

# A description of training characteristics and its association with previous musculoskeletal injuries in recreational runners: a cross-sectional study

Perfil das características do treinamento e associação com lesões musculoesqueléticas prévias em corredores recreacionais: um estudo transversal

Luiz C. Hespanhol Junior<sup>1,2</sup>, Leonardo O. P. Costa<sup>1,3</sup>, Aline C. A. Carvalho<sup>1</sup>, Alexandre D. Lopes<sup>1,2</sup>

## Abstract

**Background:** Running is one of the most popular physical activities in the world and the number of runners has increased over the past 40 years. One of the consequences of the growing running popularity is the increase of musculoskeletal injuries. **Objectives:** To describe the routines, training characteristics and history of injury in recreational runners and to evaluate possible associations between the routines and training characteristics with previous musculoskeletal running-related injuries. **Methods:** A total of 200 runners participated in this study. The participants completed an electronic form containing questions about personal characteristics, running experience, training characteristics, type of running shoes, foot type and previous injuries history over the last 12 months. The data were analyzed descriptively as well as by using logistic regression models. **Results:** The majority of the runners was male, aged 43.0 (SD=10.5) years-old, have a body mass index of 24.2 (IQR=4.3) kg/m<sup>2</sup>, and had training volume of 35.0 (IQR=28.0) kilometers per week. Fifty-five percent of runners had injuries over the last 12 months. The most prevalent injuries observed were tendinopathies and muscle injuries. The variable that showed an association with previous running-related injuries was running experience from 5 to 15 years (Odds Ratio (OR)=0.2; 95%CI=0.1 to 0.9). **Conclusions:** The prevalence of running-related injuries over the last 12 months was 55%. The variable running experience was associated with the absence of previous musculoskeletal running-related injuries.

**Keywords:** running; sports injuries; rehabilitation; physical therapy.

## Resumo

**Contextualização:** A corrida é uma das atividades físicas mais populares do mundo, sendo que o número de praticantes vem crescendo nos últimos 40 anos. Uma das consequências do aumento da popularidade da prática de corrida é o aumento das lesões musculoesqueléticas. **Objetivos:** Descrever os hábitos, as características de treinamento e o histórico de lesões de corredores recreacionais, além de verificar possíveis associações entre os hábitos e as características de treinamento com lesões musculoesqueléticas prévias relacionadas à corrida. **Métodos:** Duzentos corredores preencheram um formulário contendo questões sobre dados pessoais, histórico da prática de corrida, características do treinamento, tipo de tênis, tipo de pisada e histórico de lesões nos últimos 12 meses. Os dados foram analisados pela estatística descritiva e modelos de regressão logística. **Resultados:** A maioria dos corredores eram homens, com idade média de 43 (DP=10,5) anos, índice de massa corporal de 24,2 (IQ=4,3) kg/m<sup>2</sup>, volume de treino de 35 km semanais (IQ=28), e 55% dos corredores relataram apresentar alguma lesão musculoesquelética nos últimos 12 meses. As principais lesões encontradas foram as tendinopatias e as lesões musculares. A variável que apresentou associação com lesão musculoesquelética prévia relacionada à corrida foi a experiência de corrida entre cinco e 15 anos (Odds Ratio (OR)=0,2; IC95%= 0,1 a 0,9). **Conclusões:** A prevalência de lesões musculoesqueléticas relacionadas à corrida nos últimos 12 meses foi de 55%, e a variável experiência de corrida foi associada com a ausência de lesões musculoesqueléticas prévias relacionadas à corrida.

**Palavras-chave:** corrida; lesões do esporte; reabilitação; fisioterapia.

Received: 05/17/2011 – Revised: 08/11/2011 – Accepted: 09/19/2011

<sup>1</sup>Masters Program in Physical Therapy, Universidade Cidade de São Paulo (UNICID), São Paulo, SP, Brazil

<sup>2</sup>São Paulo Running Injury Group (SPRunIG), São Paulo, SP, Brazil

<sup>3</sup>Musculoskeletal Division, The George Institute for Global Health, Sydney, Australia

Correspondence to: Luiz Carlos Hespanhol Junior, Rua Cesário Galeno, 448/475, CEP 03071-000, São Paulo, SP, Brazil, e-mail: luca\_hespanhol@hotmail.com

## Introduction

Running is one of the most popular physical activities in the world<sup>1</sup> and the number of runners has considerably increased over the past 40 years. Many people who are looking for a healthier lifestyle, such as controlling the body-weight and improving the exercise capacity may choose running as an exercise modality, which is considered a physical activity of low cost and easy to perform.

One of the consequences of the growing popularity of running is the increase of musculoskeletal injuries among runners, which present incidence rates ranging from 19.4% to 92.4% depending on the target population and also on the definition of the term “musculoskeletal injury” used<sup>2,3</sup>. Some studies were carried out aiming to identify possible risk factors for musculoskeletal injuries in runners, and the main factors observed in these studies were the training volume and the presence of previous injuries<sup>1-11</sup>.

Many of these studies were conducted with marathon runners<sup>1,2,8,9,11,12</sup> and also with samples aiming to participate in specific races, usually with lower training volumes (such as races from 4 to 16 km)<sup>4,6,7,10</sup>. Two studies were carried out with amateur<sup>5</sup> or recreational<sup>13</sup> runners and only one study was conducted on elite runners, however these group of runners presented a weekly training volume (km) similar to the volume of training performed by marathoners<sup>14</sup>. Finally, only one study was conducted aiming to measure the association between musculoskeletal injuries and training characteristics in recreational runners without the intention to participate in any particular running race<sup>5</sup>.

It is important to be conducted more studies with runners who perform lower training volumes compared with marathoners training and also who are not committed in participating in any specific race, since a large proportion of the runners only run recreationally, not exceeding few kilometers per training session. A better understanding of the profile of recreational runners and also which factors would be associated with musculoskeletal injuries in this population may help in the implementation of prevention strategies with a multidisciplinary approach, where the involvement of physical therapists, medical doctors, coaches and other health care professionals would allow possible effective actions to reduce musculoskeletal injuries on this enormous population of runners.

Therefore, the aims of this study were to describe the habits, the training characteristics and the history of injury in recreational runners. We also aim to investigate possible associations between the habits and the characteristics of training with previous musculoskeletal running-related injuries.

## Methods

### Study design and participants

This is a cross-sectional study with the participation of 200 runners who answered an electronic form containing questions about their habits, training characteristics and history of musculoskeletal running-related injuries. Participants aged over 18 years old and who have been running for at least six months were considered eligible for this study. Runners who were unable to run at the moment of data collection due to medical restrictions or presence of musculoskeletal injury (muscles, tendons, joints, ligaments and/or bones) were excluded from this study. This study was approved by the Ethics Committee of the Universidade Cidade de São Paulo (UNICID), São Paulo, SP, Brazil (number 13506607/2010) and has been conducted in partnership with CORPORE, an organizing company of running events of São Paulo, Brazil.

An invitation with information about the study was sent by e-mail to 4.000 of the 11.000 CORPORE runner's members and the consent form was attached as a link. After agreed to participate and answered the question confirming that they were musculoskeletal running-related injury free at that moment of the data collection, the participants completed a self-report electronic form (Appendix 1) which was composed by three sections: a) questions related to the participants characteristics such as age, weight, height, running experience, education level and lifestyle; b) questions about history of running (such as the number of running sessions per week, weekly training volume, time per kilometer, the practice of other sports, favorite running races and practice of flexibility exercises) and training characteristics (i.e. number of training sessions in each type of surface, monitoring of training, motivation for running, use of special insoles, running shoes type, number of pair of running shoes used and foot-strike type) and c) questions with regards to the history of musculoskeletal running-related injuries to determine the prevalence of injuries over the last 12 months (this information was collected through several options of symptoms or diagnoses derived from a previous study<sup>15</sup>). The definition of musculoskeletal running-related injury used in this study was based on previous studies that also aimed to investigate injuries in runners, being the definition: “any running-related musculoskeletal pain that have being severe enough to prevent the runner to perform at least one training session”<sup>1,5,8,9</sup>.

### Statistical analysis

The sample size calculation of this study was performed to detect an Odds Ratio (OR) of 1.4, with a statistical power of

80%, with a significance level of 95%, therefore of 200 runners were recruited. Descriptive statistics were calculated to present the characteristics of the participants. The comparison of continuous variables between the runners with and without history of musculoskeletal injury was calculated by using independent samples Student *t* tests. Mann-Whitney tests were used for non-parametric data and Chi-square tests were used for categorical variables.

Univariate logistic regression analysis was performed to test a possible association between the variables of participants' characteristics, history of running practice and training characteristics and previous musculoskeletal running-related injuries. Variables independently associated with previous musculoskeletal running-related injuries and presented a  $p \leq 0.20$ <sup>1</sup> were considered to be included in the multivariate logistic regression model using the Backward Wald method. The coefficient of determination  $R^2$  described by Nagelkerke

was calculated in order to verify the prediction quality of the logistic regression model. The results were presented as OR and their respective 95% confidence intervals. All analyses were performed using SPSS 17.0 for Windows.

## Results ::::

The description of the participants characteristics was divided into two groups, being one group named as "with history of injury" and other "without history of injury", as it can be observed in Table 1. The prevalence of musculoskeletal running-related injuries over the last 12 months was of 55% (n=110), and the main reported injuries were tendinopathies (17.3%, n=19) and muscle injuries (15.5%, n=17). Regarding the anatomical site, the most affected region was the knee, with 27.3% (n=30) of the injuries (Table 2).

**Table 1.** Description of the training characteristics of the study participants.

Variable	All (n=200)	With History of Injuries (n=110)	Without History of Injuries (n=90)	p
Age (years) <sup>a</sup>	43.0 (10.5)	44.2 (11.0)	41.5 (9.6)	0.07
BMI (kg/m <sup>2</sup> )	24.2 (4.3)	24.0 (4.0)	24.4 (4.6)	0.24
Running experience (years)	5.0 (5.0)	5.0 (7.0)	4.0 (3.0)	0.05*
No. Training sessions / week	4.0 (2.0)	4.0 (2.0)	4.0 (2.0)	0.45
Km per week	35.0 (28.0)	35.5 (29.0)	31.5 (27.0)	0.65
Type of surface <sup>b</sup>				
Hard surface	2.0 (2.0)	3.0 (3.0)	2.0 (2.0)	<0.01*
Soft surface	0.0 (2.0)	0.0 (2.0)	0.0 (1.0)	0.66
Treadmill surface	1.0 (2.0)	0.5 (2.0)	1.0 (2.0)	0.17
Other surfaces	0.0 (0.1)	0.0 (1.0)	0.0 (1.0)	0.81
Other sports (times / week)	2.0 (1.0)	2.0 (1.0)	2.0 (2.0)	0.15
Practice duration of other sports	5.0 (12.0)	8.0 (13.0)	4.0 (7.0)	0.24
Weekly frequency of other sports	2.0 (1.0)	2.0 (1.0)	2.0 (2.0)	0.15
Training duration of other sports	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)	0.80
Do you know your type of foot?				
Yes	83.5 (167)	87.3 (96)	78.9 (71)	
No	16.5 (33)	12.7 (14)	21.1 (19)	0.11
Type of foot (self-reported)				
Neutral	56.2 (95)	56.3 (54)	56.2 (41)	
Hyperpronated	26.0 (44)	28.1 (27)	23.3 (17)	
Subpronated	17.8 (30)	15.6 (15)	20.5 (15)	0.63
Who did your foot type assessment?				
Sports store	70.0 (117)	70.8 (68)	68.6 (48)	
Physical therapist	7.2 (12)	7.3 (7)	7.1 (5)	
Physician	6.0 (10)	5.2 (5)	7.1 (5)	
Coach	5.4 (9)	6.3 (6)	4.3 (3)	
Others	11.4 (19)	10.4 (10)	12.9 (9)	0.94

Continuous data are expressed as medians and interquartile ranges (tested by the Mann-Whitney test), except age (<sup>a</sup>) that is expressed by mean and standard deviation (tested by the Student *t* test). All categorical data are expressed by percentages and number of runners (tested by the Chi-square test). <sup>b</sup>Type of surface: hard (asphalt and cement), soft (off-road track, grass and gravel), treadmill and other (sand and synthetic). \*Statistically significant difference between "with history of injuries" and "without history of injuries"

**Table 2.** Description of the injury type and anatomical site reported by the runners.

Injury Type	% (n)	Anatomical Site	% (n)
Tendinopathy	17.3 (19)	Knee	27.3 (30)
Strain / Muscle Rupture / Stretch	15.5 (17)	Foot	14.5 (16)
Sprain (ligament and/or joint injury)	13.6 (15)	Lower leg	12.7 (14)
Plantar fasciitis	12.7 (14)	Ankle	11.8 (13)
Low Back Pain	8.2 (9)	Spine	9.1 (10)
Meniscus or cartilage injury	8.2 (9)	Thigh	8.2 (9)
Stress fracture (overuse)	6.4 (7)	Hip / Groin	8.2 (9)
Others	18.1 (20)	Achilles tendon (calcaneal)	7.3 (8)
		Pelvis / Sacrum / Buttock	0.9 (1)

Most of the participants were male, and 60% (n=120) of the runners reported a Body Mass Index (BMI) that can be classified as healthy (i.e. lower than 25). Participants who reported to run in a pace between 3 and 6 minutes per kilometer represented 76.5% (n=153) of the sample. Among these runners, 64.2% (n=129) informed that the training session had a mean duration between 60 and 90 minutes. Half of participants classified themselves as non-novice runners, as they have already previous experience with running training and most of the runners reported the use of running shoes with special characteristics “to control” their foot-strike type (neutral, hyperpronated or subpronated). Table 3 describes in greater details the categorized participants information.

From all variables analyzed, nine presented a  $p \leq 0.20$  on the univariate logistic regression analysis, being age, BMI, running experience, hard surface type (such as asphalt and concrete), practice of other sports, the duration of other sports practice, weekly frequency of other sports practice, the use of running shoes with special characteristics and the knowledge of the foot-strike type (Table 3). All these nine variables mentioned above were included in the multivariate logistic regression analysis. From those, only one variable remained in the final model (running experience between 5 and 15 years) (Table 4). This proposed model explains 7% of the total variance.

## Discussion

### Runners' description

The aims of this study were to describe the habits, training characteristics and history of injuries in recreational runners, as well as to evaluate the association of these characteristics with the presence of previous musculoskeletal running-related injuries. The greater majority of runners were men, with mean age of 40 years, BMI classified as healthy, with a

mean running experience of approximately five years, four training sessions a week and with a weekly training volume of 35 km. These runners frequently ran on hard surfaces and reported the 10 km running as their favorite race. The prevalence of musculoskeletal running-related injuries over the last 12 months was 55% (n=110). The main reported injuries were tendinopathies and muscle injuries and the knee was the most affected anatomic site. Of all the obtained information from the athletes, the only characteristic that showed association with previous musculoskeletal running-related injuries was running experience.

The proportion of men/women participants of this study, their age, BMI, their running experience and the number of training sessions per week observed were similar to the ones observed in other studies that also analyzed runners<sup>8,11,16</sup>, and only one study showed a higher proportion of women<sup>17</sup>.

The training volume of the runners from our study was lower in comparison with the distances observed in most of other studies<sup>1,2,8,11</sup>. This results' discrepancy may be explained due to the fact of great part of these previous studies were conducted with marathoners<sup>1,2,8,9,11</sup>, who usually need a higher weekly training volume. This characteristic observed in the present study makes it one of the first to approach different aspects related to running, using a population of runners who do not intend to run a marathon or a specific running race.

Stretching before and/or after a race/training sessions was frequent among the participants, which is similar to other studies<sup>10,18</sup>. In spite of other studies on runners demonstrate that only a small portion performs such exercises<sup>1,9,16</sup>. The fact that a high proportion of runners stretch before or after running may be related to fact that athletes and trainers believe that stretching could prevent injuries, in spite of the lack of scientific evidence that supports this belief<sup>9,21</sup>.

Most of runners from this study reported to workout without any kind of professional monitoring (Table 3). A study suggests that a percentage about 40% of the runners has some kind of specialized orientation<sup>12</sup>, data that is in agreement with our study.

**Table 3.** Runner's profile and univariate logistic regression model.

Variable	Distribution % (n)	OR (95%CI)	p	Variable	Distribution % (n)	OR (95%CI)	p
Gender				Motivation			
Male	73.0 (146)	1	-	Improve health	23.0 (46)	1	-
Female	27.0 (54)	0.9 (0.5 to 1.6)	0.68	Performance	7.5 (15)	0.8 (0.4 to 1.5)	0.47
Age <sup>§</sup>		1.0 (0.9 to 1.1)	0.08*	Boths	69.5 (139)	1.2 (0.4 to 3.5)	0.73
BMI				Type of surface <sup>#</sup>			
Healthy	60.0 (120)	1	-	Hard surface	94.0 (188)	1.2 (1.0 to 1.5)	0.02*
Overweight	36.0 (72)	3.9 (0.8 to 20.2)	0.10*	Soft surface	44.5 (89)	1.0 (0.9 to 1.2)	0.90
Obese	4.0 (8)	3.8 (0.7 to 19.9)	0.12*	Treadmill surface	54.5 (109)	0.9 (0.7 to 1.1)	0.27
Education status				Other surfaces	5.5 (11)	0.9 (0.5 to 1.4)	0.56
Elementary school	1.5 (3)	1	-	Monitoring			
High school	13.0 (26)	1.9 (0.0 to -)	0.99	Running team	41.0 (82)	1	-
University level	42.5 (85)	2.4 (0.0 to -)	0.99	Internet or friend	10.5 (21)	1.0 (0.6 to 1.8)	0.99
Post-graduated level	43.0 (86)	1.4 (0.0 to -)	0.99	No	48.5 (97)	1.7 (0.6 to 4.7)	0.28
Smoking status				Other sports (OS)			
No	98.5 (197)	1	-	No	46.0 (92)	1	-
Yes	1.5 (3)	0.6 (0.1 to 6.8)	0.68	Yes	54.0 (108)	0.5 (0.3 to 1.0)	0.04*
Running experience				Practice time OS <sup>§</sup>		1.0 (1.0 to 1.1)	0.18*
Up to 5 years	63.5 (127)	1	-	Weekly frequency OS <sup>§</sup>		0.8 (0.6 to 1.1)	0.16*
5 to 15 years	23.0 (46)	0.3 (0.1 to 0.8)	0.02*	Training duration OS <sup>§</sup>		1.1 (0.8 to 1.5)	0.56
More than 15 years	13.5 (27)	0.3 (0.1 to 0.9)	0.03*	Stretching			
N° Training sessions/week				Before training	90.0 (180)	1.2 (0.6 to 3.0)	0.76
Up to 3 times	45.5 (91)	1	-	After training	92.5 (185)	2.0 (0.7 to 6.0)	0.21
More than 3 times	54.5 (109)	0.8 (0.4 to 1.4)	0.38	Before races	94.0 (188)	1.6 (0.5 to 5.2)	0.47
Km per week				After races	73.5 (147)	1.0 (0.5 to 2.2)	0.93
Up to 20 km	23.5 (47)	1	-	Pair of shoes			
20 to 40 km	41.5 (83)	1.0 (0.4 to 2.8)	0.94	1	7.5 (15)	1	-
40 to 60 km	23.5 (47)	0.9 (0.4 to 2.3)	0.84	2	31.5 (63)	0.8 (0.2 to 2.8)	0.75
More than 60 km	11.5 (23)	0.9 (0.3 to 2.4)	0.79	3	32.0 (64)	1.2 (0.5 to 3.0)	0.63
Time p/ km				4	14.5 (29)	1.1 (0.5 to 2.7)	0.79
3 to 5 min	39.5 (79)	1	-	+4	14.5 (29)	1.3 (0.5 to 3.7)	0.60
5 to 6 min	37.0 (74)	1.3 (0.6 to 2.7)	0.49	Special shoes			
More than 6 min	23.5 (47)	0.9 (0.4 to 1.9)	0.84	No	17.0 (34)	1	-
Self assessment				Yes	83.0 (166)	2.3 (1.1 to 4.8)	0.03*
Always run	50.0 (100)	1	-	Do you know your foot type?			
Novice runner	31.5 (63)	1.4 (0.7 to 3.0)	0.36	No	16.5 (33)	1	-
Returned to run	18.5 (37)	0.9 (0.4 to 2.1)	0.84	Yes	83.5 (167)	1.8 (0.9 to 3.9)	0.12*
Preferred races				Type of foot			
< 10 km	4.0 (8)	1	-	Neutral	56.2 (95)	1	-
10 km	67.5 (135)	0.7 (0.1 to 4.2)	0.70	Hyperpronated	26.0 (44)	1.3 (0.6 to 3.0)	0.51
>10km and < 21.5km	8.0 (16)	1.6 (0.5 to 5.2)	0.39	Subpronated	17.8 (30)	1.6 (0.6 to 4.1)	0.33
21.5 km	14.0 (28)	0.7 (0.2 to 3.1)	0.64	Special insoles			
Marathon	6.5 (13)	1.6 (0.4 to 5.8)	0.51	Yes	10.5 (21)	1	-
Company				No	89.5 (179)	1.4 (0.5 to 3.5)	0.50
Group	26.5 (53)	1	-				
Alone	73.5 (147)	1.3 (0.7 to 2.6)	0.36				

OR=odds ratio. CI=confidence interval. Each training characteristic in bold represent one variable. §Continuous variables that were not categorized (data presented in table 1). #Type of surface: hard (asphalt and cement), soft (off-road track, grass and gravel), treadmill and other (sand and synthetic). \*Variables that were included into the multivariate logistic regression model.

**Table 4.** Multivariate logistic regression model.

Variable	OR (95%CI)	p
Running experience		
Up to 5 years	1	-
5 to 15 years	0.2 (0.1 to 0.9)	0.03
More than 15 years	0.3 (0.1 to 1.2)	0.09

OR=odds ratio. CI=confidence interval.

## Previous musculoskeletal running-related injuries and associations with training characteristics

The prevalence of musculoskeletal running-related injuries over the last 12 months was 55% (n=110). The most prevalent musculoskeletal injuries reported by the participants were tendinopathies and muscle injuries. In several studies, the patellofemoral syndrome<sup>13,17,22</sup> and tendinopathies<sup>16,23-25</sup> were among the most prevalent injuries in runners. The knee was the most affected anatomic site, as observed in previous studies<sup>3,5,7,16,17</sup>. This high rate of knee injuries is usually due to the great magnitude of the impact forces present on the lower limbs while running, which may range from one and a half to three times of the body weight<sup>26</sup>.

The multivariate logistic regression analysis showed that running experience from 5 to 15 years had an association with the absence of previous musculoskeletal running-related injuries (Table 4). Some studies indicated that inexperience in running practice may be a risk factor for new musculoskeletal injuries<sup>2,4,9</sup>, in spite of a systematic review have pointed this finding as an uncertain evidence<sup>3</sup>. The association observed between running experience and history of musculoskeletal injuries may be explained by the fact that greater runner's experience, may promote better adaptation capacity to the musculoskeletal stress imposed by running<sup>27</sup>. Another possible explanation is what the literature denominates as the "survival phenomenon", because the most experienced runners would be the ones who "survives" from injuries<sup>2,9</sup>.

Our results may help runners and coaches to clarify some questions on running training characteristics. In addition physical therapists who are usually responsible for the implementation of injury prevention programs in running groups or teams can help with changing some training factors and, potentially, might reduce the incidence of musculoskeletal injuries in runners. The information of this study is also important for the runners who may be aware about their training routine, stimulating a safer practice. The identification of injuries in runners should also stimulates physical therapists to develop more effective treatment programs for this population with the aim

of reducing the recovery time and promoting a return to running in a safer way.

Nowadays, several health professionals who work with running have suggested the use of flexibility exercises (stretching) and/or the prescription of special running shoes with the aim of preventing musculoskeletal injuries, in spite of the lack of evidence supporting their use<sup>19-21,28</sup>. Longitudinal studies investigating the influence of these and of other training characteristics on the development of new musculoskeletal running-related injuries should be carry out. In addition randomized controlled trials should be encouraged to test the effectiveness of prevention programs and of rehabilitation protocols of musculoskeletal running-related injuries. Our research group is carrying out a prospective study with runners and the results of this study are likely to be published shortly.

## Study limitations

This study had some limitations, such as a sample with a very high education level which might not be considered representative. In addition due to the cross-sectional design the associations observed in our study are only exploratory, not meaning that the associated variables are the cause of musculoskeletal running-related injuries. All data were collected using self-reported questionnaires, which could have influenced our results due to some sort of recall bias.

## Conclusions

The prevalence of musculoskeletal running-related injuries over the last 12 months was 55%. The most frequent injuries reported by the runners of this study were tendinopathies and muscle injuries and the knee was the most affected anatomic site. Running experience between 5 and 15 years was associated with the absence of previous musculoskeletal running-related injuries.

## Acknowledgments

CORPORE which helped us on the recruitment of the participants as well as on presenting our results to their members. We would also like to thank two physical therapists from the São Paulo Running Injury Group (SPRunIG), Bruno Tirotti Saragiotto e Tiê Parma Yamato, for their important help on this study.

## References

1. Van Middelkoop M, Kolkman J, Van Ochten J, Bierma-Zeinstra SM, Koes BW. Risk factors for lower extremity injuries among male marathon runners. *Scand J Med Sci Sports*. 2008;18(6):691-7.
2. Satterthwaite P, Norton R, Larmer P, Robinson E. Risk factors for injuries and other health problems sustained in a marathon. *Br J Sports Med*. 1999;33(1):22-6.
3. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med*. 2007;41(8):469-80.
4. Buist I, Bredeweg SW, Bessem B, van Mechelen W, Lemmink KA, Diercks RL. Incidence and risk factors of running-related injuries during preparation for a 4-mile recreational running event. *Br J Sports Med*. 2010;44(8):598-604.
5. Macera CA, Pate RR, Powell KE, Jackson KL, Kendrick JS, Craven TE. Predicting lower-extremity injuries among habitual runners. *Arch Intern Med*. 1989;149(11):2565-8.
6. Marti B, Vader JP, Minder CE, Abelin T. On the epidemiology of running injuries. The 1984 Bern Grand-Prix study. *Am J Sports Med*. 1988;16(3):285-94.
7. Taunton JE, Ryan M, Clement D, McKenzie D, Lloyd-Smith D, Zumbo B. A prospective study of running injuries: the Vancouver Sun Run "In Training" clinics. *Br J Sports Med*. 2003;37(3):239-44.
8. van Middelkoop M, Kolkman J, Van Ochten J, Bierma-Zeinstra SM, Koes B. Prevalence and incidence of lower extremity injuries in male marathon runners. *Scand J Med Sci Sports*. 2008;18(2):140-4.
9. van Middelkoop M, Kolkman J, van Ochten J, Bierma-Zeinstra SM, Koes BW. Course and predicting factors of lower-extremity injuries after running a marathon. *Clin J Sport Med*. 2007;17(1):25-30.
10. Walter SD, Hart LE, McIntosh JM, Sutton JR. The Ontario cohort study of running-related injuries. *Arch Intern Med*. 1989;149(11):2561-4.
11. Wen DY, Puffer JC, Schmalzried TP. Injuries in runners: a prospective study of alignment. *Clin J Sport Med*. 1998;8(3):187-94.
12. Pazin J, Duarte MFS, Poeta LS, Gomes MA. Recreational road runners: injuries, training, demographics and physical characteristics. *Rev Bras Cineantropom Desempenho Hum*. 2008;10(3):277-82.
13. Lun V, Meeuwisse WH, Stergiou P, Stefanyshyn D. Relation between running injury and static lower limb alignment in recreational runners. *Br J Sports Med*. 2004;38(5):576-80.
14. Knobloch K, Yoon U, Vogt PM. Acute and overuse injuries correlated to hours of training in master running athletes. *Foot Ankle Int*. 2008;29(7):671-6.
15. Alonso JM, Tscholl PM, Engebretsen L, Mountjoy M, Dvorak J, Junge A. Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships. *Br J Sports Med*. 2010;44(15):1100-5.
16. Jakobsen BW, Krøner K, Schmidt SA, Kjeldsen A. Prevention of injuries in long-distance runners. *Knee Surg Sports Traumatol Arthrosc*. 1994;2(4):245-9.
17. Taunton J, Ryan M, Clement D, McKenzie D, Lloyd-Smith D, Zumbo B. A retrospective case-control analysis of 2002 running injuries. *Br J Sports Med*. 2002;36(2):95-101.
18. Jacobs SJ, Berson BL. Injuries to runners: a study of entrants to a 10,000 meter race. *Am J Sports Med*. 1986;14(2):151-5.
19. Shehab R, Mirabelli M, Gorenflo D, Fetters MD. Pre-exercise stretching and sports related injuries: knowledge, attitudes and practices. *Clin J Sport Med*. 2006;16(3):228-31.
20. Witvrouw E, Mahieu N, Danneels L, McNair P. Stretching and injury prevention: an obscure relationship. *Sports Med*. 2004;34(7):443-9.
21. Yeung SS, Yeung EW, Gillespie LD. Interventions for preventing lower limb soft-tissue running injuries. *Cochrane Database Syst Rev*. 2011(7):CD001256.
22. Fallon KE. Musculoskeletal injuries in the ultramarathon: the 1990 Westfield Sydney to Melbourne run. *Br J Sports Med*. 1996;30(4):319-23.
23. Pileggi P, Gualano B, Souza M, Caparbo VF, Pereira RMR, Pinto ALS, et al. Incidência e fatores de risco de lesões osteoarticulares em corredores: um estudo de coorte prospectivo. *Rev Bras Educ Fis Esp*. 2010;24(4):453-62.
24. Lysholm J, Wiklander J. Injuries in runners. *Am J Sports Med*. 1987;15(2):168-71.
25. McKean KA, Manson NA, Stanish WD. Musculoskeletal injury in the masters runners. *Clin J Sport Med*. 2006;16(2):149-54.
26. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, et al. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature*. 2010;463(7280):531-5.
27. van Mechelen W. Running injuries. A review of the epidemiological literature. *Sports Med*. 1992;14(5):320-35.
28. Richards CE, Magin PJ, Callister R. Is your prescription of distance running shoes evidence-based? *Br J Sports Med*. 2009;43(3):159-62.

**Appendix 1.** Follow up routine of Training/Race of Runners.**Part I – Personal Data**

1. How old are you? \_\_\_\_\_ years.
2. What is your approximate weight? \_\_\_\_\_ kg.
3. What is your height? \_\_\_\_\_ m.
4. How long have you been running? \_\_\_\_\_ year (s).
5. What is your educational status (completed)? \_\_\_\_\_.
6. Do you smoke? ( ) Yes. Cigarettes on average per day \_\_\_\_\_. ( ) No.

**Part II – Running History**

1. How often do you run / train? \_\_\_\_\_ times/week.
2. What is your distance (km) weekly average? \_\_\_\_\_ km/week.
3. What is your average speed? \_\_\_\_\_ minutes/km.
4. Regarding the type of surface that you train, answer how many times per week do you usually train on each floor surface?  
Asphalt \_\_\_\_\_ time(s). Treadmill \_\_\_\_\_ time(s).  
Off-road track \_\_\_\_\_ time(s). Grass \_\_\_\_\_ time(s).  
Gravel/pebbles \_\_\_\_\_ time(s). Cement \_\_\_\_\_ time(s).  
Other \_\_\_\_\_ - \_\_\_\_\_ time(s).
5. How long is a training session on average? \_\_\_\_\_ hour(s).
6. What kind of race that you run more frequently?  
( ) less than 10 km. ( ) 10 km. ( ) Races with + 10 km, but less than ½ marathon. ( ) ½ Marathon. ( ) Marathon.
7. Do you have a running coach  
( ) Yes. ( ) No.
8. Do you also practice other sports? ( )  
Yes. ( ) No.
- 8.A. Which sport? \_\_\_\_\_.
- 8.B. for how long? \_\_\_\_\_ years.
- 8.C. How often: \_\_\_\_\_ times/week.
- 8.D. How long are these training session on average? \_\_\_\_\_ hours.
9. What is your primary motivation for running?  
( ) Health improvement. ( ) Search for best performance ( ) Both.
10. How would you rate yourself?  
( ) Novice runner. ( ) Runner with prior experience but is returning to run. ( ) Runner who always had involvement with races.
11. Do you usually stretch BEFORE training / racing?  
( ) Always. ( ) Sometimes. ( ) Never.
12. Do you stretch AFTER training / racing?  
( ) Always. ( ) Sometimes. ( ) Never.

13. Do you warm up BEFORE training / racing?

( ) Always. ( ) Sometimes. ( ) Never.

14. Do you cool down AFTER training / racing?

( ) Always. ( ) Sometimes. ( ) Never.

With regards to your shoes, please answer:

15. How many pairs of shoes do you have available for running?  
\_\_\_\_\_.

16. How often do you replace your shoes?

( ) Less than 6 months. ( ) Between 1 and 1.5 years.

( ) Between 1.5 and 2 years. ( ) I don't know.

17. What is the reason that you take into account when changing your shoes?

( ) Wear off ( ) Mileage.

18. Do you have shoes with some special features such as special cushioning, stability or motion control? ( ) Yes. ( ) No.

19. Do you know your foot strike pattern? ( ) Yes. ( ) No.

- 19.A. What's your type of foot? ( ) Pronated. ( ) Neutral. ( ) Supinated.

- 19.B. Who did evaluate you?

( ) A professional from shoe store. ( ) A running coach.

( ) A physiotherapist. ( ) A medical doctor.

( ) Another evaluation form: \_\_\_\_\_.

20. Do you use any type of cushioning or insoles inside your running shoes?

( ) Yes. ( ) No.

**Part III - History of Injuries**

1. Have you ever had (past) some (s) musculoskeletal (s) injury (s) related to running, located on your lower limbs or spine, that was severe enough to cause a restriction of running for at least one training session?

\* If you have had three more injuries, please describe the three most severe injuries

( ) Yes, only one injury.

Description \_\_\_\_\_ . Body region \_\_\_\_\_.

( ) Yes, two injury.

1) Description \_\_\_\_\_ . Body region \_\_\_\_\_.

2) Description \_\_\_\_\_ . Body region \_\_\_\_\_.

( ) Yes, three injury.

1) Description \_\_\_\_\_ . Body region \_\_\_\_\_.

2) Description \_\_\_\_\_ . Body region \_\_\_\_\_.

3) Description \_\_\_\_\_ . Body region \_\_\_\_\_.

( ) No.