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Original article

Correlation of dynamic valgus with knee injuries in runners

Correlação do valgo dinâmico com lesões de joelho em corredores

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RESUMO | INTRODUÇÃO: Os corredores têm uma grande incidência de lesões em membros inferiores, sendo o joelho a articulação mais acometida. A mesma sofre influência direta do quadril e das articulações adjacentes. Fraqueza muscular de extensores, rotadores laterais e abdutores de quadril levam a uma alteração biomecânica chamada valgo dinâmico, que é um mecanismo compensatório, onde o centro da articulação do joelho se desloca medialmente. **OBJETIVO:** Esse estudo teve como objetivo correlacionar o valgo dinâmico com lesões, ângulo Q e nivelamento da pelve. **MATERIAL E MÉTODOS:** Trata-se de uma Pesquisa de campo, descritiva, investigativa e quantitativa. Os dados foram coletados nos meses de abril de 2019, na Federação de Atletismo do Piauí com 14 corredores homens, com idade acima de 18 anos. Para obtenção dos dados foi utilizado um questionário e o teste step down que foi submetido ao software para avaliação postural (SAPO) e um questionário. Os mesmos foram analisados quanto a sua normalidade de distribuição das amostras, pelo teste de Kolmogov-Sminorv, e teste de Pearson para analises de dados numéricos, foi tabulado no excel para posterior analise no GraphPad Prism 7.1. O nível de significância para análise estatística foi considerada como $p< 0,05$. O trabalho foi executado após aprovação no comitê de ética (CAAE: 11001219.5.0000.5193). **RESULTADOS:** Os resultados obtidos não mostraram correlação do valgo dinâmico com lesões, com ângulo Q (R^2=-0.200) e com nivelamento da pelve (R^2=0.253) e $p>0,05$. **CONCLUSÃO:** Neste estudo não foi encontrada correlação entre o valgo dinâmico, lesões de joelho, ângulo Q e nivelamento da pelve.

PALAVRAS-CHAVE: Corredores. Joelho. Lesões. Valgo.

ABSTRACT | INTRODUCTION: Runners have a high incidence of lower limb injuries, with the knee being the most affected joint. It is directly influenced by the hip and adjacent joints. Muscle weakness of extensors, lateral rotators, and hip abductors leads to a biomechanical change called dynamic valgus, which is a compensatory mechanism, where the center of the knee joint moves medially. **OBJECTIVE:** This study aimed to correlate dynamic valgus with lesions, Q angle and pelvic leveling. **MATERIAL AND METHODS:** This is a field research, descriptive, investigative and quantitative. Data were collected in April 2019 at the Piauí Athletics Federation with 14 male runners over 18 years old. To obtain the data, a questionnaire was used and the step down test was submitted to the software for postural evaluation (SAPO) and a questionnaire. They were analyzed for their normal distribution of samples by the Kolmogov-Sminorv test and Pearson's test for numerical data analysis, tabulated in excel for further analysis in GraphPad Prism 7.1. The significance level for statistical analysis was considered as $p <0.05$. The work was performed after approval by the ethics committee (CAAE: 11001219.5.0000.5193). **RESULTS:** The results showed no correlation between dynamic valgus and lesions, with Q angle (R^2 = -0.200) and pelvic leveling (R^2 = 0.253) and $p> 0.05$. **CONCLUSION:** In this study no correlation was found between dynamic valgus, knee injuries, Q angle and pelvic leveling.

KEYWORDS: Runners. Knee. Injuries. Valgus.

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Introduction

The race arose because of the need for humans to escape from their predators. To our ancestors, these skills were just a matter of life and death. With the advancement of civilization, this need diminished, and this made the race a new feature. Today it has become a sporting tool, and it is an excellent form of socialization and any healthy individual can practice it[1].

According to Pileggi[2], the practice of this sport has been very important in improving insulin sensitivity, reductions in the amount of body fat and concentrations of triglycerides, low density lipoprotein (LDL) and total cholesterol, increases in lean mass. and bone, aerobic power and antioxidant capacity, reduced post-exercise blood pressure and consequently improved quality of life.

Despite all these benefits, there is a high incidence of lower limb joint (LIII) injuries in runners. When relating intrinsic factors (poor flexibility, anthropometric characteristics, biomechanical and anatomical abnormalities, body composition and greater muscle strength), and extrinsic factors (session length and weekly long distances, training planning and execution errors, surface type of training, type of course), there is a strong incidence of injuries with the knee being the most affected joint in these individuals[2,3].

The knee joint is located in the lower limb between the hip and ankle, and its dynamic stability is guaranteed by the surrounding muscles. Its kinematics are directly influenced by the hip and adjacent joints, leading to the dynamic knee valgus, which is a compensatory mechanism, where the center of the knee joint moves medially in relation to the foot[4].

The factor that leads to this mechanism is the muscle weakness of the extensors, lateral rotators and hip abductors, which can be observed in activities such as descending stairs, running, landing, and single foot squats. Its excess can lead to knee injuries, such as anterior cruciate ligament injury and patellofemoral pain syndrome (PPS)[5]. Thus, this study aimed to diagnose dynamic valgus and correlate with injuries suffered by these athletes.

Methods

Type of research

Field research, descriptive, investigative.

Place and period of study

The study was conducted at the Piauí Athletics Federation (FAPI) from February to April 2019.

Population and sample

The sample consisted of 14 male runners associated with (FAPI)

Inclusion and exclusion criteria

Only male runners, aged 18 to 35 years old, duly associated with the Piauí Athletics Federation, after signing the informed consent form were included in the sample.

No athletes were selected who were not available to participate in the study, those who were injured to the point of not being able to perform the test, those under 18 years old and over 35 years old, runners who were not associated with the federation and athletes from feminine gender.

Data collection

All procedures were performed at FAPI located in Teresina-PI in the afternoon and evening shifts. were evaluated through a step down questionnaire. The subjects were invited to participate in the research after the training, they were clarified objectives and procedures of the study, in addition to signing the free and informed consent form, application of the questionnaire (Annex I), guidance for performing the step test. down The data obtained in the test were submitted to the Postural Assessment Software (SAPO) for analysis of the results. The evaluation was performed by placing markers on the anatomical correspondence between the malleoli, the anterior tibial tuberosity, the center of the patella and the anterior superior iliac spine. Participants were positioned on a 15cm high step and with a camera 2 meters away filming the step down test.

Instruments

Evaluation Instrument 1 - Questionary

The questionnaire will be aimed at investigating athlete-specific data, the following questions were asked: name; age; how long have you been playing the sport ?; frequency of training during the week ?; do you feel knee pain ?; have you ever suffered a knee injury and what structure of the knee was injured ?; did knee surgery and how long was the surgery ?; The participant must answer the questionnaire using total sincerity.

Evaluation Instrument 2 - Step down

The step down test serves to detect the dynamic valgus, to which the individual being evaluated climbs on a platform 10% of its length, with a camera two meters away from the platform. A marking was made 5cm from the platform, delimiting the access to the calcaneus contact of the evaluated. Finally, the subject was submitted to three unilateral squats, where it was observed if there was a dynamic, concentric or eccentric valgus during the exercise.

Statistical analysis

Data were analyzed with graph pad prism 7.1 software through descriptive statistical analysis. Data were analyzed for normal distribution of samples by the kolmogov-sminorv test, chi-square test for categorical variables and Pearson test for numerical data analysis. Data were tabulated in excel for further analysis on graph pad prism 7.1. The significance level for statistical analysis was considered as $p < 0.05$.

Ethical aspects

The project was submitted to the Research Ethics Committee (CEP) by the Brazil platform following the resolution of the National Health Council (CNS) No. 466 of December 12, 2012. The work was performed after the approval of the ethics committee (CAAE: 11001219.5.0000.5193).

Results

Fourteen runners from the Piauí Athletics Federation with an average age of 22 ± 1.15 years old, sports practice time of 5.71 years ± 0.71 and the average training per week of 6 times participated in this study (Table 1).

Anthropometric characteristics, training variables and sports practice time are shown in table 1.

Table 1. Anthropometric characteristics, training variables and practice time of FAPI

Parameters	Average	Standard Error
Age	22	1,15
Sports time	5,71	0,71
Workouts per week	6	0

The DAgostino-Pearson sample distribution normality test showed an average of 5.71 ± 0.71 sports practice time, average load angle of 184.7 ° ± 2.32 °, Q angle of 7.99 ± 0. , 74 and pelvic leveling of 4.61 ± 0.64 according to table 2.

According to the results presented in table 2, the loading angle of these athletes averaged 184.7 ° ± 2.32 °, the dynamic Q angle of the patella averaged 7.99 ° ± 0.74 ° and the pelvic leveling presented an angle of 4.61 ° ± 0.64 °.

Table 2. DAgostino-Pearson distribution normality test

Parameters	Medium	Standard Error	P Value
Sports time	5,71	0,71	0,177
Knee Load angle	184,7	2,32	0,002
Q angle	7,99	0,74	0,006
Pelvis leveling	4,61	0,64	0,322

Table 3 shows the correlation between sports practice time and Q angle (R^2 = 0.124 and P = 0.530), loading angle (R^2 = 0.153 and P = 0.440) and pelvic leveling (R^2 = 0.095 and P = 0.631) .

There was no correlation between knee injuries and dynamic valgus, of the 14 athletes participating in the research, only one was injured and the same was not diagnosed with dynamic valgus.

Table 3. Correlation between running time and Q angle, loading angle and pelvic

Parameters	Medium	Standard Error	P Value
Sports time	5,71	0,71	0,177
Knee Load angle	184,7	2,32	0,002
Q angle	7,99	0,74	0,006
Pelvis leveling	4,61	0,64	0,322

* Values corresponding to the Spearman or Pearson tests determined according to the type of distribution of the samples by the DAgostino-Pearson test.

Figure 1 shows the percentage of runners who experience knee pain, 71.40 do not experience knee pain, and 28.60 feel knee pain at some point in the run.

In between athletes evaluated 50% presented dynamic valgus, being 21.40% in the right leg, 14.30% in the left leg and 14.30% bilateral (figure 2).

Dynamic valgus showed no significant correlation with Q angle (R^2 = -0.200) and pelvic leveling (R^2 = 0.253). There was also no significant correlation between the angle Q and pelvic leveling (Figure 3).

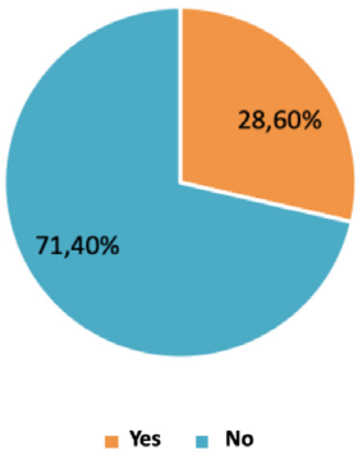
Discussion

Although this study found a high frequency of training and running time, no relationship was found between practice time and presence of injury among the runners evaluated. In contrast, Rangel et al. (2016)[3] in their cross-sectional descriptive study with 88 street runners, found that 43.2% had already had an injury, with the knee being the most affected site with an incidence of 52.6%, also showing a strong correlation between time of sports practice with injuries.

The correlation between sports practice time and Q angle, loading angle and pelvic leveling was made by Pearson correlation, which evaluates the linear correlation between two continuous variables. A relationship is linear when the change of one variable is associated with a proportional change in the other variable. Based on this, the correlation values (R^2) vary from 0 to 1, and may have positive or negative values. The correlation is greater the closer to 1, and the smaller the closer to 0. Thus, it can be seen that the correlation between the variables presented in figure 3 are all weak, two positive and one negative.

In the present study, of the 14 participants, only one suffered knee injury, and the same was not diagnosed with dynamic valgus. The percentage of runners who were diagnosed with dynamic valgus corresponds to 50%, being 21.40% in the right leg, 14.30% in the left leg and 14.30% bilateral (Figure 2). Kemler et al (6) evaluated the incidence of injuries in veteran and novice runners and observed a higher incidence in the second group 8.78 injuries per 1000 hours of running compared to experienced runners who had an incidence of 4.24 injuries to the same extent. of sports practice. However, the authors did not observe a significant difference in the proportion of knee injuries between novice (31.1%) and veteran (30.5%) athletes. In a systematic review by Francis et al[7], knee injuries were the most prevalent among men and women. Also according to this study, patellofemoral pain followed by patellar tension injuries were the most common causes of injury in this anatomical region. In a prospective observational survey of 240 participants over the age of 18, Astur et al. (8) observed the incidence of ACL and meniscus injuries in runners, where 6.24% of participants had injuries.

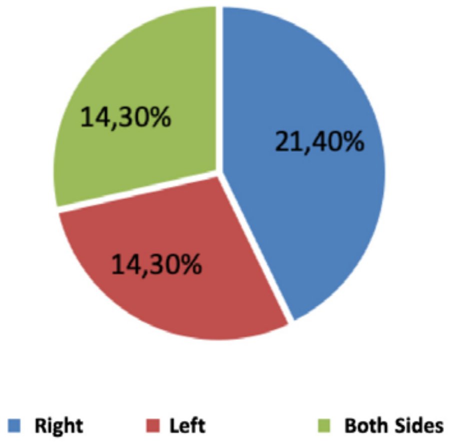
Figure 1. Percentage of FAPI runners who have knee pain



Patellofemoral pain syndrome (PFPS) is a pain in the posterior patella that affects a large number of runners, causing them to interrupt training and competitions. This is due to stress on the patellofemoral joint, which is caused by increased dynamic valgus, which can lead to ACL rupture and PFPS[9]. This indicates that 28.60% experience knee pain (Figure 1). By analyzing biomechanical factors associated with race-related injuries Ceyssens et al.[10] in a systematic review found limited evidence indicating that a higher peak of hip adduction develops PFPS. These findings corroborate with Neal et al.[11] who in a review and meta-analysis survey of 18 studies involving 4818 participants also showed that higher hip strength in adolescents were risk factors for PFPS. Ishida et al.[12] analyzed knee rotation associated with dynamic knee valgus and forefoot direction and in their results confirmed that the knee underwent external rotation in the dynamic knee valgus position. Because of this mechanism, the ACL can collide with the femoral condyle, especially in the external rotation position.

Although a high prevalence of knee pain was found in this study (28.60%), it was not possible to correlate the presence of pain with increased knee dynamic valgus.

Figure 2. Prevalence of dynamic valgus in FAPI runners diagnosed by step down test



Angle Q is the formation of two imaginary lines, one of these lines departing from the anterior superior iliac crest to the middle of the patella and the other part of the anterior tibial tuberosity to the center of the patella[13] when enlarged is a factor of triggering ACL injury rates among athletes[9].

In theory, the greater the Q angle, the greater the dynamic knee valgus, contrary to this hypothesis according to Figure 3, it is observed that the dynamic valgus presented a negative and weak correlation with the patellar Q angle with a value of R^2 = -0.200. Similar findings are reported by Almeida et al.[5], who, in their cross-sectional research, evaluated the Q angle through goniometry and dynamic valgus through 2D footage, where these data showed no significant correlation (r = −0.28; P = 0, 19). In addition, Park et al.[14] also confirmed in their study with 31 recreational runners negative correlations between the Q angle and the magnitude of the knee abduction moment peak.

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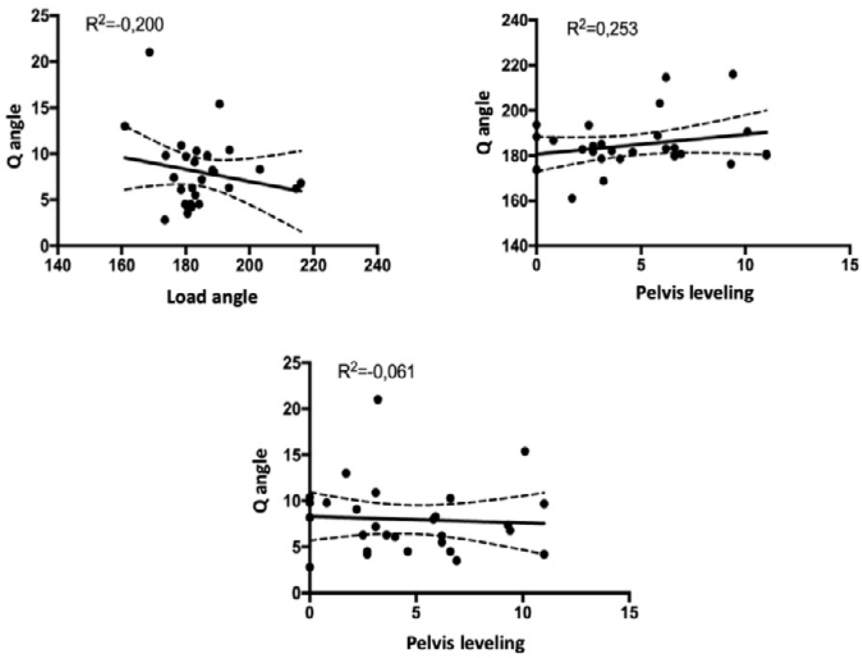
In this study, when assessing the correlation between anthropometric variables such as Q angle, pelvic leveling and knee loading angle, no significant correlation was found between the variables (p> 0.05). Similar results presented to those presented by this study were demonstrated by Ramskov et al.[15] who evaluated fifty-nine novice runners in a 10-week prospective follow-up study to associate Q-angle and foot posture with running-related injuries, and concluded that the static foot posture, quantified by Q angle does not appear to affect the risk of injury among novice runners.

Contrary to these findings, Messier et al.[16] in a study of 36 participants to evaluate the relationships between anthropometric, biomechanical variables, muscle strength and endurance, training variables and runners suffering from patellofemoral pain pointed out Q angle as a strong discriminator between distressed runners. with PFPS and uninjured runners. In addition, several variables of muscle and kinetic endurance may also be important components of the etiology of PFPS.

Nguyen et al.[17] verified the relationships between lower extremity alignment and quadriceps angle in 208 participants (102 men and 116 women) in a descriptive cohort design, and observed that the greater femoral anteversion and the tibiofemoral angle result in larger Q-angle, with changes in the tibiofemoral angle having a substantially greater impact on Q-angle magnitude compared to femoral anteversion. He also concluded that the Q angle seems to represent a broad measure of alignment in the frontal plane, and how many of these knee injuries appear to result from a combination of forces and movements in the frontal and transverse plane. This would be an explanation of why Q-angle is considered a risk factor for lower limb injuries.

Scholtes et al.[18] evaluated the correlation between two-dimensional and three-dimensional dynamic valgus indices. To calculate the indices, the authors evaluated by biophotogrammetry the pelvic tilt angles, dynamic knee valgus angle and lower limb abduction angle. Based on the analyzes, the authors found a moderate to high correlation between calculated indices and knee dynamic valgus in normal women with patellofemoral pain.

Figure 3. Correlation between angles measured by biophotogrammetry in FAPI corridors



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Pelvic leveling is observed through the Trendelenbrug test, which is performed with the patient on one foot, and is positive when contralateral pelvic deviation caused by muscle gluteus weakness is observed. Powers et al.[19], points out the importance of the gluteus medius for hip stabilization and knee kinematics. In this study, according to Figure 3, pelvic leveling did not show a significant correlation with dynamic valgus, which was positive and weak with R2 = 0.253. These results corroborate those found by Maia et al.[4]. In a cross-sectional, observational study, it was found that only 14.2% of the sample of their study composed of 104 volunteers showed a correlation between dynamic valgus and test positivity. from Trendelenburg. In contrast, Jonh et al.[20] described the relationships between hip and knee angles in the frontal plane, hip strength, and electromyographic activation (EMG) in women during the step-down test. Their results showed that hip adduction angles, gluteus maximus activation and hip abduction strength are related to increased knee dynamic valgus angle.

The correlation of Q angle with pelvic leveling showed a negative and weak correlation (R^2 = -0.061). The influence of hip on knee biomechanics has been discussed and the relationship between its changes and knee injuries has been demonstrated, for example, Christopher[21] states that hip muscles directly affect knee biomechanics, thus weakness. of hip muscle leads to excessive dynamic valgus, and has been a factor that predisposes to numerous knee injuries including ACL injuries.

Still in this sense, Rabin et al.[22] evaluated the influence of the pretest pelvic leveling on the dynamic valgus during lateral step down and observed that those evaluated with pretest pelvic misalignment presented greater contralateral pelvic fall and a higher hip adduction peak in compared to participants with good pretest pelvic alignment.

Conclusion

In this study no correlation was found between dynamic valgus, knee injuries, Q angle and pelvic leveling. More than twenty-eight percent (28.60%) of runners had knee pain. The findings of this study lead to further research in order to confirm the trends presented since the international literature itself is confusing regarding the relationships researched by this study.

Further research with larger samples and well-described methodological criteria is required. In addition, we report the small amount of studies on knee pain in men, as well as its relationship with anthropometric measurements in this population. knee and the correlation between the angle Q and knee dynamic valgus.

Author contributions

Cunha FVM participated in the conception and study design, search and statistical analysis of research data, interpretation of the results and writing of the scientific article. Paiva CA participated in the conception, study design, data collection, interpretation of the results and writing of the scientific article. Da Silva KKS participated in the study design and writing of the scientific article. Costa JAM participated in the data collection. Lima RSA participated in the bibliographic research and data collection.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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