>6</sup> evaluated absenteeism and health care after the occurrence of running-related injury over a period of six weeks. One hundred eighty-five subjects participated in the study. Work absenteeism was observed in 4% of individuals, and 51% sought a health professional. In another study, researchers investigated the economic burden of running-related injuries in Dutch athletes. One thousand six hundred ninety-six individuals participated in the study, and the incidence of injuries was observed in 272 cases. Health care injuries expenses were R\$ 207.30 in addition to R\$ 95.70 for work absenteeism.<sup>7</sup> In a similar study design that included 53 Dutch street runners, injuries were observed in 41 cases. Health care expenses for the treatment of these injuries and paid work absenteeism accounted for R\$ 630.70.<sup>8</sup> In Brazil, we did not find data on this subject.

In a prospective cohort study of 200 Brazilian recreational street runners, Hespanhol Junior et al<sup>9</sup> revealed that the incidence of injuries might increase from 31% over three months to 51% over a year. This high injury rate culminates in the discontinuity of training or competitions, and aggravates the harm resulting from a sedentary lifestyle, which is a worldwide concern.<sup>10</sup> Musculoskeletal injuries in street runners might also cause a psychosocial impact and reduce the level of motivation to continue sports activity. The occurrence of an injury might also cause anxiety, low self-esteem, excessive anger, obsession to return to sports with premature training resumption, worsening of the injury, and a feeling of helplessness while treating the injury.<sup>11</sup>

Determining the prevalence of injuries in street runners and the associated risk factors could contribute to reducing work absenteeism and the demand for health services, and encourage regular sports activity. In addition, the information may be used to define preventive strategies and improve rehabilitation programs. Systematically and critically compiled data on the prevalence of injuries in recreational street runners in Brazil do not exist.

Therefore, the objectives of this meta-analysis were to investigate the prevalence of injuries in Brazilian recreational street runners; to analyze the risk of bias in eligible studies; to investigate the relationship between

training characteristics and the onset of injuries; to verify the gender influence on the prevalence of lesions; to identify the most affected anatomic sites and the most common type of lesions.

## METHODS

We performed a systematic review and meta-analysis. The methodology followed the recommendation of the *Joanna Briggs Institute Reviewers' Manual (The Systematic Review of Prevalence and Incidence Data)*,<sup>12</sup> guidelines of the MOOSE group (Meta-analysis of Observational Studies in Epidemiology)<sup>13</sup> and Cochrane Collaboration.<sup>14</sup> Additionally, this systematic review was reported according to the PRISMA checklist (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).<sup>15</sup>

### Eligibility criteria

We included all studies conducted in Brazil that investigated the prevalence at the point, during or throughout the life of injuries in recreational street runners of both genders, aged  $\geq 18$  years. A recreational street runner was defined as someone who practices this activity for pleasure and health benefits without remuneration.<sup>16</sup> We included studies regardless of the severity of the symptoms of injury (i.e., acute, subacute, or chronic). Systematic review studies, studies performed with samples of professional athletes and triathletes, and duplicate articles in more than one database were excluded from this investigation. When the same sample was used to report the prevalence of injuries in more than one study, only the work presenting the largest sample size was included in this research. For questions about an article's eligibility, we contacted the authors.

Titles and abstracts were reviewed initially. The inclusion of full potential texts was evaluated by two independent reviewers (WPB and JEF), according to the eligibility criteria, and a third reviewer (DCF) resolved the differences.

### Search strategy

Electronic searches were conducted from the oldest record until the date preceding the submission of the article. We used the following databases: SciELO, LILACS, PubMed, and Web of Science without language restriction. In addition, a second review of related literature was performed using Google Scholar and the reference lists of all eligible studies. The search strategy used the following English and Portuguese keywords: “prevalence”, “epidemiology”, “injury”, “street runners”, “recreational runners”, and “Brazil”, which were Medical Subject Headings. These keywords were also combined with each other using Boolean operators and/or added to all descriptors.

## Data extraction

Two independent reviewers (WPB and JEF) extracted relevant data of the study subjects using a pre-defined data extraction form, and disagreements were solved by a third reviewer (DCF).

The following data were extracted: the type of study, definition of injury, number of participants, and prevalence of injury. For the prevalence of injury, the percentage and absolute number of events (injuries) were extracted.

## Statistical analysis

The data were initially analyzed using descriptive statistics. Prevalence estimates and their respective confidence intervals (ICs) were obtained from the total sample size and the number of events (injuries) for each study included in the review. Prevalence estimates are expressed as percentages (proportion  $\times$  100).<sup>12</sup>

The  $I^2$  statistic was used to assess homogeneity between studies. In the meta-analysis, studies had low heterogeneity if  $I^2 < 50\%$  or moderate to high heterogeneity if  $I^2 \geq 50\%$ . Grouped effects were estimated using the random effect model. A funnel plot was used to determine publication bias. The Begg-Mazumdar and Egger tests were performed to verify the statistical significance of plot results in potential cases.<sup>14</sup>

After estimating the prevalence of injuries in recreational runners, two independent reviewers (WPB and JEF) evaluated the risk of bias for each study using a validated instrument that included 10 items, which assessed the risk of bias in prevalence studies.<sup>12</sup> Each item was classified as "yes," "no," and "not clear" according to the information given in the article, and a maximum positive score of 10 points was permitted. A third reviewer (DCF) resolved potential disagreements.

Subsequently, meta-regression analyses were performed with the aim to investigate the relationship between training characteristics (frequency of running [weekly], running distance, and running experience [years]) and the onset of injuries, to verify the effect of sex on the prevalence of injuries, to evaluate the most affected anatomic sites (e.g., the hip, knee, and ankle), and to verify the most frequent types of injuries (muscular, inflammatory, bony, and ligament injuries).

The level of significance was 5% for all statistical tests. All statistical analyses were performed using the Comprehensive Meta-Analysis program, version 3.3.070 (Biostat Inc., Englewood, NJ, USA).

## RESULTS

Four hundred forty-eight studies were investigated. Of these, 54 were eligible for full-text analysis, and 16 were excluded after evaluating the full-text article. Of the excluded articles, 13 were systematic reviews that used samples from professional runners and triathletes, and three other studies had duplicate samples. An additional 15 studies were excluded because they were found in duplicate databases. The flow chart of studies is shown in Figure 1.

### Description of the included studies

Of the 23 included studies, 20 were performed using samples collected from both sexes. Among 3,786 participants, 2,605 were men. Twenty studies were cross-sectional, and three were prospective cohort investigations with prevalence data reported. The articles were published from 2009 to 2017. Table 1 shows that only 10 studies provided a definition of injury, and 13 studies did not present enough data to extract injury prevalence information in relation to participants' sex. The prevalence of injury ranged from 20% to 65.9% among the studies.

### Prevalence of injuries in Brazilian recreational street runners

According to the meta-analysis of 23 studies, the prevalence of injuries was 36.5% (95% CI 30.8-42.5%). The  $I^2$  value of 0.0 revealed a low heterogeneity among the studies (Figure 2).

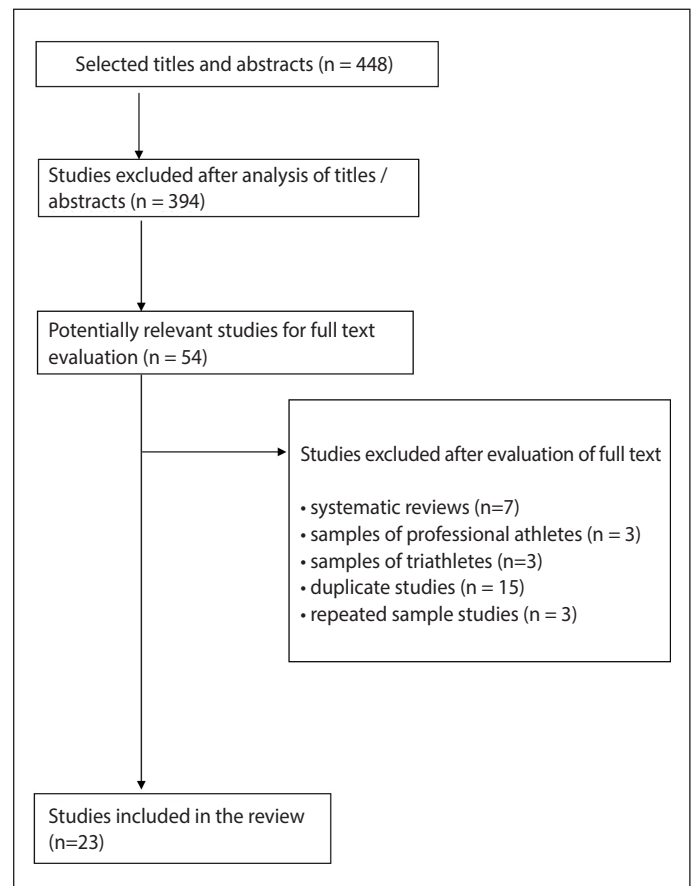


Figure 1. Flowchart of included studies.

### Risk assessment of bias

Table 2 shows the risk assessment of bias of the included articles. The methodological quality varied from 5 to 9 points.

The funnel plot analysis showed no publication bias. Results of the Begg-Mazumdar ( $p = 0.270$ ) and Egger tests ( $t=1.21$ ,  $df=21$ ,  $p=0.118$ ) were not significant (Figure 3).

Analysis of the relationship between training characteristics and the occurrence of injury

The descriptive analysis showed that six studies showed a relationship between a running distance of 20 km or more per week and the occurrence of injuries, five studies showed a relationship between running experience of more than five years and the occurrence of injuries, and only four studies showed a relationship between a weekly training frequency greater than or equal to three days and the occurrence of injuries. Six studies did not investigate the effect of training variables and the occurrence of injuries. These research studies only analyzed training variables according to the entire sample, without distinction between injured and non-injured individuals, with the aim of describing the training profile of all runners.

### Prevalence of injury in recreational male and female street runners

The prevalence of injury among male street runners was 28.3 (95% CI 22.5-35.0%), whereas that among female street runners was 9.1% (95% CI 5.3-15.2%). The  $I^2$  value was 50 for men and that for women was 0.0, indicating moderate and low heterogeneity, respectively.

Affected anatomical sites

The prevalence of knee injury was 32.9% (95% CI 26.7-39.6%), that of ankle injury was 17.7% (95% CI 11.2-26.9%), and that of hip injury was 13.3% (95% CI 6.9-24.1%). The  $I^2$  value of 0.0 revealed low heterogeneity between those results.

**Table 1.** Descriptive analysis of the characteristics of included studies (n = 23).

Studies	Definition of Injury	Participants	Prevalence %		
		n (F/M), age ± SD	Total	F	M
Abiko et al, 2017 <sup>16</sup>	---	162 (70/92) 35,5 ± years	47,5	15,5	32
Araújo et al, 2015 <sup>17</sup>	Event occurred during a training / competition that caused the athlete to miss the next training / competition	204 (87/117) 32,6 ± 9,3 years	41,6	---	---
Campos et al, 2016 <sup>18</sup>	Damage caused by physical trauma suffered by body tissues	139 (61/78) 36,6 ± 8,6 years	37	---	---
Fernandes D; Lourenço TF; Simões EC, 2014 <sup>19</sup>	Any musculoskeletal distress that has led the runner away from practice / competitions for at least a week	107 (22/85) 38,3 ± 9,9 years	21,5	---	---
Ferreira et al, 2012 <sup>20</sup>	---	100 (27/73) 34,7 ± 11,4 years	40	10	30
Hespanhol Junior et al, 2012 <sup>10</sup>	Any pain of musculoskeletal origin related to running practice severe enough to prevent the performance of a workout	200 (---/---) 43 ± 10,5 years	55	---	---
Hespanhol Junior et al, 2013 <sup>9</sup>	Any pain of musculoskeletal origin related to running practice severe enough to prevent the performance of a workout	191 (50/141) 42,8 ± 10,5 years	31	6	25
Hino et al, 2009 <sup>21</sup>	Any pain or injury that has excluded participation in training / competitions	293 (66/227) ---	28,5	5,5	23
Ishida et al, 2013 <sup>6</sup>	---	94 (0/94) 39 ± 13 years	34	---	34
Lopes et al, 2011 <sup>22</sup>	---	1049 (253/796) 39 ± 11 years	22	7	15
Oliveira et al, 2012 <sup>23</sup>	---	77 (34/43) -----	32,5	---	---
Oliveira EGA; Santos-Filho SD, 2018 <sup>24</sup>	---	30 (8/22) 27,7 ± 8,1 years	60	13	47
Pazin et al, 2008 <sup>25</sup>	The one that has led to the interruption of training due to muscle or osteoarticular impairment for at least two days	115 (0/115) -----	37,7	---	---
Pileggi et al, 2010 <sup>26</sup>	---	18 (5/13)	50	11,2	38,8
Purim et al, 2014 <sup>27</sup>	Musculoskeletal condition, pain or inability to practice / competitions	220 (54/166) 38,4 ± 11,3 years	65,9	---	---
Rangel et al, 2016 <sup>28</sup>	---	88 (32/56) 35,5 ± 9,7 years	43,2	---	---
Rios et al, 2017 <sup>29</sup>	---	123 (35/88) 31,4 ± 11,0 years	21,95	---	---
Rolim et al, 2015 <sup>30</sup>	---	50 (24/26) 37,4 ±	20	6	14
Salicio et al, 2017 <sup>31</sup>	---	101(43/58) 33,9 ± 8 years	37,7	---	---
Saragiotto et al, 2014 <sup>32</sup>	---	95 (30/65) 40,1 ± 12,6 years	45	---	---
Saragiotto et al, 2016 <sup>33</sup>	Any pain of musculoskeletal origin attributed to running, severe enough to prevent the runner from performing at least one training session	19 (4/15) 39,3 ± 9,3 years	21	---	---
Souza et al. 2014 <sup>34</sup>	Event that limits the athlete's participation for at least one day	154 (39/115)	37	5,2	31,8
Yamato et al, 2011 <sup>35</sup>	---	155 (35/120) 38,0 ± 10,0 years	25,1	---	---

### Most common types of injuries

The prevalence of muscle injuries, which included sprains, stretches and contractures, was 27.9% (95% CI 18.2-40.1%). The prevalence of ligament injuries, such as sprains and dislocations, was 27.8% (95% CI 19.4-38.1%). Plantar fasciitis, tendinitis, synovitis, bursitis, and medial stress syndrome of the tibia were grouped as inflammatory lesions, and their prevalence was 26.5% (95% CI 14.9-40.1%). Bone injuries included fracture, chondromalacia patella and bone edema, and their prevalence was 5.6% (95% CI 1.8-16.3%). The I<sup>2</sup> value of 0.0 also revealed low heterogeneity for the results obtained in this subgroup.

### DISCUSSION

This review is the first national meta-analysis that was performed to investigate the prevalence of injuries in 3,786 recreational street runners. The data herein provide moderate quality evidence that the prevalence of injuries in recreational street runners is 36.5%. The distance of running per week is a predictive variable of injuries. Most injured individuals are men. The most affected anatomic site is the knee, and the most common injuries are muscular injuries.

This review revealed a prevalence of injuries in Brazilian recreational street runners of 36.5%. A similar value was reported by Von Rosen et al<sup>37</sup> in a study of 64 male and female participants, in whom the prevalence of injuries in street runners was 35.7%. Our findings are also consistent with the study published by Kluitenberg et al,<sup>38</sup> which included 1,696 male and female participants; 33.6% of the subjects reported injuries. The prevalence rate in our study is also in line with the ranges proposed in the systematic reviews published by Van Gent et al<sup>39</sup> (19.4% to 79.3%) and Von der Worp et al<sup>40</sup> (20.6% to 79.3%). In soccer, the prevalence of injuries was 28.23% for teams of professional juvenile athletes,<sup>41</sup> whereas the prevalence of musculoskeletal injuries in crossfit athletes with an average age of 32 years was 30.2%.<sup>42</sup> The findings confirm that running is associated with risks of musculoskeletal injuries; therefore, it is important to define preventive strategies to promote safe running practice.

We highlighted the divergence of national studies regarding the definition of injury. Most studies did not use a standard definition. Thus, several authors claimed that some differences in injury rates were certainly linked to different definitions used in each study,<sup>22,39,43,44</sup> corroborating our findings that the prevalence of injury ranged from 20% to 65.9%.

**Table 2.** Methodological quality of included studies (n = 23).

Studies	1	2	3	4	5	6	7	8	9	10	Scores (0–10)
Abiko et al <sup>16</sup>	Y	U	N	N	N	Y	N	Y	Y	Y	5
Araújo et al <sup>17</sup>	Y	Y	N	N	N	Y	N	U	Y	Y	5
Campos et al <sup>18</sup>	Y	Y	N	N	N	Y	N	Y	Y	U	5
Fernandes et al <sup>19</sup>	Y	Y	N	N	N	U	N	Y	Y	Y	5
Ferreira et al <sup>20</sup>	Y	Y	N	Y	Y	Y	N	Y	Y	Y	8
Hespanhol Junior et al <sup>10</sup>	Y	Y	N	N	N	Y	N	Y	Y	Y	6
Hespanhol Junior et al <sup>9</sup>	Y	Y	N	N	Y	Y	N	Y	Y	Y	7
Hino et al <sup>21</sup>	Y	Y	N	N	N	U	Y	U	Y	Y	6
Ishida et al <sup>6</sup>	Y	Y	N	Y	Y	Y	N	Y	Y	Y	8
Lopes et al <sup>22</sup>	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	9
Oliveira et al <sup>23</sup>	Y	Y	N	U	U	Y	N	Y	U	Y	5
Oliveira;Santos Filho <sup>24</sup>	Y	Y	N	N	N	Y	N	Y	U	Y	5
Pazin et al <sup>25</sup>	Y	Y	Y	N	N	Y	N	Y	Y	N	6
Pileggi et al <sup>26</sup>	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	9
Purim et al <sup>27</sup>	Y	Y	N	N	N	Y	N	Y	Y	Y	6
Rangel et al <sup>28</sup>	Y	Y	N	N	N	Y	N	Y	Y	Y	6
Rios et al <sup>29</sup>	Y	Y	N	N	N	Y	N	U	Y	Y	5
Rolim et al <sup>30</sup>	Y	Y	N	U	N	Y	N	Y	U	Y	5
Salicio et al <sup>31</sup>	Y	Y	N	U	N	Y	N	U	Y	Y	5
Saragiotto et al <sup>32</sup>	Y	Y	N	Y	Y	Y	N	Y	Y	Y	8
Saragiotto et al <sup>33</sup>	Y	Y	N	Y	N	Y	Y	Y	Y	Y	8
Souza et al <sup>34</sup>	Y	Y	N	Y	U	Y	N	N	N	Y	5
Yamato et al <sup>35</sup>	Y	Y	N	N	U	Y	N	Y	Y	Y	6

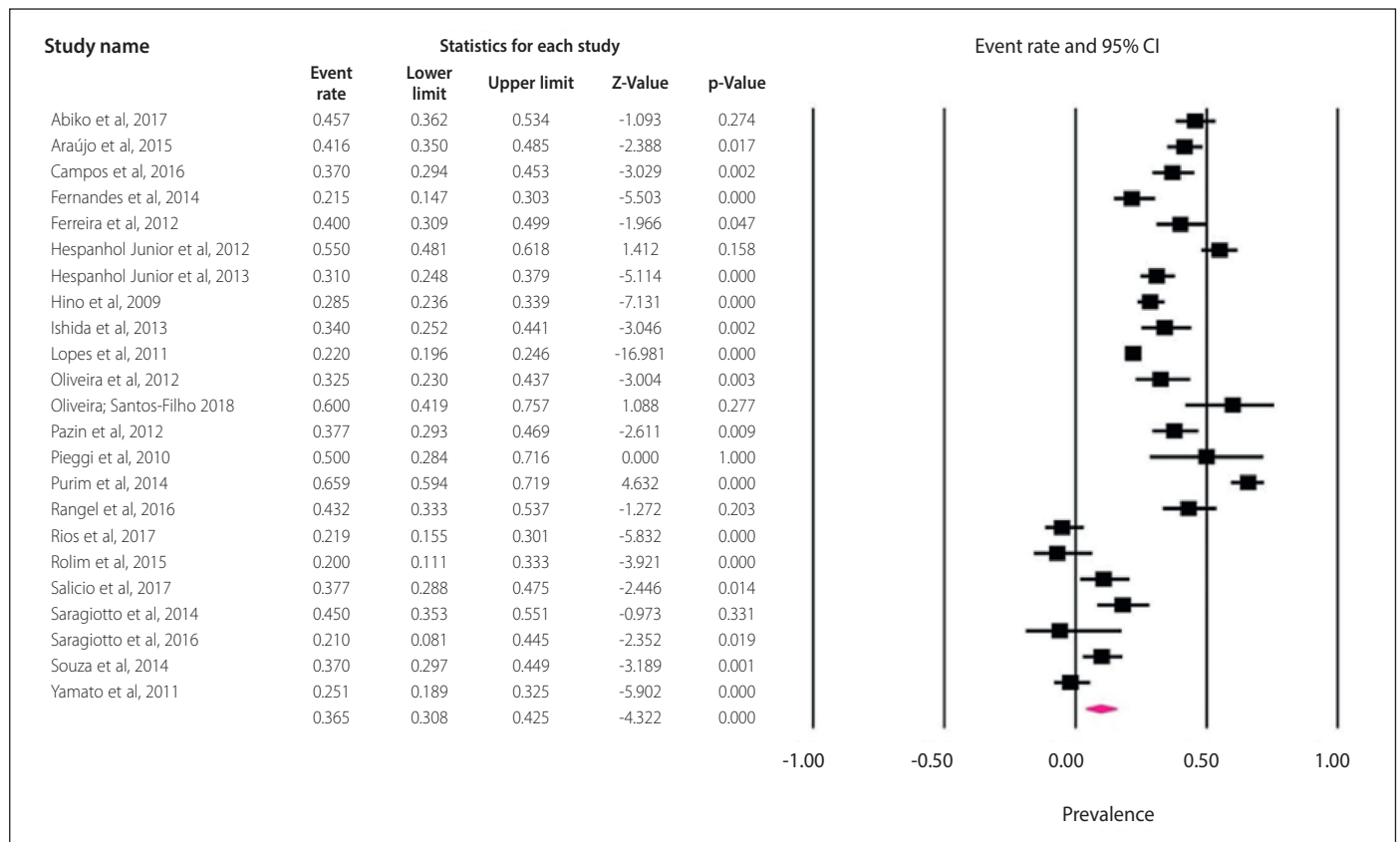
1. Was the sample representative of the target population? 2. Were study participants recruited in an appropriate way? 3. Was the sample size adequate? 4. Were the study subjects and setting described in detail? 5. Is the data analysis conducted with sufficient coverage of the identified sample? 6. Were objective, standard criteria used for measurement of the condition? 7. Was the condition measured reliably? 8. Was there appropriate statistical analysis? 9. Are all important confounding factors/ subgroups/differences identified and accounted for? 10. Were subpopulations identified using objective criteria? Y = yes; N = no; U = unclear

The lack of a standard definition hinders the comparison of studies. Hence, a standard definition of running-related injury, specifically for street runners, may contribute to reducing the large variations observed in reported injury rates.

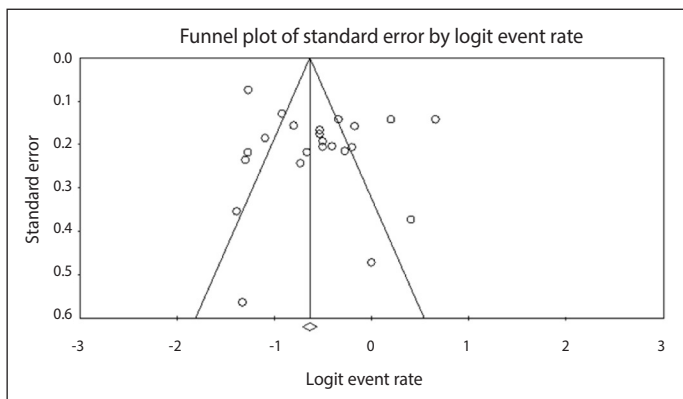
Regarding training characteristics, the running distance was the main variable related to the onset of injuries. Van Poppel et al<sup>45</sup> and Van der Worp et al<sup>40</sup> also found a positive correlation between injuries and runners running distances greater than 20 kilometers per week. However, studies pointed out that other training characteristics may also predispose individuals to develop injuries, such as previous injuries and running speed.<sup>9,39,46</sup> Therefore, it is necessary to conduct longitudinal studies to investigate these variables.

In relation to sex, the present study's results showed that most runners are men and that the prevalence of injuries is also higher in this sex. A higher percentage of men was also observed in previous studies,<sup>9,37,46</sup> which may be related to social structure since women have a double working day. It may also be associated with the characteristics of running itself, as it is a sport with greater impact and low socialization.<sup>47</sup> It has been suggested that inadequate flexibility, muscle imbalances, and deficits in neuromuscular coordination may cause inadequate movement patterns, which increase the risk of injuries in men.<sup>48</sup> Additionally, the risk profile in men could be also related to the higher running speed and greater distance of running per week.<sup>40,49</sup>

Concerning the anatomical region, we observed that the knee is the most affected site of injury, with a prevalence of 33.5%. A similar value was reported by Van Poppel et al<sup>45</sup> (31.1%) for knee injuries in 713 subjects. The literature indicates that the high rate of knee injuries in recreational runners is related to mechanical overload caused by the impact of running.<sup>34,49,50</sup> The magnitude of impact forces acting on the lower limbs during running can range from one and a half to three times one's body weight.<sup>51</sup> However, there is evidence that running practice is a protective factor for knee and hip osteoarthritis in recreational street



**Figure 2.** Forest plot of the prevalence meta-analysis of lesions and their respective confidence intervals.



**Figure 3.** Funnel graph of the standard error by event rate (n = 23).

runners compared to sedentary individuals and professional runners. This is because the weekly running distance of recreational runners is generally less than 20-40 km, and their running experience is about 15 years.<sup>52,53</sup> We infer that knee pain has a multifactorial origin, such as load and training volume, body mass index, concomitant practice of another type of exercise, biomechanical alterations, soil type and footwear, and other factors that must be considered to prevent knee pain.

Regarding the type of injuries, muscle consequences showed the highest prevalence rate, 27.9%, followed by ligament injuries, 27.8%, inflammatory injuries, 26.6%, and bony injuries, 5.6%. In the study published by Hespanhol Junior et al,<sup>7</sup> 29.5% of subjects had inflammatory injuries and 30.3% had muscle injuries. Nielsen et al<sup>54</sup> reported that

inflammatory injuries accounted for 38%, muscle injuries comprised 20%, and bone lesions accounted for 6%. Baumann et al<sup>55</sup> suggested that muscle injuries in runners result from eccentric muscle actions, the generation of more muscle torque, and activation of fewer motor units for a particular load. This causes a high degree of mechanical stress on activated muscle fibers, failure in the excitation contraction coupling, and damage of muscle structures. Poorly supplied tissues, such as ligaments, are also particularly at risk, since they adapt slowly to an increase in mechanical load.<sup>40</sup>

The limitations of the study include the moderate quality of evidence, use of self-administered questionnaires that can lead to memory bias, and lack of standard collected information, thus compromising a more detailed interpretation of the data. Longitudinal studies are needed to comprehensively investigate predictive factors of injury.

## CONCLUSIONS

The prevalence of injuries in Brazilian recreational street runners was 36.5% among 3,786 runners. The running distance per week was greater than 20 km and predictive of the occurrence of injury. Additionally, most injured individuals were men. The most affected anatomic site of injury was the knee, and the most common types of injury were muscular ones. The prevalence of injuries was moderate, although caution is required regarding the duration of running per week.

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