Journal of Physical Education and Sport ® (JPES), Vol. 21 (1), Art 3, pp. 21 - 28, January 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Injury in street runners: prevalence and associated factors

BRUNO GIGLIO DE OLIVEIRA[1], RICARDO TEIXEIRA[2], EDUARDO IRINEU BORTOLIFUNEZ[3], CIRO ROMELIO RODRIGUEZ-AÑEZ[4], CINTIA DE LOURDES NAHHAS RODACKI[5], ROGÉRIO CÉSAR FERMINO[6]
[1,3,4,5,6]Federal University of Technology - Parana, Post-Graduate Program in Physical Education, Research Group on Environment, Physical Activity and Health, PR, BRAZIL
[2,4,5,6]Federal University of Technology - Parana, Academic Department of Physical Education, PR, BRAZIL
[6]Federal University of Parana, Post-Graduate Program in Physical Education, PR, BRAZIL

Published online: January 30, 2021
(Accepted for publication January 22, 2021)
DOI:10.7752/jpes.2021.01003

Abstract
Problem statement: The street running practice has grown substantially in the last decades. Some musculoskeletal injuries from this running can cause prolonged periods of absence from this activity. **Aim:** To estimate the occurrence of running-related injuries and to analyze their association with sociodemographic characteristics, training variables, and characteristics of the primary type of competition in adult street runners from Curitiba, Brazil. **Material and methods:** A observational and cross-sectional design study was conducted in 2017. The 195 participants (60.5% male) were recreational street runners, intentionally selected among clients of four running consultancy companies or approached after a race competition. Injury occurrence was self-reported and measured with a dichotomous answer to the question: *In the last six months, have you suffered any type of injury to your lower limbs as a result of running?* The independent variables included sociodemographic characteristics (sex, age group, body mass, height, Body Mass Index), training variables (weekly frequency, volume, place, professional monitoring), and characteristics of the primary type of competition (main running types, distance, and years of practice). Data were analyzed using a multivariate Poisson regression in SPSS 26.0. **Results:** The prevalence of injury was 16.9% and was positively associated only with five or more years of run practices (PR: 2.11; 95% CI: 1.07-4.17; p = 0.032). The most injured site was the leg (49%), while the least common was the thigh (3%). Tibial periostitis (47%) and muscle strain (3%) were the most and least reported types of injury, respectively. **Conclusion:** These results may help professionals develop preventive injury strategies with adequate exercise and periodization to preserve long-time street runners' health.
Keywords: **recreational runners; running; sports medicine; sports injuries; musculoskeletal injuries; running-related Injuries**

Introduction

Regular physical activity is associated with essential health benefits such as reduced mortality, the incidence of hypertension, type II diabetes, anxiety, depression, overweight, and improved cardiorespiratory fitness (Ding et al., 2016). Among the various physical activities, street running is one of the most popular and accessible activities and has shown substantial growth in the last decades (Bueno et al., 2020; Lima et al., 2017; Torres et al., 2020).

However, musculoskeletal injuries are common among runners (Bueno et al., 2018; Saragiotto et al., 2014). These injuries can be related to intrinsic factors (sex, age, experience) and extrinsic factors (such as place of training, type of race, and professional monitoring), which may lead to a reduction in the practice of running (Benca et al., 2020; Hino et al., 2009; Hollander et al., 2021). In some cases, injuries require a lengthy recovery period and are often reported as the reason for giving up the physical activity (Bueno et al., 2018; Hespanhol Junior et al., 2012; Kluitenberg et al., 2015).

Despite the evidence showing an increase in the number of injuries among street runners, there is still some disagreement on the factors that can influence these injuries. Still, there is a relative lack of epidemiological studies in street runners in Brazil. These findings make it difficult to carry out interventions that can prevent injuries in this modality and help maintain and improve its practitioners' health and increase their performance (Borel et al., 2019; Hino et al., 2009; Torres et al., 2020).

In this context, a recent study (Borel et al., 2019) reported the prevalence of injuries ranging between 21-65% and an international study between 20-79% (Van der Worp et al., 2015). These variations in results may be due to divergences in the definition of injury related to street running (Yamato et al., 2015). For example, Purim et al. (2014) classified an injury as *"any pain, or condition that has limited or removed for one or more days the athlete's participation in training andor competitions in the last six months"* and found a prevalence of 65%. On

Corresponding Author: ROGÉRIO CÉSAR FERMINO, E-mail: rogeriofermino@utfpr.edu.br

the other hand, Hespanhol Junior et al., classified injury as *"any musculoskeletal pain related to running practice severe enough to prevent training"* and found a prevalence of 31% (Hespanhol Junior et al., 2013).

There seems to be a lack of studies using a standardized concept of injury suffered by street runners, presenting a difficulty in comparing the data, with low consistency of results in the prevalence of injuries (Yamato et al., 2015). This characteristic may, in part, make it difficult to understand the primary injuries and the factors associated with them, thus limiting prevention and treatment strategies (Torres et al., 2020; Van der Worp et al., 2015). In this context, the aim of this study was 1) to estimate the occurrence of running-related injuries in adult street runners in Curitiba, Brazil, and 2) to analyze the association of their injuries with sociodemographic characteristics, training variables, and characteristic the primary type of competition.

Material & methods

Design, research location, and ethical aspects

Between August and September 2017, an observational study with a cross-sectional design was conducted to identify aspects related to injuries in street racing practitioners, both recreational and long-distance (Kluitenberg et al., 2015).

The study was conducted in Curitiba, Parana State, in the south of Brazil. The city has a diversified calendar of traditional street races or relay events, children's circuit, in addition to regional and international races, such as a half-marathon and a marathon, promoted by the Municipal Secretariat for Sport, Leisure and Youth (PMC, 2020). Private companies and sports entities promote other events during the year. In 2017, it was estimated that there were 92 street racing events in the city (PMC, 2020). These characteristics can contribute to the popularization of this type of physical/sports activity and, consequently, increase practitioners' number in recent years. For example, it estimated that about 4% of men and 2% of women in Curitiba city are runners (Lima et al., 2017).

The Research Ethics Committee approved the study of Federal University of Technology - Paraná (# 2,533,719), and the participants signed informed consent.

Participants and sample power

Participants were non-probabilistic selected among the clients of four street running consultancy companies and participants in three street running events. As an inclusion criterion, they had to be adults and to have practiced street racing for at least a year.

Running advisors were intentionally selected as they offer their services in public parks in the city. Ninety-five individuals (61% men) were invited to study before or after the training sessions. Acceptance rate was 100% (n=95). A street race competition was also selected, given its proximity to the place of the data collection. One hundred and forty-three individuals (60% men) were approached after a race competition and invited to participate in the study; the acceptance rate was 70% (n=100). The final number of participants was 195 street runners, 85% of those invited to participate.

The sample power was calculated posterior using the software G*Power 3.1.1 and show power of 92% for an alpha value of 5%.

Dependent variable

The injuries' characteristics were assessed using a self-reported morbidity survey, enabling collecting information on the frequency of health problems and their possible risk factors (Pastre et al., 2004). Injury occurrence was assessed with a dichotomous response with a question*: In the last six months, have you suffered any type of injury to your lower limbs as a result of running?* (no, yes).Self-reporting is commonly used in similar studies to verify the occurrence of injuries resulting from the practice of running (Hino et al., 2009; Van der Worp et al., 2015; Hespanhol Junior et al., 2016; Torres et al., 2020).

The injury was considered any musculoskeletal pain or condition that caused restriction and withdrawal from running for a) at least seven days; or b) three consecutive training sessions; or c) made it necessary to consult a doctor/health professional. After a consensus of researchers on injuries in recreational and amateur street runners, this operational definition was established for an adequate comparison between studies (Yamato et al., 2015). The type of injury was assessed with series of questions, in which participants were asked about the location of the injury, point to the region on a sex-specific figure of the human body (e. g.: right or left leg, knee), as well as to give the characteristics of the moment of the injury occurrence (training, competition), the time off (number of days), the use of medications (no, yes) and the need for surgical intervention (no, yes) (Kasimov et al., 2018).

Independent variables

Sociodemographic characteristics

Sex was observed, and age wasclassified into two age groups (≤ 39.9 years, ≥ 40 years). Body mass (kg) and height (m) were self-reported and classified by the median according to the parameters of the Brazilian Institute of Geography and Statistics for the adult population of southern Brazil (below and above) (IBGE, 2010). The body mass index (BMI) was categorized in ≤ 24.9 kg/m^2 and ≥ 25kg/m^2.

Training characteristics

The weekly frequency of training was assessed with the question: *How many times a week do you train street running?*This continuous variable was classified as 1-3 times/week and ≥ 4 times/week for analysis purposes. Training volume was assessed with the question: *On average, how many kilometers per week do you run in your training?* The variable was categorized as ≤ 19.9 km/wk, 20-39.9 km/wk, and ≥ 40 km/wk.

The training place was assessed with the question: *What is the predominantly used place for your training?* (urban street, rural street, park, treadmill, trail). The response options were grouped into three categories according to their potential for injuries: urban street, rural street or trail, and park (Kluitenberg et al., 2015). Finally, professional monitoring was assessed with the question: *Do you have any monitoring during training?*(no, trainer, personal trainer, and sports advisor). The variable was classified into three categories for analysis purposes: no, trainer/personal trainer, and sports advisor).

Characteristics of running practice

The primary type of race was evaluated with the question: *What is the primary type of race you practice?* (street race, trail run, mountain race, obstacle race, and triathlon). This variable was grouped according to injuries' potential into two types: street race and trail run/mountain race/obstacle race/triathlon (Kluitenberg et al., 2015). The primary type of race's distance was assessed with four answer options (5 km, 10 km, 21 km, and 42 km) and categorized in ≤ 10 km and ≥ 11 km. Finally, the experience in years of practice was evaluated with four options (< 1 yrs, 1-4.9 yrs, 5-9.9 yrs and ≥ 10 yrs) and classified into two categories (≤ 4.9 yrs and ≥ 5 yrs).

Statistical analysis

The absolute and relative frequency distribution was used to describe the categorical variables of the participants' characteristics, while the mean and standard deviation described the quantitative variables. The occurrence of injuries was described for the different independent variables, and the association between the variables was analyzed with Poisson regression. After bivariate analysis, all the same or higher-level variables presented a p-value <0.10 and were selected for adjustment in the multivariate model. The final model was carried out following multiple models elaborated from the hierarchical structure with the following levels and variables: level 1 – sociodemographic characteristics; level 2 - training characteristics; and level 3 - running characteristics. The analyses were performed using SPSS 26 software, and the significance level was maintained at 5%.

Results

Most participants were male (60.5%), aged ≤ 39.9 yrs (59.0%), had body mass below the median (52.8%), height above the median (57.4%) and BMI ≤ 24.9 kg / m^2 (60.0%) (Table 1).

Regarding training characteristics, there was a more proportion of participants who performed between 1-3 training sessions per week (60.0%), with a volume between 20-39.9 km/week (39.0%), trained in parks (52.1%), and had professional support of sports advice (48.2%). Regarding the characteristics of the race, the largest proportion of participants performed street races (67.7%), at distances ≤ 10 km (75.9%), and with practice time ≤ of 4.9 years (74.9%) (Table 1). The occurrence of injuries was 16.9%. The largest proportion of participants reported the occurrence of injuries during training (69.7%), stayed away for a period ≤15 days (53.1%), used medication (69.7%), and did not need surgical intervention (100.0%) (Table 1).

Table 1. Descriptive characteristics of street runners. Curitiba, Brazil. 2017 (n = 195).

Variable	Category	n	%	Average ± s.d.
Sociodemographic				
Sex	Female	77	39.5	.
	Male	118	60.5	.
Age group	≤ 39.9 years	115	59.0	37.1 ± 10.7
	≥ 40.0 years	80	41.0	
Body mass (median)	Below	103	52.8	70.8 ± 8.8
	Above	92	47.2	
Height (median)	Below	83	42.6	1.70 ± 0.6
	Above	112	57.4	
Body Mass Index	≤ 24.9 kg/m^2	117	60.0	24.4 ± 2.3
	≥ 25.0 kg/m^2	78	40.0	
Training characteristics				
Frequency	1 - 3 trainings/wk	117	60.0	3.4 ± 1.4
	≥ 4 trainings/wk	78	40.0	.

Volume	≤ 19.9 km/wk	60	30.7	.
	20 - 39.9 km/wk	76	39.0	.
	≥ 40 km/wk	59	30.3	.
Place	Urban street	60	31.6	.
	Rural streetor trail	31	16.3	.
	Park	99	52.1	.
Professional monitoring	No	69	35.4	.
	Personal trainer[#]	32	16.4	.
	Sports adviser	94	48.2	.
Running characteristics				
Main running type	Street race	132	67.7	.
	Other[##]	63	32.3	.
Distance	≤ 10 km	148	75.9	.
	≥ 11 km	47	24.1	.
Years of practice	≤ 4.9 yrs	146	74.9	.
	≥ 5 yrs	49	25.1	.
Injury characteristics				
Running-related injuries	No	162	83.1	.
	Yes	33	16.9	.
Moment	Training	23	69.7	.
	Running	10	30.3	.
Recovery time (timeoff)	≤ 15 days	17	53.1	22.0 ± 15.0
	≥ 16 days	15	46.9	
Use of medicines	No	10	30.3	.
	Yes	23	69.7	.
Surgical intervention	No	33	100.0	.

[#]Trainer or personal trainer; [##]Trail run mountain, obstacles and/or triathlon

The most common site of the injury was the leg (49%), while the least common was the thigh (3%) (Figure 1). Tibial periostitis (47%) and muscle strain (3%) were the types of injury most and least reported, respectively (Figure 2). In the bivariate analysis, weekly training frequency ≥ 4 times/week (PR: 2.03; 95% CI: 1.09-3.82; p=0.027) and years of practice ≥ 5 yrs (PR: 2.48; 95% CI: 1.35-4.58; p=0.003) was positively associated with the occurrence of injuries (Table 2). After adjusting for possible confounding factors, there was a reduction in association strength for both (weekly training frequency and years of practice) (Table 3). The weekly frequency of training ≥ 4 times/wk lost significance, but it had a marginal association with the occurrence of injuries (PR: 1.77; 95% CI: 0.94-3.33; p=0.077). However, the years of practice maintained a significant association, indicating that those individuals who performed the primary type of race as trail run mountain, obstacles or triathlon ≥ 5 yrs were 111% more likely to be affected by musculoskeletal injuries (PR: 2.11; 95% CI: 1.07 -4.17; p=0.032) (Table 2).

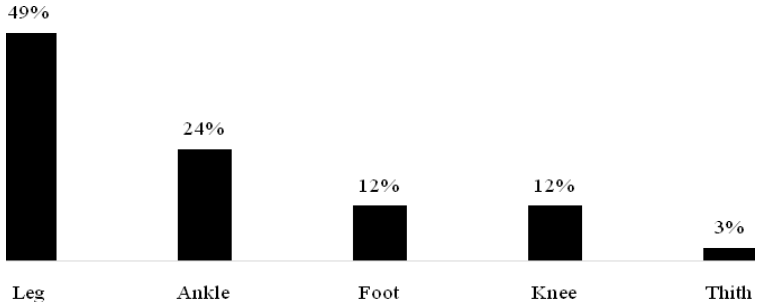

Figure 1. Locations of running-related injuries in street runners. Curitiba, Brazil, 2017 (n=33).

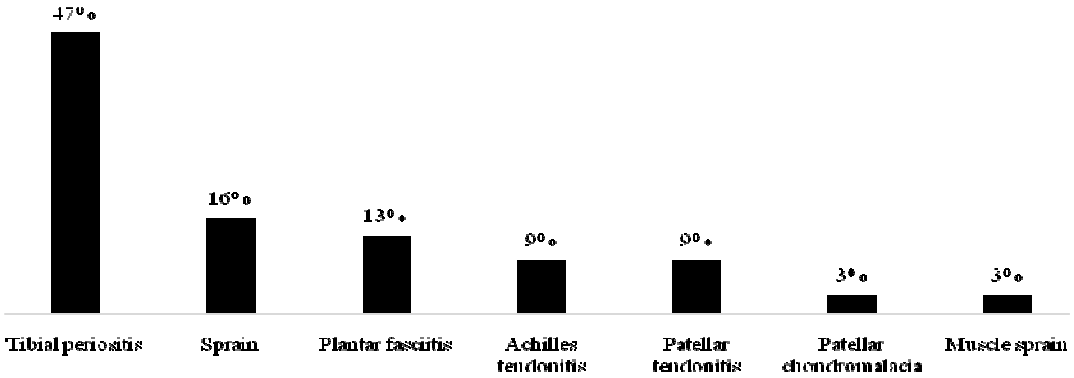

Figure 2. Type of running-related injuries in street runners. Curitiba, Brazil, 2017 (n=33).

Table 2. Associated factors torunning-related injuries in street runners. Curitiba, Brazil. 2017 (n=195).

				Bivariate analysis			Multivariate analysis		
Level and variables	Category	n	%	PR	95% CI	p	PR	95% CI	p
Level 1 – *Sociodemographic*									
Sex	Female	9	11.7	1					
	Male	24	20.3	1.74	0.86-3.54	0.126	-	-	-
Age group	≤ 39.9 yrs	21	18.3	1					
	≥ 40.0 yrs	12	15.0	0.82	0.42-1.57	0.553	-	-	-
Body mass (median)	Below	22	21.4	1					
	Above	11	12.0	0.56	0.29-1.09	0.088	-	-	-
Height (median)	Below	19	22.9	1					
	Above	14	12.5	0.54	0.29-1.02	0.060	-	-	-
Body Mass lndex	≤ 24.9 kg/m^2	23	19.7	1					
	≥ 25.0 kg/m^2	10	12.8	0.65	0.32-1.29	0.221	-	-	-
Level 2 – *Training characteristics*									
Frequency	1 - 3 trainings/wk	14	12.0	1					
	≥4 trainings/wk	19	24.4	**2.03**	1.09-3.82	0.027	1.77*	0.94-3.33	0.077
Volume	≤ 19.9 km/wk	9	15.0	1					
	20 - 39.9 km/wk	9	11.8	0.78	0.33-1,86	0.590	-	-	-
	≥ 40 km/wk	15	25.4	1.69	0.80-3.56	0.165	-	-	-
Place	Urban street	12	20.0	1					
	Rural street or trail	8	25.8	1.29	0.59-2.82	0.523	-	-	-
	Park	12	12.1	0.60	0.29-1.26	0.181	-	-	-
Professional monitoring	No	11	15.9	1					
	Personal trainer[#]	9	28.1	1.76	0.81-3.82	0.151	-	-	-
	Sports adviser	13	13.8	0.86	0.41-1.81	0.707	-	-	-
Level 3 – *Running characteristics*									
Main type	Street race	23	17.4	1					
	Other[##]	10	15.9	0.91	0.46-1.79	0.788	-	-	-
Distance	≤ 10 km	24	16.2	1					
	≥ 11 km	9	19.1	1.18	0.59-2.36	0.638			
Years of practice	≤ 4.9 yrs	18	12.3	1					
	≥ 5 yrs	15	30.6	**2.48**	1.35-4.58	0.003	**2.11****	1.07-4.17	0.032

**adjusted for body mass and height; **adjusted for body mass, height, and weekly frequency; [#]Trainer or personal trainer; [##]Trail run mountain, obstacles or triathlon*

Discussion

This study's main objective was to estimate injuries in participants in a street running and analyze their association with sociodemographic, training, and competition characteristics in adults from Curitiba, Brazil. In the epidemiological context, running-related injuries were measured using a standardized question and classified according to the consensual definition for this modality, which is one of this study's strengths. The identification of these characteristics enables an adequate preventive approach related to injuries, as well as allowing comparison with similar studies. The results showed a positive association between the years of practice in the primary running competition type and injury occurrence.

In this study, an injury prevalence of 16.9% was identified. Worldwide, a study involving 1,696 runners reported a 34% prevalence of injury (Kluitenberg et al., 2015). A recent meta-analysis published with studies conducted in Brazil (Borel et al., 2019) identified an average prevalence of injuries of 36.5%. Of the 23 studies included, only 11 (48%) reported some conceptual and operational definition of "injury". It is essential to highlight that the consensual definition established in 2015 was not used in the studies included in that meta-analysis, as they were conducted before the year in which the consensus was established (Yamato et al., 2015). This is important implies little comparative data due to the lack of definition or different definitions of injury in the studies, which leads to difficulty in developing prevention strategies.

There seems to be a positive relationship between time of practice and injury. Other studies have reproduced similar results, and for example, a systematic review indicated that a long time of practice was a risk factor for injuries in runners (Van der Worp et al., 2015). Likewise, this same result was found in Brazil's study (Rangel & Farias, 2016). One study identified that an amount of practice experience < 1 year was a factor of protection against injuries (McKean et al., 2016). On the other hand, a longer practice time should reflect a more significant running experience and greater self-knowledge of runners, reducing injuries' prevalence (Damsted et al., 2017). Since the practice of running, however, is based on essential training variables, such as volume, intensity, duration, and frequency, these, if organized incorrectly over time, could generate more significant damage to runners (Benca et al., 2020; Bueno et al., 2018; Nielsen et al., 2012).

Among the injuries identified, tibial periostitis was the most prevalent, with 47%. The tibia is the most common site of stress injuries in runners, representing 33 to 55% of the total reported stress fractures (Zadpoor & Nikooyan, 2011). When the foot is on the ground, the tibia's anterior portion absorbs high compressive loads, while the posterior portion of the leg receives traction loads (Zadpoor & Nikooyan, 2011; Kasimov et al., 2018). This can explain the tibia's bone geometry, wherein the anterior portion there is more bone mass, due to compressive loads, than in the posterior portion that receives traction loads (Meardon et al., 2015). The musculature of the posterior portion of the leg must be strong enough to help distribute the loads, generating a compressive force in the posterior region of the tibia and reducing the loads in the anterior portion. Thus, tibial stress fractures may be more likely to occur in individuals whose muscles suffer fatigue more quickly or those whose muscles fatigue at different rates, resulting in muscle imbalance (Zadpoor & Nikooyan, 2011; Meardon et al., 2015; Lopes et al., 2012).

In this study, the variables sex and age group were not associated with injuries. Some studies have indicated that men, mainly < 40 yrs old, have a higher risk of injury (Van der Worp et al., 2015; Van Gent et al., 2007), mainly due to factors related to overload and overtraining (Benca et al., 2020; Meardon et al., 2015). The relationship between the occurrence of injuries with weight and height is still inconsistent in the literature, and the body mass index does not seem to have any effect on the risk of injury (Van der Worp et al., 2015). Most injuries in runners occur due to overload (Hreljac, 2004), and training characteristics play a fundamental role in this regard (Nielsen et al., 2012). In this study, the variable training frequency was positively associated with injuries only in the bivariate model and was not associated with the other variables. This suggests that the relative risk of injury proportionally increases with weekly training frequency (Nielsen et al., 2012), as well as training volumes > 32 km/wk (Van der Worp et al., 2015; Nielsen et al., 2012; Lopes et al., 2012). These characteristics become visible in this study; 70% of the participants reported that the moment of injury occurred during training, yet only 24% had ≥ 11 km as the distance run in their primary type of race; however, 70% had a training volume of > 20 km/wk.

Some limitations must be considered for the proper understanding of the results presented here. The sample is not representative of Curitiba's street runners. The type of lesion was self-reported, which does not include diagnostic confirmation (Kasimov et al., 2018). The impossibility of evaluating some essential variables, such as biomechanical data and the type of footwear used, made it impossible to analyze these variables' association with injuries (Benca et al., 2020). Finally, the absence of some information related to training (e. g.: intensity) makes it challenging to comprehend the occurrence of injuries.

Conclusions

The occurrence of running-related injuries in lower limbs among recreational street runners was 16.9%. The most common injury site was the leg, and tibial periostitis is the primary injury reported. The amount of practice time within the primary race type of competition, as a trail run mountain, obstacles, or triathlon, over a

period equal to or greater than five years, showed a positive association and increased two times the likely occurrence injuries.

These results can be used as a basis for comparison with future studies that use the same definition of injury. They are also essential to guide interventions that include injury prevention strategies, mainly related to the organization of training variables, so that amount of practice time in running is not a risk factor due to the accumulation of musculoskeletal injuries. Future studies could follow longitudinally different training periodization models for running, including the intensities used and their associations with injury incidence, so the running practice could contain more benefits than risks, thus preserving practitioners' health and longevity.

Conflicts of interest: None

References

Benca E, Listabarth S, Flock FKJ, Pablik E, Fischer C, Walzer SM, et al. (2020). Analysis of running-related injuries: The Vienna Study. *Journal of Clinical Medicine*, 9(438), 1-17.

Borel WP, Filho JE, Diz JBM, Moreira PF, Veras PM, et al (2019). Prevalence of injuries in Brazilian recreational street runners: meta-analysis. *Brazilian Journal of Sports Medicine*, 25(2),161-167.

Bueno AM, Pilgaard M, Hulme A, Forsberg P, Ramskov D, Damsted C, et al. (2018) Injury prevalence across sports: a descriptive analysis on a representative sample of the Danish population. *Injury Epidemiology,* 5(6), 2-8.

Damsted C, Parner ET, Sorensen H, Malisoux L, Nielsen RO (2017). Design of ProjectRun21: a 14-week prospective cohort study of the influence of running experience and running pace on running-related injury in half-marathoners. *Injury Epidemiology*, 4(30), 1-12.

Ding D, Lawson KD, Kolbe-Alexander TL, et al. (2016). The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *Lancet*. 2016, 388(10051), 1311-1324.

Hespanhol Junior LC, Carvalho ACA, Costa LOP, Lopes AD (2016). Lower limb alignment characteristics are not associated with running injuries in runners: prospective cohort study. *European Journal of Sport Science*, 16(8), 1137–1144.

Hespanhol Junior LC, Costa LOP, Carvalho ACA, Lopes AD (2012). A description of training characteristics and its association with previous musculoskeletal injuries in recreational runners: a cross-sectional study. *Brazilian Journal of Physical Therapy*, 16(1), 46–53.

Hespanhol Junior LC, Costa LOP, Lopes AD (2013). Previous injuries and some training characteristics predict running-related injuries in recreational runners: a prospective cohort study. *Journal of Physiotherapy*, 59(4) 263-269.

Hino AAF, Reis RS, Rodriguez-Añez CR, Fermino RC (2009). Prevalence of injuries and associated factors among street runners. *Brazilian Journal of Sports Medicine*, 15(1)**,** 36–39. [In Portuguese]

Hollander K, Johnson CD, Outerleys J, Davis IS (2021). Multifactorial determinants of running injury locations in 550 injured recreational runners. *Medicine and Science in Sports and Exercise,* 53(1), 102-107.

Hreljac A (2004). Impact and overuse injuries in runners. *Medicine and Science in Sports and Exercise*, 36(5), 845-849.

IBGE - Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics) (2010).National survey of family budgets 2008-2019: anthropometry and nutritional status of children, adolescents and adults in Brazil. [2020 May 05]. Available from: https://biblioteca.ibge.gov.br/visualizacao/livros/liv45419.pdf [In Portuguese]

Kasimov V, Russkih A, Shabokha A, Osipov A, Zhavner T, Vapaeva A (2018). Histological features of knee joint meniscus injuries of the professional athletes practicing various types of sports activities. *Journal of Physical Education and Sport*, 18(Suppl 4), 1814-2819

Kluitenberg B, van Middelkoop M, Diercks R, Van der Worp H (2015). What are the differences in injury proportions between different populations of runners? a systematic rewiew and meta-analysis. *Sports Medicine*, 45(8), 1143-1161.

Kluitenberg B, van Middelkoop M, Smits DW, Verhagen E, Hartgens F, Diercks R, et al. (2015). The NLstart2run study: incidence and risk factors of running-related injuries in novice runners. *Scandinavian Journal of Medicine and Science in Sports*, 25(5):515-523.

Lima DF, Lima LA, Silva MP (2017). Time trends of the main modalities of physical exercise and sport practiced in leisure time in Curitiba, Brazil: 2006-2014. *Brazilian Journal of Science and Movement,* 25(3):98-105. [In Portuguese]

Lopes AD, Junior LCH, Yeung SS, Costa LOP (2012). What are the main running-related musculoskeletal injuries? a systematic review. *Sports Medicine*, 42(10), 891-905.

McKean KA, Manson NA, Stanish WD (2016). Musculoskeletal injury in the masters runners. *Clinical Journal of Sport Medicine*, 16(2), 149-154.

Meardon SA, Wilson JD, Gries SR, Kernozek TW, Derrick TR (2015). Bone stress in runners with tibial stress fracture. *Clinical Biomechanics*, 30(9), 895-902.

Nielsen RO, Buist I, Sorensen H, Lind M, Rasmussen S (2012). Training errors and running related injuries: a systematic review. *International Journal of Sports Physical Therapy*, 7(1), 58-75.

Pastre CM, Filho GC, Monteiro HL, Júnior JN, Padovani CR (2004). Sports injuries in track and field: comparison between information obtained in medical records and reported morbidity inquires. *Brazilian Journal of Sports Medicine*, 10(1), 9-15.

PMC - Prefeitura Municipal de Curitiba (Curitiba City Hall). Street race calendar (2020). [2021 Jan 18]. Available from:https://www.curitiba.pr.gov.br/conteudo/corridas-chanceladas-de-curitiba/3010[In Portuguese]

Purim KSM, KappTiski AC, Bento PCB, Leite N (2014). Sports inuries and skin lesions in adepts of street racing. *Brazilian Journal of Sports Medicine*, 20(4), 299-303. [In Portuguese]

Rangel GMM, Farias JM (2016). Incidence of injuries on street running practitioners in Criciuma city, Brazil. *Brazilian Journal of Sports Medicine*, 22(6), 496-500. [In Portuguese]

Saragiotto BT, Yamato TP, Junior LCH, Rainbow MJ, Davis IS, Lopes AD (2014). What are the main risk factors for running-related injuries? *Sports Medicine*, 44(8):1153-1163.

Torres FC, Gomes AC, Silva SG (2020). Characteristics of training and association with injuries in recreational road runners. *Brazilian Journal of Sports Medicine*, 26(5)**,** 410-414.

Van der Worp MP, ten Haaf DSM, van Cingel R, de Wijer A, Sanden MWGN, Staal JB (2015). Injuries in runners: a systematic review on risk factors and sex differences. *PLoS One*, 10(2), 1-18.

Van Gent RN, Siem D, Van Middelkoop M, Van Os AG, Bierma-Zenstra SMA, Koes BW (2007). Incidence and determinants of lower extremity running injuries in long distance runners: a systematic rewiew. *British Journal of Sports Medicine*, 41(8), 469-480.

Yamato TP, Saragiotto BT, Lopes AD (2015). A consensus defnition of running-related injury in recreational runners: a modified delphi approach. *Journal of Orthopaedic and Sports Physical Therapy*, 45(5), 375-380.

Zadpoor AA, Nikooyan AA (2011). The relationship between lower-extremity stress fractures and the ground reaction force: a systematic review. *Clinical Biomechanics*, 26(1), 23-28.