Relationship between Knee Symptoms and Biological Features in Recreational Runners*

Relação entre sintomatologia no joelho e as características biológicas em corredores recreacionais

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Abstract

Objective The main objective of the present study was to compare the subjective perception of pain and symptoms of anterior knee pain with the different body mass index (BMI) classifications. The secondary objective was to verify the association between biological and anthropometric variables with the results of subjective questionnaires.

Methods A total of 126 recreational runners from both genders, aged between 20 and 59 years old, were recruited. Data regarding the biological variable (age), anthropometric variables (weight, height), visual analog scale (VAS), and Lysholm and Kujala questionnaires scores were collected. Information was obtained with a digital platform, available through a single link, allowing volunteers to answer these questions using electronic devices. Normality was verified by the Shapiro-Wilk test. T-tests and Wilcoxon tests were used to compare mean values. The association between variables was determined by the Pearson linear correlation.

Results There were significant differences in height between overweight and grade 1 obesity subjects ($p = 0.029$), in weight and BMI comparing normal weight subjects and both overweight and grade 1 obesity subjects ($p < 0.001$ and $p < 0.05$, respectively). An unclear significant correlation was observed between BMI values and specific questionnaires and subjective scale scores ($p < 0.05$).

Conclusion Recreational runners who present high BMI values are more likely to experience knee pain than those with normal BMI values.

Keywords
- running
- Lysholm knee scoring scale
- body mass index
- sport-related injuries
- knee injuries
- patellofemoral pain syndrome

Resumo

Objetivo O principal objetivo do presente estudo foi comparar a percepção subjetiva de dor e sintomas de dor anterior no joelho com as diferentes classificações de índice de massa corporal (IMC). O objetivo secundário foi verificar a associação entre as variáveis

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biológica e antropométrica com os resultados apresentados pelos sujeitos nos questionários subjetivos.

Métodos Foram recrutados 126 corredores recreacionais de ambos os gêneros, com idades entre 20 e 59 anos. Foram coletados dados referentes à variável biológica idade, e as variáveis antropométricas peso e altura, além da escala visual analógica (EVA) e os questionários Lysholm e Kujala. As informações foram obtidas por meio de plataforma digital, disponibilizado em um único link, para que fossem respondidos através de dispositivos eletrônicos pelos próprios voluntários. A normalidade foi verificada por meio do teste Shapiro-Wilk. Foi utilizado o teste-T e o teste de Wilcoxon para comparação das médias. A associação entre as variáveis foi determinada pela correlação linear de Pearson.

Resultados Houve diferença significativa entre a estatura do grupo sobrepeso e o grupo obesidade grau 1 ($p = 0{,}029$), e o peso do grupo peso normal para os grupos sobrepeso e obesidade grau 1 ($p < 0{,}001$), e entre as médias do IMC ($p < 0{,}05$). Foi observada correlação significativa não clara entre o IMC e os questionários específicos e a escala subjetiva ($p < 0.05$).

Conclusão Os corredores recreacionais que possuem IMC acima dos valores de normalidade estão mais predispostos a apresentar dor no joelho do que aqueles com IMC normal.

Palavras-chave
- corrida
- escala de Lysholm para joelho
- índice de massa corporal
- lesões esportivas
- lesões do joelho
- síndrome da dor patelofemoral

Introduction

Running is the sport that most contributes to the occurrence of injuries in physically active adult individuals.[1] The incidence of lower limb injuries in runners ranges from 19.4 to 92.4%, affecting mainly the knees, with a specific incidence from 7.2 to 50%;[2] 30 to 70% of these injuries require training reduction and > 79% require medical attention.[3] Anterior knee pain, also called patellofemoral pain (PFP),[5] is a frequent cause for medical care.[4]

Short and long distance recreational runners report mainly knee injuries,[6] with 50% of them resulting from excessive use.[3] In addition, these lesions may be associated with risk factors, such as body mass index (BMI)[7] and advanced age.[2,3,8] Since injuries are multifactorial, studies on running-related risk factors must present a high quality to allow precise conclusions.[9] For Powers et al.,[10] failure to treat this lesion is constant, and it can be attributed to the lack of understanding of its causes.

The diagnosis is based on the history and physical examination of the patient, since imaging tests, including radiography and magnetic resonance imaging (MRI), do not provide specific findings.[11] As such, qualitative and quantitative assessment tools are required.[12] These tools include the Lysholm questionnaire, due to its reliability and validity in athletes and patients with joint cartilage conditions,[13,14] and the Patellofemoral Disorders Scale (Kujala Anterior Knee Pain Scale), which is a specific tool for anterior knee pain evaluation.[15–17]

Due to the diverse etiology, the diagnosis is complex and susceptible to interpretation errors.[18] Therefore, the Lysholm and Kujala questionnaires can provide additional information to the history and physical examination of the patient, reducing the inaccuracy in clinical evaluation; in addition, these are easily applied, low-cost tools. The main objective of the present study was to compare the subjective perception of pain and anterior knee pain symptoms in people with different BMI classifications. The secondary objective was to verify the association between biological and anthropometric variables with subjective questionnaires scores. Our initial hypothesis is the existence of an association between biological (age) and anthropometric (BMI) variables with pain perception and PFP symptoms.[7,8]

Material and Methods

Study Design

The sample consisted of 126 recreational runners of both genders, aged between 20 and 59 years old. All volunteers were recruited by invitation and declared they did not run competitively. An Informed Consent Form (ICF) was signed; this document provided the telephone number of the researchers in charge to resolve possible doubts, since there was no direct contact with the volunteers. The document was in a digital format, according to a project approved by the Research Ethic Committee (CEP, in the Portuguese acronym) under the number 2.774.475/2018.

The study was conducted through questionnaires digitally available on a single link, via the internet; a brief explanatory text about these tools was also provided. In addition, data regarding age, knee pain intensity according to the visual analog scale (VAS), weight and height for BMI calculation were collected. Next, recruited individuals were encouraged to answer the Lysholm and Kujala questionnaires on their computers, notebooks, cell phones, tablets, or other electronic devices.

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Body mass index

Body mass index was used to assess the subject's weight in relation to height, with the following classification: < 18.5, low weight; from 18.5 to 24.9, normal weight; from 25 to 29.9, overweight; ≥ 30, obesity. The BMI was calculated by dividing the body mass in kilograms (kg) by the squared height (m^2). Data were provided by the subjects, who were instructed to weight themselves on a digital or analogic scale, and to measure their heights before answering the online questionnaires.

Lysholm questionnaire

The Lysholm questionnaire is a specific knee questionnaire, which was translated and validated in Portuguese.[19] The questionnaire was answered by the volunteers, who chose only one answer per item. Items are divided into limping, support, locking, instability, pain, swelling, climbing stairs and squatting. The score 5 refers to the maximum in the items support, limping and squatting, the score 10 refers to the maximum in the items swelling and climbing stairs, the score 15 refers to the maximum in the item locking and the score 25 refers to if the maximum in the items instability and pain. The total score is classified as excellent ($\geq$ 95 points), good (94 to 84 points), fair (83 to 65 points) and poor ($\leq$ 64 points).[20]

Kujala questionnaire

The Kujala questionnaire (Patellofemoral Disorders Scale) is used to assess anterior knee pain and functional limitations. It was validated and translated into Portuguese, and it is the only questionnaire that concomitantly evaluates anterior knee pain, patellofemoral joint function and patellar alignment.[12] It scores from 0 to 100 points, where 0 represents the absence of pain and/or functional limitations, and 100 points corresponds to constant pain and several functional limitations. It consists of 13 multiple choice items, and 1 answer per item is allowed. Items are divided into limping, supporting body weight, walking, going up and down stairs, squatting, running, jumping, sitting for a long time with bent knees, pain in the affected knee, swelling, subluxations, loss of muscle mass and difficulty flexing the injured knee. A maximum score of 5 points is attributed to limping, sustaining body weight, walking, squatting, loss of muscle mass and difficulty flexing the injured knee, while a maximum score of 10 points is given to going up and down stairs, running, jumping, sitting for a long time with bent knees, pain in the affected knee, swelling and subluxations. Scores are classified as excellent ($\geq$ than 95 points), good (94 to 85 points), fair (84 to 65 points) and poor ($\leq$ 64 points).[15]

Visual analog scale

The VAS was used to subjectively measure the level of knee pain in recreational runners. The classification goes from 0 to 10 points, where 0 to 2 corresponds to mild pain, 3 to 7 equates to moderate pain and 8 to 10 represents severe pain. The VAS was answered according to current pain during the application of the questionnaire.[21]

Statistical analysis

Descriptive data were presented as mean $\pm$ standard deviation (SD). Data normality was examined using the Shapiro-Wilk test. A paired sample t-test compared mean values from parametric data, while the Wilcoxon test was used for non-parametric data. Variables were analyzed by Pearson linear correlation. The 95% confidence interval (CI) for variables association was calculated. The magnitudes of the correlation adopted were (r): Trivial when less than or equal to 0.1; small when greater than 0.1 to 0.3; moderate when greater than 0.3 to 0.5, large when greater than 0.5 to 0.7, very large when greater than 0.7 to 0.9 and almost perfect when greater than 0.9 to 1.0. In case of 95%CI overlapping, small positive and negative magnitude values were considered unclear; otherwise, the observed magnitude was considered.[22] Significance was adopted at $p \leq 0.05$. Analyzes were performed using IBM SPSS Statistics for Windows, Version 22 (IBM Corp., Armonk, NY, USA). Figures were generated with GraphPad Prism software, version 6.0 (San Diego, CA, USA).

Results

A total of 138 questionnaires were responded, with 126 considered viable and included in the analyzes. Twelve questionnaires were excluded: 5 due to the duplicate participation, 2 from subjects younger than the age stipulated by our study, 1 from a volunteer older than required, and 4 for not fully completing the questionnaire.

Descriptive data regarding age, height and body mass from recreational runners are presented in ►**Table 1**. A significant height difference was observed between overweight and grade 1 obesity subjects ($p = 0.029$) (►**Table 1**); body mass was significantly different when comparing the normal weight group to the overweight ($p < 0.001$) and grade 1 obesity groups ($p < 0.001$) (►**Table 1**).

The mean BMI values from overweight subjects were significantly different to those from normal weight subjects; the mean BMI values from grade 1 obesity subjects were significantly different from normal weight and overweight subjects (►**Figure 1A**). The VAS, Kujala and Lysholm mean scores presented no significant difference between groups (►**Figure 1B**, **1C**, **1D**).

Table 1 Characterization of recreational runners divided into groups according by body mass index

	Normal weight group	Overweight group	Grade 1 obesity group
Age (years old)	33.83 ± 7.98	34.10 ± 8.23	39.22 ± 8.84
Height (m)	1.67 ± 0.08	1.71 ± 0.09	1.68 ± 0.08**
Weight (kg)	63.26 ± 8.22	78.64 ± 9.48*	91.55 ± 11.87*

Abbreviations: m, meters; kg, kilograms.
*Significant difference, normal weight group, $p < 0.05$.
**Significant difference, overweight group, $p < 0.05$.

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Significant correlations between BMI and the VAS ($r = 0.18$; $p = 0.04$), Kujala score ($r = -0.17$; $p = 0.05$) and Lysholm score ($r = -0.22$; $p = 0.01$) were observed (►**Figure 2**); however, there were no significant correlations between age and specific questionnaires and VAS scores (►**Figure 3**).

The virtual questionnaire inquired the running experience of participants, with three possible answers: 1 - < 6 months; 2 - > 6 months; 3 - ≥ 1 year. The weekly frequency, referring to how many times a week the subject does street running, was also questioned, with three possible answers: 1 - Once a week; 2 - Twice a week; 3 - ≥ 3 times a week. Regardless of their nature, all answers were included in our analysis; this information was collected to better understand the characteristics from our volunteers.

Discussion

Our main findings were the following: 1-) There is a significant difference between mean BMI values. 2-) BMI has a significant correlation with the VAS, Kujala and Lysholm scores. 3-) There is no significant correlation between age, subjective pain scale and specific questionnaires. The significant difference observed between BMI classifications (►**Figure 1A**) is due to the difference between the body weight from normal weight, overweight and grade 1 obesity subjects (►**Table 1**) and the height difference between the overweight and grade 1 obesity groups (►**Table 1**).

Our data suggest that the BMI is associated with the level of pain and PFP symptoms (►**Figure 2**). Linton et al.[7] observed that injured subjects have a higher BMI compared with non-injured individuals, so BMI can be a risk factor for running injuries; in addition, runners from the injured group reported both a knee injury in the previous 12 months and a current lesion. Kastelein et al.[23] detected an association between persistent knee pain in subjects with BMI values > 25 kg/m^2 during the 1st year of follow-up; those same patients, at a 6-year follow-up, presented bilateral symptoms, including reports of knee swelling and locking sensation in the Lysholm questionnaire. Similarly, Nielsen et al.[24,25] highlighted that an increased BMI consequently increases the risk of running-related injuries, and that BMI values < 20 kg/m^2 are considered protective factors for the development of lesions.[24]

Neal et al.,[26] demonstrated that BMI is not a risk factor for injuries in runners since the evaluated papers show evidence that subjects both above or within an ideal weight are predisposed to PFP development; furthermore, these authors state that the risk of having this type of pain is present regardless of the type of runner. Nevertheless, these results are not yet fully elucidated in the literature. Vitez et al.[8] and Linton et al.[7] observed that overweight runners are more susceptible to injuries than those with normal weight, corroborating our findings, which demonstrate an unclear significant correlation between BMI and VAS, Kujala and Lysholm scores.

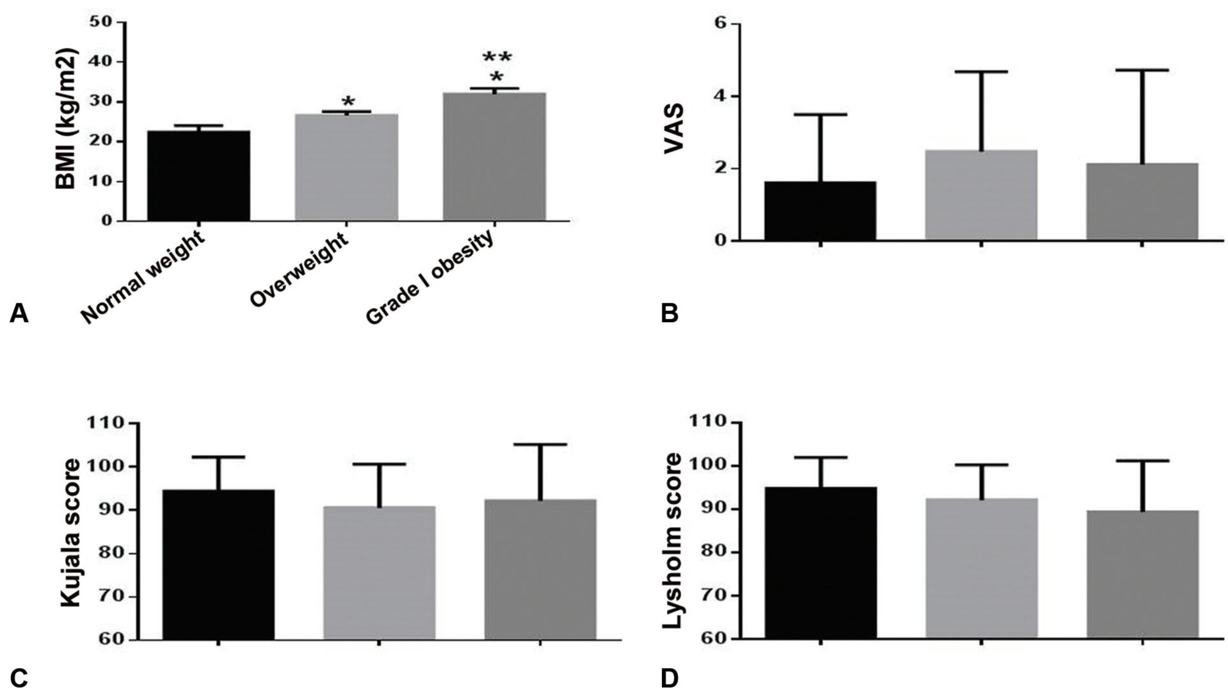

Fig. 1 (**A**) The black bar refers to the average body mass index (BMI) of normal weight subjects, the light gray bar represents the average BMI of overweight subjects, and the dark gray bar indicates the average BMI grade 1 obesity subjects. (**B**) The black bar corresponds to the average visual analog scale (VAS) score of normal weight subjects, the light gray bar shows the average VAS score of overweight participants, and the dark gray bar corresponds to the average VAS score of grade 1 obesity patients. (**C**) The black bar symbolizes the average Kujala score of normal weight subjects, the light gray bar refers to the average Kujala score of overweight subjects, and the dark gray bar represents the average Kujala score of grade 1 obesity individuals. (**D**) The black bar refers to the average Lysholm score of normal weight participants, the light gray bar refers to the average Lysholm score of overweight subjects, and the dark gray bar represents the average Lysholm score of with grade 1 obesity individuals. *, significant difference compared with normal weight subjects, $p \leq 0.05$; **, significant difference compared with overweight subjects, $p \leq 0.05$.

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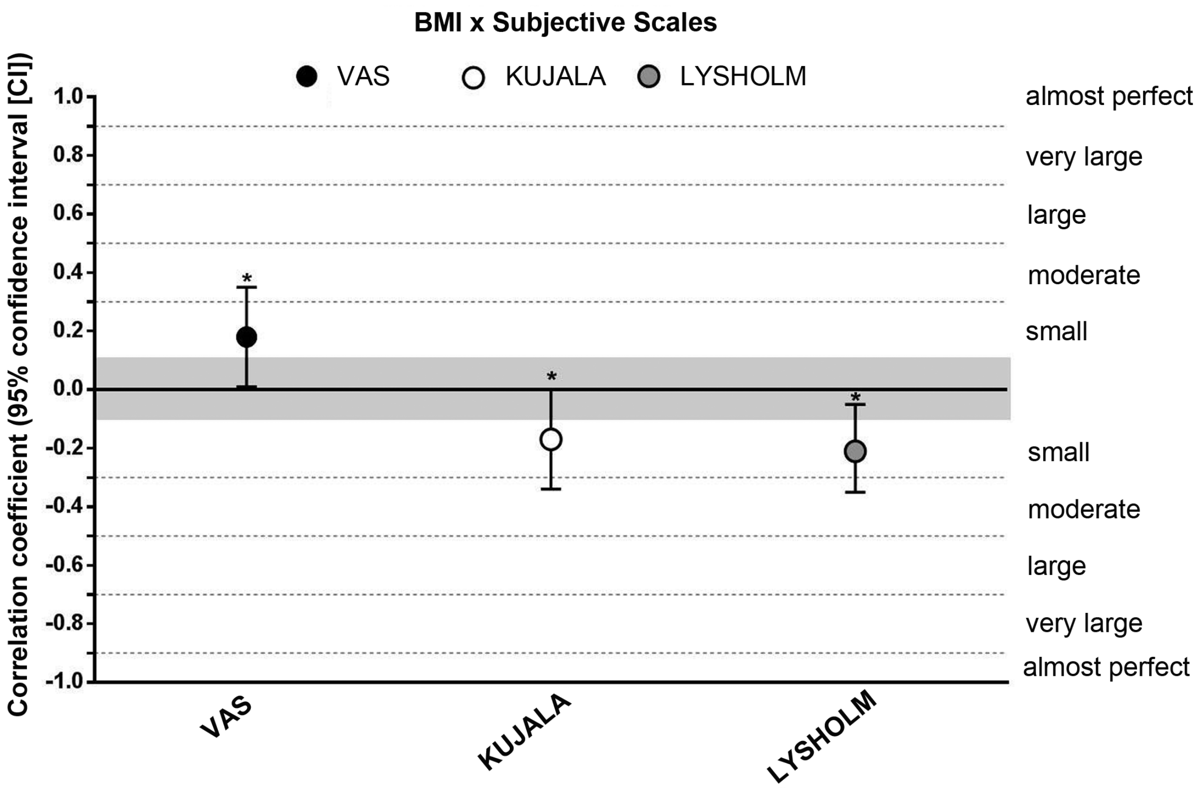

Fig. 2 Correlation between body mass index (BMI) and subjective scales scores. The black circle corresponds to the correlation with the visual analog scale (VAS), the white circle represents the correlation to the Kujala score, and the gray circle shows the correlation with the Lysholm score. The black line represents the limit between positive or negative correlation. The gray area shows the trivial correlation threshold, while the dotted lines represent small, moderate, large, very large or almost perfect correlation thresholds. *, significant difference, $p \leq 0.05$.

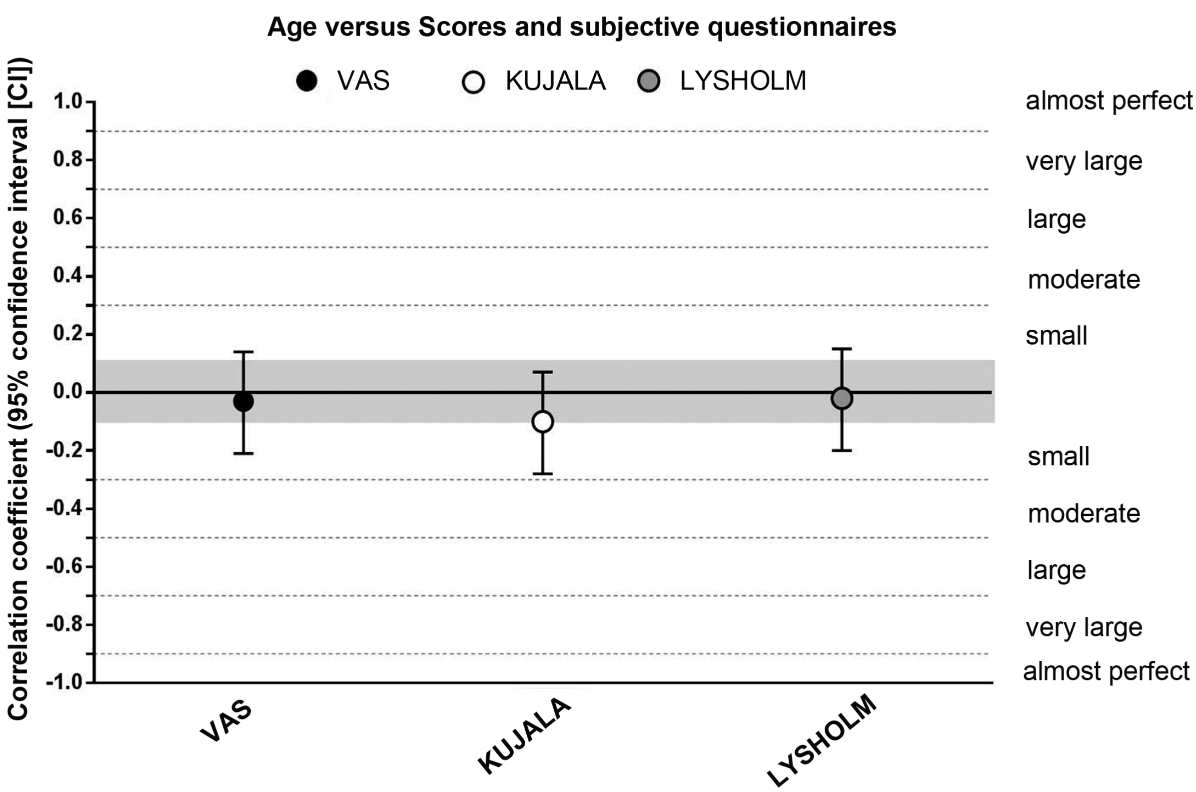

Fig. 3 Correlation between participants' age and subjective scales scores. The black circle corresponds to the correlation with the visual analog scale (VAS), the white circle represents the correlation to the Kujala score, and the gray circle shows the correlation with the Lysholm score. The black line represents the limit between positive or negative correlation. The gray area shows the trivial correlation threshold, while the dotted lines represent small, moderate, large, very large or almost perfect correlation thresholds. *, significant difference, $p \leq 0.05$.

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Our results indicate that age has a trivial correlation with specific knee and pain questionnaires. On the contrary, Gionnogueron et al.,[3] Van Gent et al.,[2] and Vitez et al.[8] pointed out that advanced age is a risk factor for lower limb injury. A recent systematic review and meta-analysis found moderate evidence that age is not a risk factor for patellofemoral pain in runners, including recreational runners.[26] According to Nielsen et al.,[24] middle-aged runners between 45 and 65 years old are more susceptible to running-related injuries. This observation justifies the trivial correlation found by our study, in which most volunteers were young adults (►**Table 1**), since few symptoms are reported by this age group.

Our study had two main limitations: Indirect contact with volunteers and the lack of distinction between pain and injury, mainly due to the difficulty in diagnosing and controlling the injury factor. Future studies must attempt to control variables that the literature proposes as risk factors for PFP, including sport experience, flexibility, patellar alignment, quadriceps muscles strength, weekly training volume, running speed, running shoes and mileage covered with them, step type, guidance and periodization by a professional, as well as face-to-face questionnaire application and the differentiation between pain and injury.

Conclusion

We conclude that a high BMI value can be a causative factor for knee pain in recreational runners; therefore, the weight of such subjects must be controlled to minimize the occurrence of injuries. Lysholm and Kujala questionnaires can be used to assess knee symptoms in this population, providing additional information to the physical evaluation and assisting in preventive strategies, as they enable the characterization of current symptoms.

Conflict of Interests
The authors have no conflict of interests to declare.

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