

## Foot Behavior and Pain in Elderly with Unilateral Knee Osteoarthritis

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### ABSTRACT

**Objective:** To analyze the behavior of the foot through the plantar arch index and plantar pressure distribution in elderly diagnosed with unilateral knee osteoarthritis. Materials and

**Methods:** The study included 17 elderly people of both sexes with an average age of 71.23 who were diagnosed with unilateral knee osteoarthritis. With the aid of a 50x50cm Barosscan, Podotech plantar pressure platform with 4,096 capacitive sensors with a sampling frequency of 50hz, the plantar arch index (PAI) and plantar pressure distribution of the right and left foot were evaluated during postural control.

**Results:** The plantar pressure distribution in the areas of the foot can perceive a statistically significant change between the right foot and the left foot, where the right foot presents greater plantar pressure distribution in the areas of the rearfoot ( $p = 0.03$ ) and in the forefoot ( $p = 0.04$ ) when compared with the left foot. Already in the midfoot the left foot presents greater plantar pressure distribution ( $p = 0.01$ ) when compared with the right foot.

**Conclusion:** The elderly who are diagnosed with unilateral knee osteoarthritis present changes in the plantar pressure distribution of the right and left foot, being with the eyes closed these changes become more evident.

**Keywords:** Plantar Pressure; Elderly; Osteoarthritis; Knee, Pain

### INTRODUCTION

Changes in static and dynamic balance are frequently observed in elderly individuals diagnosed with knee osteoarthritis, a degenerative condition with multiple possible causes. These alterations can significantly affect the quality of life of the elderly, restricting their mobility and increasing the risk of falls.<sup>[1]</sup>

Static balance, which is maintained when we are standing still, is naturally unstable. Small deviations from the upright position are common due to the force of gravity on the body. However, the human body has continuous correction mechanisms to counterbalance the effects of gravitational force. These adjustments are coordinated by

a complex system involving neural, muscular, joint response, and spatial perception components. The organization of these systems contributing to postural stability is still under study.<sup>[2]</sup>

In Brazil, the demand for Total Knee Arthroplasty (TKA) has been increasing. Between 2008 and 2015, the number of procedures grew at an annual rate of 8.7%. In 2018, the average was 4 procedures per 100,000 inhabitants, representing one TKA for every 3,249 inhabitants.<sup>[1]</sup>

Plantar pressure distribution refers to how the body weight is distributed across the feet during posture, walking, or engaging in physical activities. When there are knee injuries, individuals may adjust how they distribute weight to relieve pressure on the affected joint, thus minimizing pain and discomfort.<sup>[3-5]</sup>

Knee joint injuries can range from sprains and strains to more severe injuries such as ligament tears, cartilage injuries, or osteoarthritis. In elderly individuals with knee injuries, plantar pressure distribution can be significantly affected due to pain, stiffness, and gait changes that often accompany these injuries.<sup>[3-5]</sup>

This study aims to analyze plantar pressure distribution in the feet of elderly individuals diagnosed with unilateral knee osteoarthritis. Additionally, it is important to consider the analysis of elderly individuals' static balance using a plantar pressure platform to understand pressure distribution in the feet's support base area. Therefore, changes in plantar pressure distribution and static balance in elderly individuals with knee osteoarthritis are crucial aspects to understand the impact of this condition on the quality of life and mobility of these patients.

## **METHODOLOGY**

### **Participants**

This study involved the participation of 17 individuals of both genders, all diagnosed with unilateral knee osteoarthritis. The average age of the participants was 71.23 years, with a standard deviation of 1.53 years. Regarding body mass, the mean was 76.26 kg, with a standard deviation of 3.46 kg. As for height, the mean was 161.00 cm, with a standard deviation of 2.06 cm. These anthropometric data are crucial for understanding the sample profile and contextualizing the study on unilateral knee osteoarthritis in the elderly.

### **Inclusion and Exclusion Criteria**

To ensure sample consistency, inclusion and exclusion criteria were defined. Exclusion criteria included the presence of neurological dysfunctions, history of lower limb prosthesis use, and occurrence of deformities or calluses on the plantar surfaces. As an inclusion criterion, participants were required to have a confirmed diagnosis of unilateral knee osteoarthritis, thus ensuring they were within the target group of interest.

### **Ethical Considerations**

All participants received comprehensive information about the study's objectives and procedures before participating. Each participant signed an Informed Consent Form, formalizing their voluntary consent. The research project was approved by the Ethics Committee of the Federal University of Goiás registration number: 6.232.443, ensuring compliance with ethical principles and participant protection.

### Experimental Protocol

Participants were instructed to stand barefoot on a pressure platform, in bipedal support, respecting their natural posture. Data collection was performed using a Barosccan plantar pressure platform (HS Technology, Brasil) recording plantar pressure for 60 seconds, repeated three times, with rest intervals.

The arch index (AI) was used to evaluate plantar parameters and categorize the type of arch. Plantar pressure distribution was analyzed in the rearfoot, midfoot, and forefoot areas, providing a detailed understanding of plantar parameters. Throughout the experimental protocol, the participant's level of pain was measured using the Visual Analog Scale for Pain (VAS).

### Statistical Analysis

The data were analyzed using Minitab 21 software. Normality of distributions and data homogeneity were checked. To determine differences within the group, the non-parametric Tukey test was applied, considering a value of  $p \leq 0.05$  as statistically significant. Results were presented as mean and standard deviation, offering a clear description of the data.

## RESULTS

In this study, the distributions of plantar pressures, arch index, and plantar pain levels during static balance were observed in individuals diagnosed with unilateral knee osteoarthritis. **Table 1** presents the results related to plantar distributions and arch index (IAP).

**Table 1:** Analyzed Variables of Foot Pressure Behavior on the Support Base

	RIGHT FOOT	LEFT FOOT	P VALUE
<b>Arch Index</b>	0.26 ( $\pm 0.30$ )	0.27 ( $\pm 0.30$ )	0.78
<b>VAS</b>	8.29 ( $\pm 2.75$ )	8.29 ( $\pm 2.75$ )	0,68
<b>% Rearfoot Pressure</b>	61.77 ( $\pm 9.68$ )	41.77 ( $\pm 9.55$ )	0.03*
<b>% MIDFOOT PRESSURE</b>	4.71 ( $\pm 6.80$ )	25.01 ( $\pm 6.84$ )	0.01*
<b>% Forefoot Pressure</b>	44.64 ( $\pm 3.80$ )	37.51 ( $\pm 12.14$ )	0.04*

Data are expressed as mean  $\pm$  standard deviation. \* statistical significance using the Tukey test ( $p \leq 0.05$ ). VAS indicates visual analogue pain scale.

No presente estudo, o índice de Arco Plantar revelou valores de 0.26 para o pé direito e 0.27 para o pé esquerdo, indicando uma classificação de pé plano. Apesar dessa classificação comum para ambos os pés, não foram observadas diferenças estatisticamente significativas entre eles nesse aspecto, sugerindo uma semelhança no comportamento do arco plantar.

During the postural control test with both eyes open, the elderly achieved an average score of 8.29 on the VAS scale for both feet, indicating a high level of pain. In this case, no statistically significant differences were observed between the right foot and the left foot during this balance task.

However, when analyzing the distribution of plantar pressure in different areas of the foot, statistically significant differences were identified between the right foot and the left foot. The right foot exhibited a significantly greater distribution of plantar pressure in the rearfoot area ( $p = 0.03$ ) and forefoot area ( $p = 0.04$ ) compared to the left

foot. On the other hand, in the midfoot area, the left foot showed a greater distribution of plantar pressure ( $p = 0.01$ ) compared to the right foot.

These findings indicate that, although no significant differences were observed in pain perception during postural control with both eyes open, there was a notable asymmetry in the distribution of plantar pressure between the right and left feet of elderly individuals with unilateral knee osteoarthritis. This asymmetry may have important implications for the balance and functionality of these patients.

## DISCUSSION

In this study, the distribution of plantar pressure and the plantar arch index (IAP) were analyzed in elderly people diagnosed with unilateral knee osteoarthritis, comparing these results with previous studies involving elderly people without joint problems.<sup>[5,7,9]</sup> Maintaining postural control is fundamental and involves systems such as the vestibular, visual, musculoskeletal, and somatosensory systems. Activities that stimulate these systems can improve postural balance.<sup>[10,11]</sup>

When evaluating pain using the VAS scale, we observed that the elderly participants in this study had an average score of 8.29, indicating high intensity pain. It is important to note that this pain did not vary significantly between knees diagnosed with osteoarthritis. These results are in line with a prospective, randomized, and controlled study carried out by Nacca et al.<sup>[13]</sup>, which did not identify significant differences in VAS scores in patients undergoing knee prosthesis surgery after 8 years of postoperative follow-up.

The plantar arch index is a relevant measure to assess foot health, especially in elderly people diagnosed with osteoarthritis. In our study, the IAP indicated a low plantar arch, with values of 0.26 in the right foot and 0.27 in the left foot, classifying the foot as flat. This implies a smaller than normal curvature in the foot, resulting in greater contact with the ground. This reduced plantar arch can contribute to foot stiffness, decreased mobility, and potentially increase the risk of falls in the elderly.<sup>[5,6,7,8]</sup>

Stiffness in the foot and reduced mobility in the joints can affect the ability to maintain balance. Furthermore, the tendency to pronate the foot (turn the foot inward) due to a low plantar arch can cause misalignment in the lower limbs, impacting posture and gait, which, in turn, increases the risk of falls.<sup>[5,6,7,8]</sup>

During bipedal static balance, we noticed that elderly people diagnosed with unilateral osteoarthritis in the left knee presented a greater distribution of plantar pressure in the forefoot (tips of the feet) and rearfoot (heel) areas of the right foot. This suggests that the overload on the base of support of the feet of the unaffected limb is a strategy of the neuromuscular system to compensate and adjust stability. This adaptation can help preserve balance, but it also indicates the need to monitor foot health and function in patients with osteoarthritis.<sup>[5,6,7,8,14,15]</sup>

Knee osteoarthritis can limit mobility in the elderly, increasing the risk of falls due to restricted range of motion in the knee joint and difficulty in flexing the knee. This limitation in knee flexion can affect the daily activities of elderly people, making balance and mobility crucial issues to be considered.<sup>[1]</sup> These results highlight the importance of evaluating and treating issues related to the plantar arch and plantar pressure distribution in elderly people with unilateral knee osteoarthritis, aiming to improve quality of life and minimize the risks associated with this condition.

## CONCLUSION

Therefore, based on the analyzed results, it can be concluded that elderly individuals diagnosed with unilateral knee osteoarthritis present significant alterations in plantar pressure distribution on their feet, with a higher expression of these alterations observed during the test with eyes closed.

These findings reveal substantial implications in the clinical context, suggesting that the assessment of static balance in this group of patients should be considered as a crucial complementary tool for specialist physicians in therapeutic planning, both conservative and surgical. A deeper understanding of plantar pressure distribution can serve as a valuable resource to guide the selection of the most appropriate intervention strategies aimed at improving the quality of life of these elderly individuals and mitigating the risk of falls, a significant concern in this demographic.

By investing in the assessment and management of static balance, it is possible not only to attenuate the adverse impacts of unilateral knee osteoarthritis but also to promote a substantial improvement in the quality of life and functional autonomy of affected elderly individuals.

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