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Baropodometric profile of patients assisted in a physiotherapy clinic

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ABSTRACT

Background: Computerized baropodometry, a posturographic recording technique used in the diagnosis and assessment of plantar pressure, which records the pressure points exerted by the body on the plantar surface, is an accurate, objective and quantitative examination. Its record is used in the diagnosis and evaluation of plantar pressure, both in static and dynamic positions. **Objective:** Analyze the baropodometric profile of patients in a physiotherapy clinic. **Methods:** A cross-sectional study of documentary character of baropodometry exams registered in the database of a physiotherapy clinic in Teresina (PI), carried out from January 2015 to December 2018. Totaling 193 exams, which include the types of feet, peak plantar pressure and correlation between peak plantar pressure with age, weight, height and BMI. The collected data were analyzed statistically by the software Win Track version 12.0, and presented through tables and figures. In this research, all ethical precepts were carried out in accordance with the resolution of the National Health Council and was approved by the ethics committee. **Results:** There was a higher prevalence of hollow feet (96.89%), showing a greater occurrence of displacement of the center of gravity posteriorly to the right (46.11%), it was found that there was no satisfactory correlation of anthropometric parameters with peak plantar pressure ($p>0.05$). **Conclusion:** It was possible to observe that the examinations evaluated showed a higher prevalence of hollow feet and center of gravity posteriorized to the right. In addition, there was no satisfactory correlation between peak plantar pressure with the variables age, weight, height and BMI.

Keywords: Baropodometry; Balance; Posture; Plantar pressure.

BACKGROUND

The stabilization of the human body in an upright position is due to information from its sensory and sensitive organs in relation to the environment.⁽¹⁾ Postural control and balance consist of the sensory system and musculoskeletal biomechanics, the foot being one of the main sensors of the sensory system.⁽²⁾

According to the concepts of Biomechanics, the foot is classified as: dynamic foot, when as support and static foot, with the function of weight support, making this three-dimensional structure the foundation of support for the body. Satisfactory posture control is defined by the association of the accommodation of the feet on the ground. Tone change causes subtle positional changes in the body that, consequently, triggers tonic changes from the soles of the feet to the head.⁽²⁾

Proper foot biomechanics is important for symmetrical distribution of plantar pressure and maintenance of posture, as well as having an important effect on postural control during orthostatic position and gait. The data obtained in an analysis of plantar pressure help to understand the problems and establish an appropriate form of

treatment for cutaneous, neurological and musculoskeletal disorders.⁽³⁾

Different pathologies that affect the foot structure are diagnosed by studying the footprints. Plantigraphy, which allows the printing on paper of the plantar surfaces of the feet.⁽⁴⁾ Podoscopy is a test that consists of a table with tempered glass top, below it there is a mirror where the plantar surfaces are reflected giving information about the feet⁽⁵⁾. Ways to evaluate plantar impressions are through plantigraphy, podoscopy and also computerized baropodometry, a posturographic recording technique used in the diagnosis and assessment of plantar pressure, both in static and dynamic positions, which records the pressure points exerted by the body on the plantar surface.⁽⁴⁾

Baropodometry is an accurate, objective and quantitative examination, which analyzes plantar pressure on a platform, composed of sensors connected to software for the acquisition of load forces for each foot that aim to measure and compare the pressures developed at different points in the plantar region.⁽⁶⁾

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METHODS

This is a cross-sectional study of documentary character of baropodometry exams registered in the database of a private clinic in Teresina-PI and performed from January 2015 to December 2018. All baropodometric tests in the database were analyzed. The exams were captured by the Win Track-Medicapteurs® platform, 652 mm wide and 1610 mm deep, which has 12,288 sensors, by the Win Track software version 12.0, which contains the types of feet, plantar pressure peaks and contact time with the ground during gait and functional dysfunctions of balance.

The research included the completed baropodometry exams, adult patients aged from 18 years of both genders, who underwent baropodometric examination from January 2015 to December 2018. It was excluded from the work incomplete baropodometry exams, exams of patients with lower limb amputations, active balance dysfunction or any other co-morbidity that could camouflage or increase the real results of the exams.

The data collected were based on the analysis of sample distribution and a Pearson correlation test was performed, which is a measure of adequacy of deviation from normality, which aims to establish whether the sample comes from a population normally distributed, in which it was developed to deal with more numerous samples ($n > 100$) using SPSS (Statistical Package for Social Sciences) version 15.0 and presented through tables. In this research, all ethical precepts were carried out in accordance with the resolution of the National Health Council (NHC) n°466 of December 12, 2012 together with the Data Usage Commitment Term (TCUD), which was approved by the research committee of Faculdade Maurício de Nassau (UNINASSAU) with number 3243317/2019.

Step type classification

To detect the type, anatomical division and regions of the foot in the examination, it was used the foot description according to Valenti⁽⁷⁾, which is classified as hollow foot, when the width of the midfoot impression is less than 1/3 of the forefoot measurement; normal foot, when the width of the midfoot impression corresponds to 1/3 of the width of the forefoot; and flat foot when the width of the midfoot impression is wider than 1/3 of the forefoot.

RESULTS

The baropodometry exams of patients aged 18 years or older registered in the database of a

private clinic located in Teresina (PI) were analyzed. In total, 193 exams were analyzed whose patients had an average age of 42.28 ± 16.92 years, an average weight of 68.84 ± 13.43 kg, and an average height of 163.2 ± 12.57 m. The mean body mass index (BMI) of the sample was 25.6 ± 5.777 kg/m², characterized in the normal range.⁽⁸⁾ In the analysis of the peak plantar pressure values, the mean area of 1034 ± 193.1 cm² of standard error is indicated (Table 1).

Table 1. General characteristics of the sample

Parameters	Mean	Standard Error
Age	42.28	16.92
Weight	68.84	13.43
Height	163.2	12.57
Body mass index	25.6	5.797
Peak plantar pressure (g/cm ²)	1034	193.1

*Note: g: grams; cm2: centimeter square.

Table 2 shows that the variables analyzed showed normal distribution ($p < 0.0001$). Pearson's correlation test was performed based on the sample distribution analysis, the results of which are in the table 3.

Table 2. D'Agostino-Pearson test of normal distribution of samples.

Parameters	Value of p
Age	<0.0001
Weight	<0.0001
Height	<0.0001
Body mass index	<0.0001
Peak plantar pressure (g/cm ²)	<0.0001

*Note: g: grams; cm2: centimeter square.

In the correlation analysis of anthropometric parameters and peak plantar pressure, Pearson's test was used, which measures the degree of linear correlation between two quantitative variables that has a dimensionless index with values between -1.0 and +1.0. The greater the absolute value of the coefficient, the stronger the relationship between the variables. An absolute value of 1 indicates a perfect linear relationship.

In the observation of the type of foot, a greater number of patients with hollow feet were analyzed in the examination, as shown in Figure 1, in which 96.89% had a hollow foot and 3.11% showed a flat foot.





Table 3. Correlation between anthropometric parameters and peak plantar pressure.

Correlation	R ² *	Value of p*
Peak plantar pressure X Age	-0.037	0.605
Peak plantar pressure X Weight	0.178	0.126
Peak plantar pressure X Height	0.111	0.013
Peak plantar pressure X Body mass index	0.095	0.187

DISCUSSION

As shown in table 3, it was found that there was no satisfactory correlation of anthropometric parameters due to standards being within normal limits.⁽⁶⁾ However, unlike the findings of this research, studies show that weight may be correlated with peak plantar pressure, as shown by Bacha, Benetti and Greve⁽⁹⁾, who evaluated sixteen patients of both sexes, before and six months after bariatric surgery. And their results showed that the loss of body weight six months after bariatric surgery caused reductions in the value of the vertical component of the ground reaction force and in the plantar support area in all evaluations of the forefoot and hind foot. In addition, they show that a significant reduction in the load applied to the feet occurs in patients with morbid obesity when there is loss of body weight and a decrease in the BMI because the overload in the musculoskeletal system of people with balance induces abnormal gait patterns, containing loss of mobility, little cadence and imbalance, and these patterns are properly linked to foot diseases.

Almeida et al.⁽¹⁰⁾ also found in a study with 50 women, that there were more numerical indices of plantar pressure in overweight and obese individuals (2.3 +/- 0.4 and 03.2 +/- 1.1). Excess weight causes mechanical stress causing complaints of pain in the feet and ankles. The increase in body weight can overload the longitudinal arch of the foot, where it is the main area of energy absorption and dissipation. The increase in weight in the subject is associated with pain in the foot due to the increase in plantar pressure. The same was demonstrated in the study of Oliveira Junior et al.⁽¹¹⁾ which analyzed 119 patients (67 males: 56%, 52 females: 44%), totaling 238 feet. Of this total of feet, 141 (59.2%) had a hollow foot, respectively.

The search for Gomes et al.⁽¹²⁾ with 66 Ballet dancers aged 15 to 25 years showed a significant predominance of hollow feet (62.1%). The same states that this prevalence in this population group can be explained by the tendency that ballerinas have to rotate their feet outward, shifting their body weight to the outer edge of the foot when in the “en pointe” position, stimulating the formation of the hollow foot.. Yi et al.⁽¹³⁾ in his study, which consisted of a sample of 30 obese subjects, of both genders in which the hollow foot had the highest prevalence, despite being common to overweight, a higher occurrence of flat feet is expected. Some studies suggest that obese subjects show a higher prevalence of flat feet, the overload imposed by body weight on the plantar arch.

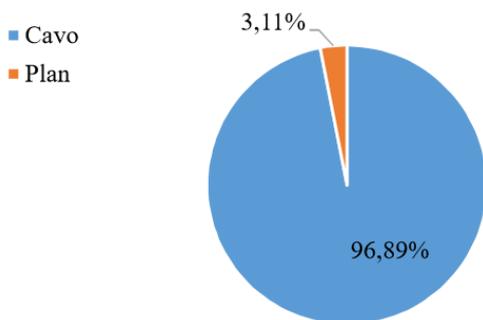


Figure 1. Percentage of types of steps found in the exams analyzed.

*Note: Cavo: Hollow feet; Plan: Flat feet.

The data on the variable center of gravity of the exams analyzed showed a greater occurrence of displacement of the center of gravity posteriorized to the right and centralized posteriorized, as shown in Figure 2.

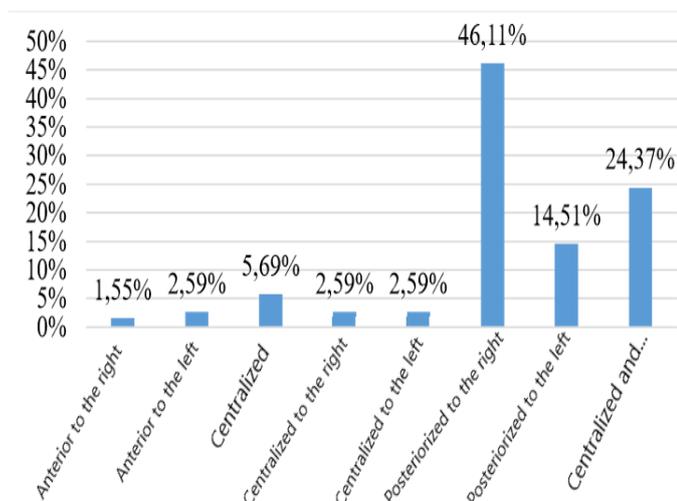


Figure 2. Distribution regarding the location of the center of gravity in the evaluated exams.





However, the research of Nazario, Antos and Avila⁽¹⁴⁾ was performed with 11 subjects with a mean weight of 74 ± 10 kg, in which it was noticed that most of them had flat feet when compared to subjects with normal feet. It was also stated that anatomical characteristics influenced the dynamic pattern of plantar pressure distribution, because subjects with flat feet had a greater contact area in the medial region. This increase occurs due to the hyper-flexibility (depression) presented by the medial longitudinal arch.

The foot is the point of contact that the body has with the ground, making it a transmitter of forces to and from the surface during locomotion, balance and posture maintenance actions. To fulfill these functions, the foot behaves equally with rigidity and flexibility, thanks to its 26 bones and 33 joints that provide mobility in all planes. According to Sánchez, Alarcón, Morales⁽¹⁵⁾ the functionality of the foot cannot be evident without taking into account its structure, aspects that are closely related such as ethnicity, sex, age, body composition, activities of daily living, the use of shoes, among others, indicate the type of foot. Several pathologies of the feet are of biomechanical origin and constantly associated with the type of foot.⁽¹⁶⁾

The method in which postural balance is observed in detail through baropodometry is stabilometry, in which it quantifies the oscillations of the body, it is able to evaluate the projection of the forces of the center of gravity on the support polygon. This circumstance means measuring a body's property of keeping itself stable. In that the results start from an assumption that the closer the subject is to the baseline 0 mm (abscissa and coordinates), the more the posture is stable. On the other hand, the farther the record is from the baselines, the greater the body instability.⁽¹⁷⁾

Baropodometry is essential to understand the importance of plantar proprioceptors, which can cause an inadequate adaptation of posture causing tegumentary and musculoskeletal conflicts. In this way, this technique can be used as a mechanism to measure and evaluate skeletal, muscular and, consequently, postural changes when analyzing postural alignment or control in foot pressure.⁽¹⁸⁾

The latter can be verified in the study of Mantovani et al,⁽²⁾ that evaluated the postural control and plantar pressures of students before, during and after the use of proprioceptive insoles. Fifteen subjects were evaluated and it was found that after one minute of using the insole, it was efficient in postural realignment. Foot functions are dependent on the anatomical arrangement of bones, ligaments and muscles, and dynamically, on the appropriate kinematics of the numerous joints, their movements

are responsible for absorbing impacts, preserving balance and dividing forces. An appropriate biomechanics of the foot is reflected by maintaining posture and a symmetrical distribution of plantar pressure, in addition to having an important effect on postural control.⁽³⁾ The postural system is connected to the control of body balance, which is related to postural captors, among which podal and ocular captors stand out; the data from these captors are evaluated by the nervous system and show as a result the postural muscular adjustment, in order that the body's center of gravity is the command of the global body balance.⁽¹⁹⁾

Proper biomechanics of the foot is achieved by maintaining posture and symmetrical ordering of plantar pressure, in addition to having an important effect on postural control during standing and walking.⁽²⁰⁾ Foot posture involves the influence of sensory information from the body's periphery. This information causes precise changes to occur due to fine adjustments that compensate for the continuous and spontaneous balance of the body in the standing position.⁽²¹⁾

CONCLUSION

The information obtained in this study allows us to conclude that the baropodometric profile of the examinations evaluated presented a higher prevalence of hollow feet and a posterior center of gravity on the right. In addition, there was no satisfactory correlation between peak plantar pressure with the variables age, weight, height and BMI. Further studies are necessary in order to establish a national database in order that, in the future, a normogram be made to be taken as a standard for the Brazilian population and thus facilitate the diagnosis and improve the prognosis of trampling, gait disorders and postural.

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