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Musculoskeletal Injuries in Brazilian Recreational Runners: Associated Factors and Score Development to Determine the Risk

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ABSTRACT

Zaar A, Cirilo-Sousa MS, Neto EAP, Sales TH, Nascimento JA, Rouboa AI. Musculoskeletal Injuries in Brazilian Recreational Runners: Associated Factors and Score Development to Determine the Risk. **JEPonline** 2017;20(6): 1-14. The purpose of this study was to determine the factors associated with musculoskeletal injuries and the development of a score to determine the risk. A total of 1,573 runners of both sexes (1,090 men and 483 women) participated in this study. Each subject answered a multiple choice form that consisted of 41 questions about the retrospective information on SLE. The runners' prevalence of injuries was 62.3% (direct ones 22.5% inflammation/tendinitis, 16.8% stretch/muscle, 9.4% soft tissues/meniscus knee ligaments, 5% tibial stress fracture, and indirect 4.3% sprain/joint at the ankle, 3.8% contusion/trauma, and fracture 0.6%), which was associated with the: (a) type of step (P=0.001); (b) gender (P<0.001); (c) increase in the volume of the sessions (P=0.003); (d) percentage of the increase in the volume of the sessions (P=0.015); and (e) increase in the intensity of the sessions (P=0.045). The association between the categories and the risk of injury was confirmed by the Chi-Square test that was statistically significant (P=0.015). The findings indicate that the injuries in recreational runners occur directly and indirectly, reaching grade III, exclusively in the lower limbs and are associated to gender, type of step and to the methodology of the training. In addition, the development of a score to determine the risk of injury makes it possible to establish a preventive and individualized strategy that should help to promote greater safety of the runners.

Keywords: Injury Prevention, Musculoskeletal Injuries, Recreational Runners

INTRODUCTION

The benefits attributed to regular running practice include improvements in physical and mental health, weight control, stress reduction, and socialization (6,37). After a period of regular running, it is common for the practitioners to report changes in lifestyle, including better eating habits, improved sleep quality, and reduced alcohol and tobacco intake. They feel happier, more relaxed, and energized (30).

However, regular running is also associated with injuries of the lower musculoskeletal system. The injuries often restrict running speed, distance, duration, and/or frequency during a minimum period of 1 wk (12, 16, 19). Yet, given the expectation and/or desire to exercise, the demand for continuous activity often provokes microtraumas caused by the overload of the musculoskeletal structure (30).

In the 1980s, the incidence of injuries in runners was 60% (27). During the 1990s, the incidence of injuries increased to ~70% (29). Researchers currently estimate that about 92% of regular runners will get some type of injury during a time period of 1 yr (18). The broad spectrum of these epidemiological findings can be attributed, in part, to the differences in the definitions of the terms runner and injury (11). The literature has typically characterized a runner as an person who runs a minimum distance of 3 $km \cdot session^{-1}$ (34), regularly (3 $times \cdot wk^{-1}$) (29), and has been consistent for a minimum period of 1 yr (34).

The potential for increased race-related injuries over the last decades is attributed to intrinsic factors such as biomechanical abnormalities (39); body mass index (BMI) and gender (3); postural deviations (39); poor flexibility (13); anthropometry (19); previous injury (10,33); technical experience (29,31); mobility of the plantar foot face (12); high longitudinal arches (bare feet) (38); muscle weakness, genu varum knee, high Q angle (7); as well as extrinsic factors, such as methodological misunderstandings, namely the intensity, volume, frequency of running (2,3,11,13,15,22) along with inadequate footwear, and surface (25,28).

Due to the interference of several conditions, the exposure to the risk of injury becomes indispensable to the creation of methods that offer prognosis. The creation of an instrument that allows for the classification of injury risks according to the presence of associated factors identifies the runner by a score would help to predict the injury risk. Such an instrument would become an indispensable contribution in the prevention of injuries related to running. It would help to detect risk factors, thus enabling the establishment of preventive strategies. Hence, the purpose of this study was to identify the factors associated with injuries in recreational runners and to develop a score to determine the risk.

METHODS

Subjects

The sample consisted of 1,573 recreational runners (n = 1,090 men, n = 483 women). The age, body mass, and height by gender are presented in Table 1. The subjects were selected probabilistically. The inclusion criteria were: (a) individuals who ran a minimum distance of 3 $km \cdot session^{-1}$, (b) at least 3 $times \cdot wk^{-1}$, (c) been consistent for at least 1 yr. After being informed about the purpose of the study, the subjects signed an informed consent form, elaborated according to the principles of the Declaration of Helsinki (Table 1), and approved by the Ethics Committee (Protocol No. 1.458.205).

Table 1. Characteristics of the Subjects by Gender.

Characteristics	**Values** (Average ± SD)
Age (yrs)	
Men	42.60 ± 11.29
Women	37.79 ± 10.94
Body Mass (kg)	
Men	76.86 ± 10.63
Women	60.90 ± 10.75
Height (cm)	
Men	176.28 ± 9.60
Women	161.23 ± 10.19

Study Design

Instrument for Data Collection

After understanding what was needed from the subjects, the data collection questionnaire was prepared. The following factors were taken into consideration: its effectiveness, validity, relevance, specificity, clarity, depth, and extension. For greater effectiveness, we felt the need to limit the extension as far as possible and to group the questions by categories. The questionnaire consisted of 41 questions that covered the following categories: (a) training habits; (b) running shoes; (c) surface used for training; and (d) retrospective information on musculoskeletal injuries. The questions were closed and in multiple choice style. We sought to use clear, objective, and accurate language by adapting the terminology that the subjects' normally use. There was also a logical progression from general questions to the more specific questions. The questions that were considered relatively easy were placed at the beginning to characterize the sample. The relation between questions was avoided, so that the preceding one had no influence on the following, separating the questions, and placing the simple, dichotomous (yes, no), before the complex ones, in multiple choice style.

The final form of the document that served as an instrument was carefully elaborated. The instrument was then submitted to experts who determined its validity, which was organized in accordance with the following. Before the final document of the data collection, a pre-form was made for preparation with a set of ideas and questions that were formulated, discussed, and analyzed by three experts of recognized theoretical ability who elaborated upon the set of questions that constituted the questionnaire. After the elaboration, the instrument was tested (applied as a pre-test) in an attempt to evaluate the instrument, with subjects chosen as being typical of the actual sample. This situation provided an analysis of the difficulties encountered, and allowed for a global ordering to ensure clarity and precision in the adopted terminology. The presentation was tested, which made the instrument more effective. It was submitted to experts of recognized theoretical capacity to identify inconsistencies or failures in relation to the objectives. This procedure was important to help ensure that the instrument was valid (i.e., it estimated the validity of the agreement of experts) before being consecrated as a questionnaire and, then, it was applied.

Procedures

After contacting the runners and presenting the purpose of the research, they were invited to participate in this study. With the established verbal agreement, the participants completed the Informed Consent Term (ICT). Prior to the start of the survey, the purpose of the study was again clarified to the each subject. Full confidentiality of the data and content obtained was ensured. It was clarified that the data would be treated together. There was no possibility of being identified in the presentation of the results, and the importance of their answers for the study was highlighted, but that it could be determined if it were at the will of the subject. A cordial environment was created so that the subjects felt comfortable.

Statistical Analysis

Statistical analysis was performed by SPSS® software version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). The descriptive analysis was presented in absolute and percentage values. To verify the association between the presence of lesions and the independent variables, the Chi-Square test with significance of $P<0.05$ was used. The analysis of the standard residues of each cell from the contingency tables was used to determine which category contributed most to the significance. The prevalence ratio for the factors as well as a 95% confidence interval was used to determine the association of these factors with the MI. For the elaboration of a predictor score of the risk of injury, the significantly associated variables were categorized from the highest to the lowest risk of injury based on the literature about the topic. After that, a score was generated, categorized according to their quartiles and classified as: (a) low risk; (b) moderate risk; and (c) high risk of injury.

RESULTS

This study analyzed data from 1,573 recreational runners (1,090 males and 483 females), of which 981 (62.3%) of the runners were affected by an injury in the last year while 592 (37.7%) did not present any type of an injury. The prevalence of direct Running Related Injuries (RRIs) in the subjects consisted of: (a) Grade II [22.5% inflammation/tendonitis, 16.8% stretch/muscle, 9.4% soft parts/meniscus/knee ligaments, 5% tibial stress fracture, and indirect 4.3% sprain/joint in the ankle degree]; and (b) Grade III [3.8% contusion/trauma and 0.6% fracture].

According to the Chi-Square test, the step type variable, gender, experience time, increase in the volume of the sessions, percentage of the volume of the sessions increase, and the intensity of the sessions increase were significantly associated with the presence of lesions (P<0.05). Since many independent variables were tested, only the values of significance and association of these six statistically associated variables will be presented (Table 2) while the other results will be presented in a descriptive way. The highest values of residues were in the associations between: (a) pronated or highly pronated step and presence of lesions (4.0); and (b) females and presence of injuries (3.0), pointing out that these were the categories that contributed most to the significance of the Chi-Square statistics. The other variables that presented significant difference did not indicate an important contribution in the cells in their categories. Thus, the application of the Chi-Square test showed that: (a) greater experience in running is associated with a lower risk of injury; (b) the increase in volume; (c) the percentage of increase in volume; and (d) increased intensity is associated with an increased risk of injury.

Table 2. Independent Variables Associated with the Presence or Absence of Lesions.

Variables	Categories	Injuries n = 978 (62.3%)	Absence of Injuries n = 592 (37.7%)	P	Prevalence Ratio	IC 95%
Gender	Male	724 (66.1)	372 (33.9)	<0.001	1	-
	Female	257 (53.9)	220 (46.1)		1.23	1.12-1.35
Type of Step	Neutral	246 (69.7)	107 (30.3)	0.001	1	-
	Supinated	497 (58.6)	351 (41.4)		1.19	1.09-1.30
	Pronated or Overpronated	238 (64.0)	134 (36.0)		1.09	0.98-1.21
Experience Time	More	640 (66.0)	330 (34.0)	0.001	1	-
	3 yrs	130 (61.0)	83 (39.0)		1.08	0.96-1.21
	2 yrs	107 (57.8)	78 (42.2)		1.14	1-1.30
	1 yr	104 (50.7)	101 (49.2)		1.30	1.13-1.50
Increase in Sessions Intensity	It does not increase	315 (60.1)	209 (39.9)	0.045	1	-
	Day	71 (52.2)	65 (47.7)		1.15	0.97-1.37
	Week	298 (64.5)	164 (35.5)		0.93	0.85-1.03
	Month	296 (65.6)	155 (34.4)		0.92	0.83-1.01
Increase in Sessions Volume	It does not increase	350 (58.7)	246 (41.3)	0.030	1	-
	Day	82 (55.7)	65 (44.2)		1.05	0.90-1.23
	Week	305 (64.6)	167 (35.4)		0.91	0.83-1.00
	Month	244 (68.2)	114 (31.8)		0.86	0.78-0.95
Percentage of Increase in Session Volume	It does not increase	349 (58.1)	252 (41.9)	0.015	1	-
	1 to 15%	329 (65.3)	175 (34.7)		0.89	0.81-0.98
	16 to 25%	133 (60.7)	86 (39.3)		0.96	0.84-1.08
	More than 25%	170 (68.3)	79 (31.7)		0.85	0.76-0.95

Other variables surveyed in the present study were considered clinically important, although not statistically significant. It was verified that 45.3% of the runners do not have guidance from a coach, and that 69.7% of the runners engage in other sports activities. They perform on average 3 training sessions·wk^{-1} (29.5%), lasting more than 50 min (44.1%), totalling a volume greater than 40 km·wk^{-1} (25.9%). The intensity control was achieved by the time per km (60.2%), those who control the intensity of the Heart Rate (HR) target (11.3%) classified intensity as vigorous, and those using Subjective Perception (PSE) (19.4%) classified the intensity as moderate. The recovery interval between the training sessions was 24 hrs (60%). They performed stretching in all training sessions (43.2%), and the majority participated in sporting events (89.9%). The pace set for distances up to 10 km was 4 to 4 min and 30 sec·km^{-1} and for longer distances was 5 to 5 min and 30 sec·km^{-1}.

Among the surveyed runners in this study, 73.3% used asphalt as the main terrain. As far as running shoes were concerned, 85% of the subjects wore traditional footwear for a period of 1 yr. The characteristics considered essential to running shoes were cushioning (39.4%), comfort (32.8%), and stability (14.1%). Those who used minimalist footwear, 10.3% of them ran with a footwear thickness up to 9 mm, and 9.7% with transition footwear (10 to 11 mm), only 1 subject in this study ran without shoes (barefoot). As for the body regions affected by the RRIs, the main complaint was in the knee (17.5%), which was followed by the leg (12%), and then the ankle (9.6%), and a 15-day away from training (14.1%). In relation to the instrument created, the variables were classified according to Table 3.

Table 3. Scoring for Instrument Variable Categories.

Variable	Category	Score
Gender	Female	8
	Male	12
Type of Step	Neutral	0
	Supinated	5
	Pronated or overpronated	10
Experience Time	More	2
	3 yrs	3
	2 yrs	5
	1 yr	10
Increase in Session Intensity	It does not increase	0
	Month	2
	Week	3
	Day	5
Increase in Session Volume	It does not increase	0
	Month	2
	Week	4
	Day	9
Percentage in the Session Volume Increase	It does not increase	0
	1 to15%	2
	16 to 25%	3
	More than 25%	5
	Minimum Score	**10 points**
	Maximum Score	**51 points**

Based on the quartiles of the scores obtained by all investigated ones, the categories were divided into: low risk (10-19 points); moderate risk (20-29 points); and high risk (30-51 points). To confirm the association between the categorization of this score and the presence or absence of SCI, the Chi-Square test was performed between the classes and the presence of an injury in which a significant association was observed (P=0.015). Then, for each category, the risk of injury was determined (Table 4), indicating that the instrument attributes a higher risk to individuals of the highest score category.

Table 4. Association Values between the Categories Generated by the Instrument and the Presence of Injuries.

Categories	Without Injuries n = 592	Injuries n = 978	P	X^2	Prevalence Ratio	IC 95%
Low Risk	147	284			1	-
Moderated Risk	290	499	0.015	8.467	1.04	0.96 - 1.14
High Risk	592	981			1.08	1 - 1.17

It was observed that higher scores led to the classification of an individual in a category that has a higher risk of musculoskeletal injuries. Therefore, when entering this category, it should be investigated as to which significant factors contribute to the occurrence of the injury. This would enable preventive intervention in the occurrence of RRIs. The reason for choosing the first category with Scores up to 19 points was stimulated by the ROC curve that presented a 95% interval for the area under the curve above 0.50, characterizing the instrument with a measure that discriminates the groups with and without the injury. For this level of score (= 19), the sensitivity was 0.752 and specificity 0.29 for a cut-off point below 19 points to diagnose the absence of an injury.

DISCUSSION

The purpose of this study was to investigate the prevalence of musculoskeletal injuries and factors associated with the injuries in recreational runners. Although there are studies in this area, none has such a representative sample in Brazil. These ones were directly and indirectly affected, reaching grade 3, exclusively in the lower members. The prevalence of RRIs in 62.3% of Brazilian recreational runners in the last year is verified. Confirming that there are intrinsic and extrinsic factors associated with the prevalence of injuries in recreational runners and elucidating the threshold in which they occur, with the greatest effect being on the dependent variable intrinsic factors, type of step, and gender. Among the extrinsic factors, the time of experience, the increase in the volume of the sessions, the percentage of the increase of the volume of the sessions, and the increase in the intensity of the sessions.

Type of Step

Our results demonstrate that the pronated step, overpronated was associated with injuries compared to those with the neutral footprint. However, the supine footprint showed greater relative risk compared to the neutral footprint. Individuals with one of these two types of footprint have more risk of RRI than those with neutral footprint. A certain degree of pronation is normal in an overloaded foot, but over pronation is a compensatory movement caused by an incorrect relationship between the heel and the foot or between the leg and the foot. It is common that if the relationship between leg and foot is slightly imperfect, the result may be an imbalance. During the static support of the body weight, the soles of the feet can be forced against the ground by excessive pronation. During running, overuse may be due to the redundant pronation (34) or the over pronation that is maintained for a long time in the support phase. Both increase the stress placed on the foot support structures. Over pronation may also be a mechanism by which the body compensates for other defects or smooth anatomical deviations. It can cause increased load on the lower extremities as a whole, which results in an increased internal rotation of the leg. This can lead to a modification of the biomechanical work pattern of the thigh, so that the leg, knee, and hip are subject to more overload stress. This can be the cause of overuse injuries or other painful conditions in these areas. Injuries associated with this type of step include patellar chondromalacia, posterior tibial syndrome, plantar fasciitis, and trochanteric bursitis (41).

However, anatomical changes (misalignment) are not directly related to a specific diagnosis. The misalignment of the foot can be divided into flat foot and cavus foot with type affecting about 20% of the runners (32). The flat foot results in over pronation at the intermediate position. It may be physiological, but it can also be the consequence of a 10° tibia varus, functional equine, varus talar, or forefoot supination. There may be a low probability of developing injury if the total varus is less than 8°, and a higher incidence of RRIs if the varus is greater than 18° (26). There may be combinations of different misalignments, such as the syndrome of external tibial sprain, observed in some runners, combining anteversion of femoral neck with internal rotation of the hip and genu varum, with or without hyperextension of the knee, converging patella, excessive Q angle (quadricipital), tibia varus, functional equinus, and compensatory pronation of the foot. This syndrome can cause so many problems with regular practice of running that it is recommended not to run long distances. Also, in this regards, Lee Yoon, and Cynn (17) verified the effect of a certain level of impact force exerts on the body. Pronation is a protection mechanism during running because it allows the impact forces to be attenuated over a longer period of time than it would be possible without it. For this reason, some researchers (15,27) suggest that some pronation is favorable during running (i.e., as long as it is within normal physiological limitations). However, overpronated runners are at increased risk due to primarily to the large torque generated and the instability that is associated with the anatomical condition.

Gender

Women have natural tendency to overuse compared to average adult men for several reasons. Their musculoskeletal system is weaker, has 25% less muscle mass, a fat tissue 10% bigger, smaller bone density, and a larger pelvis, besides the flexibility excess that may lead to biomechanical abnormalities through the pathological laxity of a joint support by the ligaments. The abnormal alignment of the lower extremities is an example of structural vulnerability that starts, therefore, a joint degenerative cycle. These factors can predispose women to specific injuries, such as pelvic fractures and patellofemoral pain syndrome.

Considering the anatomical and physiological differences and the structural vulnerability that can contribute to the fatigue and eventual insufficiency or tissue failure through the overload, the injuries in women are also related to the tension or excessive stress (40). As indicated in the present data, 89.9% of the runners participate in sports events on a regular basis. This challenge is motivated by the desire to perform better than their opponents, which is in agreement with Torres (35) who reported that 35% to 50% of all sports related injuries are connected to overuse.

Also, it is clear that women less than 40 yrs of age have a significantly greater risk compared to men (5,23). Van der Worp et al. (36) alluded to the risk factors when they observed that men have greater risk when they restart running, have history of previous injuries, and until they have trained for 2 yrs. For the women, the age was the major risk factor, but also previous participation in other sports activities, running on concrete, a week volume from 48 to 63.8 km, and using running shoes 4 to 6 months old. Macera et al. (21) affirmed that in population studies the injury rate was the same for male and female recreational and elite runners. These findings are opposed to the ones from a systematic review regarding RRI risk factors. Van Gent et al. (37) concluded that the only statistically significant association in lower limbs presented positive relation with the female gender.

Experience

It is verified in the sample surveyed that more experienced runners have a lower risk of being affected by RRIs. Marti et al. (22) and Jakobsen et al. (14) indicate that this is likely an outcome of the runners' increased awareness of their own injury threshold compared to the beginner runners, thus making them less to go beyond their musculoskeletal limit. It is to be noted that beginner runners are more likely to report injuries compared to runners who have experienced many races in the past. Also, it is likely that the experience runners do not consider some conditions serious enough to classify them as injuries (24). Macera (20) found that runners with less than 3 yrs of practice had a 2.2-fold greater risk compared to runners with more experience. This fact contrasts with the findings of Gingrich and Harrast (9), who found an increased risk of developing an injury in the expert runners, suggesting that the injury patterns in these athletes are unique as well as the distribution and frequency when compared to the beginner runners (5).

Volume

On the researched sample, it was verified that the daily increase of the running volume promotes greater injury risk while the increase on every micro and mesocycle presented as a protection factor. The runners asked in the present study trained an average of 3 sessions·wk^{-1} with duration and distance of 50 min and 13.5 km·session^{-1}, respectively. This represented a volume of 40 km·wk^{-1}, which is considered excessive and associated with an increase in risk of injuries in recreational runners (2,4,36).

The most common form of muscular tissue damage, but apparently beneficial, may occur in association with the training methodology. In this instance, injury is an integral part of the training and competition process. In fact, in highly trained athletes it is acceptable to present some degree of muscle damage, which can be seen as an accelerator of the physiological turnover of muscle fibers. Unlike the overuse injury, an appropriate period of recovery is sufficient to restore the satisfactory condition of the musculoskeletal system (32), thus, the excess leads to injury, while the proper dose promotes a healthy and trouble-free practice.

The analysis of the association with training is complex since the variables can interact with each other. Volume and duration are two variables partially independent, while running intensity depends on the volume and duration. So, we measured and evaluated all three variables because it seems likely that a relationship exist between the RRIs association and the training methodology. Besides that, the frequency, which is directly connected to the volume, should be included in the analysis since weekly volume is associated with injuries. But it is still not possible affirm the exact safe percent increase in volume to reduce injury risk.

Intensity

The daily increase in the running intensity was responsible for a greater injury risk in the present study while the increase in every micro and mesocycle presented as a protection factor. This understanding is particularly important to the runners who must progress with alternating high, moderate, and low intensity training, and who must perform a regenerative micro cycle every three micro cycles of intensity increase. Paying attention to the runners' intensity allows them to generate adaptations resulting from the combined effect of fatigue over a period of time and from the regeneration of specific structural capacity. Additionally, the target area of the training used by the runners analyzed through the target HR, classified as Vigorous (from 96% to 76% of HR max), was identified. Those who did not control the intensity of race by the rhythm per km and FC target, attributed the control through the PSE, classified as Moderate. As for as the pace set for distances of up to 10 km, they were from 4 min to 4 min and 30 $sec{\cdot}km^{-1}$, and for longer distances, from 5 min to 5 min and 30 $sec{\cdot}km^{-1}$. According to the available literature, this study appears to be the first to verify the association of absolute intensity (time/km), relative one (target HR and PSE), and injuries in recreational runners.

The injury caused by the unusually high intensity run is associated with the sensation of late muscle pain. This pain prevails at the start of a season due to the fact that this race is not more common because many runners abstain from exercising out of season. The sensation of late muscle pain is also observed after an event involving a dramatic increase in the intensity and/or the number of movements in the eccentric phase, such as running downhill (8).

A curious phenomenon that is associated with unusual muscle injury is the effect of repeated sessions. Following an initial session of prejudicial exercise, the subsequent session at similar intensity and/or volume performed in the same time period of several weeks after the initial session, will produce a significantly lower muscle injury, associated late muscle pain and a significant decrease in performance (1). Although the research on recreational runners is incipient and the information contained in the literature is often conflicting as to the intensity of training and association of injuries, it seems that the way to evaluate and report the pace of training may be the reason for the inconsistency in the results. This is measured subjectively by assessing the self-reported running pace. It may result in error, since self-reporting is affected by memory bias. The variability in rhythm within and between sessions was found in the studied sample, so the variation in training intensity is known and may play an important role in the relationship between training intensity and RCC risk.

Each mesocycle is followed by a recovery period of ~1 wk for the physiological adaptations before starting the next mesocycle. The subsequent incremental mesocycle adds greater intensity, duration or volume than the previous mesocycle. There is a large number of variables that compose the training using methods with different intensities, durations of stimuli, and recovery intervals. However, the ideal methodology is far from being determined. The training routines must be verified and methodological misunderstandings identified. It is suggested that effective strategies to reduce injury to recreational runners should include: (a) to start a preparatory training to running; (b) increase the repetition frequency (volume) at each training microcyle; (c) attenuate the load and tension on the locomotor system by increasing intensity at each microcyle.

These findings are useful in the design of training periodization for the recreational corridor, allowing for adjustment to the training methodology. Many variables contribute potentially to injury, modifying one or more of these factors may help prevent RRIs. The data indicate training methodology standards useful in prevention orientation, filling a knowledge gap with respect to the intrinsic and extrinsic factors associated with the prevalence of injuries in recreational runners, which implies in prescribing the training with greater safety and reducing the prevalence of injuries.

CONCLUSION

The findings in the present study indicate that the prevalence of RRIs in recreational runners occur directly and indirectly, reaching grade III, exclusively in the lower limbs and are associated with intrinsic factors (step supinated, pronated or overpronated and gender female) and extrinsic factors (that include experience time, increase in session volume, percentage of session volume increase, and increase in session intensity). Therefore, the injury threshold should be considered by coaches and runners and the prevention efforts should be adapted to this group to reduce the risk of specific injuries. The development of a score to determine the risk of injury allows us to establish a preventive and individualized strategy that will promote greater safety among the practitioners.

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