Dynamic knee valgus prevalence in children and its association with pain intensity, foot mobility, and sex—A cross-sectional study

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ABSTRACT

Introduction: Knee pain can impact the performance of activities and sports participation in children. Dynamic knee valgus is a movement pattern commonly related to health conditions that may be associated with sex and foot kinematics in children.

Objective: To assess the prevalence of dynamic knee valgus and its relationship with foot mobility, sex, and knee pain in children.

Method: A cross-sectional observational study was carried out with 144 children (10–18 years old). The pain level was investigated using the Visual Analog Pain Scale and categorized into no pain/minor pain (≤2 cm), moderate pain (3–4.9 cm), and severe pain (≥5.0 cm). Foot mobility was assessed using the adapted navicular drop test and categorized into poor/adequate foot mobility (0.0 cm–0.9 cm) and greater foot mobility (≥1.0 cm). The dynamic knee valgus presence was checked using the step-down test. The association analysis was performed using simple tabulation considering the cluster effect. The Prevalence Ratios and the respective confidence intervals (95%) were estimated from Multiple Poisson Regression with robust variance. A significance level of 5% was adopted.

Results: The dynamic knee valgus prevalence was 26.3% and 26.9% in the right and left lower limbs, respectively. Females presented greater dynamic knee valgus frequency in the left lower limb than males. The dynamic knee valgus presence in males was associated with foot mobility in right (p = 0.001) (Prevalence Ratio: 9.33 Confidence Interval: 2.93–29.72) and left lower limbs (p = 0.003) (Prevalence Ratio: 6.25 Confidence Interval: 1.7–22.62).

Conclusion: Male and female children showed different relationships of the analyzed factors, suggesting that characteristics related to sex may impact the aspects linked to dynamic knee in children.

1. Introduction

The knee is the most common injured joint throughout life [1]. Specifically, in adolescents, a study showed a prevalence of 22% of knee pain [2]. Orthopedic injuries have a relevant impact on the children's life [3]. They can reduce their functional capacity to practice sports [3], limiting or interrupting the performance of daily activities and consequently, also impacting their academic performance [4, 5]. In addition, the presence of knee injuries throughout life is considered a significant factor for the development of osteoarthritis in this joint, the rheumatic disease more common in the elderly [6]. Osteoarthritis has a considerable impact on individual health and, due to its high prevalence in the elderly, it is characterized as a public health problem [6]. Thus, understanding the factors related to the development of knee pain in children can contribute to planning preventive and treatment strategies that would impact health in the short and long term.

Dynamic knee valgus (DV) is a movement pattern that has been associated with injuries, such as anterior cruciate ligament tear [7, 8],...
Patellofemoral Pain Syndrome (PFPS), and iliotibial tract injuries [8, 9, 10, 11]. The DV can be observed during weight-bearing activities, such as the single-leg squat [12, 13]. This movement pattern is characterized as the combination of excessive hip medial rotation and adduction, knee abduction, and foot pronation, leading to the medial displacement of the knee about the foot [14, 15]. A higher prevalence of DV in adolescents has been associated with females than males [16, 17], and this relationship is more significant as children get older [18]. Besides, foot kinematics has been described as another risk factor for developing knee injuries [1]. For example, greater foot mobility has been observed in those with PFPS compared to healthy individuals [14], and it may be related to anterior cruciate ligament injuries in soccer players [19, 20].

Currently, it is known that DV is associated with an increased risk of orthopedic injuries and prolonging painful conditions. Few studies have investigated the prevalence of DV and its association with greater foot mobility, sex, and the presence of knee pain. Also, population-based epidemiological studies that assess these factors in children are scarce in the literature. Thus, the present study aimed to evaluate the prevalence of DV and its relationship with greater foot mobility, sex, and knee pain in children.

2. Methods

A cross-sectional observational study was carried out with 144 children (72 males aged 15.03 ± 2.40 years and 72 females aged 15.07 ± 2.10 years) enrolled in elementary or high school public schools in the city of Natal/RN during 2019 and 2020. The inclusion criteria were age between 10 and 18 years and not having orthopedic, rheumatic, or neurological problems. The exclusion criteria were children with physical or mental disabilities or with another disease that prevented maintaining the orthostatic position. The sampling was probabilistic, stratified, and proportional to the total number of students in each school, with a random draw using the numbered attendance list for each classroom. Children from 17 schools in Natal/RN participated in the research. The University Research Ethics Committee approved the investigation (CAAE: 07389318.1.0000.5292) and all the participants and their legal guardians signed an informed consent form.

2.1. Procedures

Initially, descriptive data were collected. Also, the pain level was registered using the Visual Analog Pain Scale (VAS) [18], and the answers were categorized as no pain/minor pain (0–2 cm), moderate pain (3–4.9 cm), and severe pain (>5 cm) [21]. Then, foot mobility was assessed using the adapted Navicular Drop Test (TQN) [22, 23]. This test begins with the participant sitting with the feet on the floor [22]. In this position, a point was marked with a pen on the palpable region of the navicular’s tuberosity [22]. Then, the vertical distance of the navicular’s tuberosity was measured [22]. Subsequently, the participant was instructed to stand up in double support, and the vertical distance from the navicular’s tuberosity to the ground was measured again [22, 23]. The difference between the two measurements was recorded in millimeters. A single measurement was taken by only one physical therapist examiner, who performed previous measurement training. This test is described in the literature as showing good clinimetric properties [22]. For data analysis, the results of this test were categorized as poor/adequate foot mobility (0.0 cm–0.9 cm) and greater foot mobility (>1.0 cm) [24, 25].

The DV presence was assessed according to the test described by Piva et al. [12]. First, the participant stood on a single leg on a 20 cm height step, with both hands on the waist, knee extended, and the foot close to the edge [12]. Then, the examiner asked the participant to touch the contralateral heel to the floor (i.e., without unloading the weight) and subsequently, returning the supporting lower limb to the initial position [11, 12]. The test assesses each lower limb separately during five repetitions [11, 12, 26]. The test is considered positive (i.e., presence of DV) if the knee deviates medially, crossing the medial edge of the supporting foot [12]. The judgment was carried out by a single physical therapist examiner, who had previously trained this measure. The literature also show that the test presents good clinimetric properties [11]. All procedures were performed in just one meeting during the school period, lasting approximately 30 min.

2.2. Statistical analysis

Demographic characteristics (sex and age) and the outcome from the performed tests were described using simple tabulations [27] considering the complex sampling design [28]. The prevalence of each variable was calculated from the complex sampling design, including weights and cluster effects [28]. For the association analysis between the DV and each independent variable (sex, foot mobility, age group, and knee pain presence), the Prevalence Ratios (PR) and the respective 95% confidence intervals (95% CI) of the outcome were estimated from Multiple Poisson Regression with robust variance and according to the participant’s sex. A significance level of 5% (α < 0.05) was adopted. For the analysis of demographic characteristics and PR we used de SPSS (version 25) and for the Multiple Poisson Regression the Stata (Stata/IC 12.0).

3. Results

The description of the investigated variables are presented in Table 1. The prevalence of DV was 26.3% (95% CI: 18–35) in and 26.9% (95 CI %: 19–36.5) in the right and left lower limb, respectively. The prevalence of greater foot mobility was 29.1% (95% CI: 20.2–40.1) and 20.4% (95% CI: 14–28.7) in the right and left lower limb, respectively. Severe knee pain was present in 17.2% (95% CI: 8.7–31.3) of the sample.

| Variable                        | Prevalence | % (#) | 95% CI          |
|---------------------------------|------------|-------|-----------------|
| **Sex**                         |            |       |                 |
| Male                            | 72         | 51.4  | 41.6–61.1       |
| Female                          | 72         | 48.6  | 38.9–58.4       |
| **Right Dynamic Knee Valgus**   |            |       |                 |
| Absent                          | 101        | 73.7  | 58.8–84.7       |
| Present                         | 43         | 26.3  | 15.3–41.2       |
| **Left Dynamic Knee Valgus**    |            |       |                 |
| Absent                          | 102        | 73.1  | 57.9–84.4       |
| Present                         | 42         | 26.9  | 15.6–42.1       |
| **Age Group**                   |            |       |                 |
| 10–12 years old                 | 22         | 22.7  | 11.8–39.1       |
| 13–15 years old                 | 54         | 38.4  | 26.0–52.5       |
| 16–18 years old                 | 68         | 38.9  | 23.3–57.2       |
| **Pain Level (VAS)**            |            |       |                 |
| No pain/minor pain              | 85         | 59.8  | 49.5–69.4       |
| Moderate pain                   | 33         | 23.0  | 18.1–28.6       |
| Severe pain                     | 26         | 17.2  | 8.7–31.3        |
| **Right Foot Mobility (TQN)**   |            |       |                 |
| Poor/adequate foot mobility     | 105        | 70.9  | 59.9–79.8       |
| Greater foot mobility           | 39         | 29.1  | 20.2–40.1       |
| **Left Foot Mobility (TQN)**    |            |       |                 |
| Poor/adequate foot mobility     | 110        | 79.6  | 71.3–86.0       |
| Greater foot mobility           | 34         | 20.4  | 14.0–28.7       |

Note: n = Number of participants evaluated; 95% CI = 95% Confidence Interval; VAS = Visual Analog Pain Scale; TQN = Adapted Navicular Drop Test; (%) = The percentage was obtained after weighting and cluster effect. It does not correspond to the same proportion of the sample.
The prevalence of DV and greater foot mobility according to sex. Prevalence Ratios and the respective 95% CI.

Table 2 - Association between DV and foot mobility, pain level, and age group in males. Prevalence Ratios, respective 95% CI and Multiple Poisson Regression.

Table 3 - Association between DV and foot mobility, pain level, and age group in males. Prevalence Ratios, respective 95% CI and Multiple Poisson Regression.
determinant than distal factors (e.g., foot mobility) for female children. Furthermore, together with lower performance of hip muscles, quadriceps weakness was related to the developing of PFPS in adults [32]. Probably, females would present greater benefits of a training program focusing on increasing the capacity of the hip and knee muscles to deal with the stresses of closed chain tasks.

Another finding was the absence of association between the DV and the presence of knee pain and age group in both sexes. Despite not being associated in the current transversal design study, both factors may be relevant to longitudinal followings. The knee pain reported by part of the sample may predispose to the development of health conditions in the lower limbs and promoting healthy growth for the young person.

5. Conclusion

Male and female children presented different relationships of factors linked to DV. Females presented greater DV prevalence in the left lower limb than males. Besides, the lower foot mobility was associated with the absence of DV only in males. Thus, characteristics related to sex may impact the factors related to DV in children.

Declarations

Author contribution statement

Sanchis: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Lopes and Assis: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Catão: Performed the experiments; Wrote the paper.

Ribeiro: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Roncalli: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

No data was used for the research described in the article.

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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