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ASSESSMENT OF GERIATRIC FOOT USING THE BAROPODOMETRIC P-WALK PLATFORM

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Abstract: *The purpose of this study was to identify foot typology in senior individuals using barapodometry as an evaluation tool. 20 individuals, with a mean age of 74,35 years (15 female and 5 male), were enrolled in the study. Methodology: By utilizing the P-Walk method to assess the 12 variables in both static and dynamic ways, we discovered that there are no statistically significant differences between the two groups. Just 15% of the elderly without neurological problems have a normal foot, while the remaining 85% have a pes cavus. 25% of participants in the Parkinson's disease group have normal feet, 5% have flat feet, and 70% have pes cavus.*

Key words: *elderly, foot typology, Parkinson, baropodometry.*

1. Introduction

Modern technological advances provide healthcare professionals, including physical therapists, additional tools to objectively evaluate patient interventions [9], [11]. These new technologies, such as baropodometric platforms, accelero-meters, and inertial sensors, which provide less expensive, faster, and more efficient clinical and biomechanical examinations of patients, have attracted increasing interest in recent years [1]. The use of baropodometric platforms facilitates the recording of parameters useful in the scientific study of biomechanics and in postural evaluation [6]. Baropodometric data can be used to identify gait disorders and provide a personalized treatment plan. Spatiotemporal gait parameters, such as walking speed, are measured using baropodometric platforms [5].

Baropodometry is a non-invasive method that measures the pressure distribution on the sole while standing or walking [2],[6].

The data collected by baropodometric platforms can be used to analyze the influence of age stages on the static

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distribution of plantar pressure [4], [8], [12]. Foot pressure distribution (FPD) assessment is clinically important because it may identify anatomic foot deformities and guide the diagnosis and treatment of gait disorders and falls [7], [13].

The aim of this study was to identify foot typology in senior individuals using barapodometry as an evaluation tool and to determine if there are any significant differences between the elderly with and without neurological disorders.

2. Methodology

2.1. Subjects

Twenty subjects were recruited for the research, consisting of 15 females and 5 males with an average age of 74.35 years old. Participant characteristics such as their height, weight, and neurological history were assessed to determine eligibility for the study's two groups: one comprised of elderly individuals, without any neurologic illnesses and a second one comprised of ten people diagnosed with Parkinson's disease (Table 1).

Table 1

Anthropometric characteristics of the subjects

Variable	Parkinson Group	Elderly Group
Gender **(F /M)**	7/3	8/2
Age **(year)**	72.7 ± 8.32	76 ± 7.13
Weight **(kg)**	79.4± 23.09	74.10± 13.11
Height **(m)**	1.61± 1.14	1.62± 1.17
BMI	30.43± 6.77	28.13± 3.76

Mean ± standard deviation,
BMI - body mass index.

There were no significant differences between the two groups based on demographic and anthropometric data. The patients were informed about the study and signed an informed permission form, ensuring the confidentiality of the recorded data.

2.2. Instruments

The modular platform system P-WALK (Bioengineering, Milan, Italy) was used to quantify plantar pressure while standing and walking. The device provides quantitative information regarding static and dynamic plantar support, which aids identification of plantar overloads, rotations, and postural asymmetries.

This platform can assess and interpret the plantar pressure distribution, determine if the plantar arch is normal or whether a flat foot or high-arched foot (pes cavus) is present, and perform a stabilometric study. In dynamic circumstances, the force, area, and speed of the foot rolling on the device are also recorded in addition to the evaluation of plantar pressure and plantar arch.

The participant's feet are placed over the lines marked in the center of the platform for doing the static analysis. The patient is told to hold a comfortable posture, concentrate their gaze on a fixed place and remain still for 30 seconds.

For the dynamic analysis, the subject went on the pressure plate with his left foot, and a sequence in dynamics was obtained. The subject repeated this movement with his right foot. The software performs the recording of the movements of the legs in the dynamics starting with the contact phase of the heel, continuing with the unipodal support phase, and ending with the phase of detaching the foot from the ground.

Depending on the contact surface detected in the midfoot, known as the Arch Index, the software places the foot type into one of seven different groups on a scale from 0% to 100%. The arch types are divided into the following categories: Heavy High Arch Foot: between 0% and 7%; High Arch Foot: between 7% and 14%; Light High Arch Foot: between 14% and 21%; Normal Foot: between 21% and 28%; Light Flat Foot: range from 28% to 35% and Heavy Flat Foot: between 42% and 100%.

2.3. Statistical analysis

Statistical analysis was performed after the data from the assessments were exported to Microsoft Excel and processed and interpreted using the statistical tool IBM SPSS Statistics 23 (Statistical Package for Social Sciences). Independent sample T-tests were applied to compare groups based on age, body mass, and height. The Shapiro-Wilk test for verifying the normality of the data distribution and the homogeneity of variance test (Levene's) were the first tests used in statistical analysis.

3. Results

3.1. Static and dynamic baropodometric analysis among the two groups

Table 2 shows the results of the descriptive statistical analysis that includes the mean, the deviation, and the standard error, values obtained from the measurements of the plantar pressures both static and dynamic. From the 12 analyzed variables we can see that between the two groups there are no statistically significant differences for any of the analyzed variables.

The analyzed variables were Left/Right Foot Arch Index; Left/Right weight load index; Left/Right Foot Arch Index dynamic.

Left/Right Surface_ cm^2 static and dynamic and Time left/right foot (ms)

We began with the assumption that the two groups differ statistically. Nevertheless, following assessments, the null hypothesis was shown to be false since all the variables that were examined had p values greater than 0.005.

Table 2

Descriptive Statistics and Independent t-Test Results for Elderly and Parkinson's Disease Group

Variables	Group	Mean	SD	Std error	*t*	*P* (Significant when < 0.05)
Left Foot Arch Index	EG	14.37	6.49	2.05	-.897	***0.382***
	PD	17.19	7.50	2.37	-.897	***0.382***
Right Foot Arch Index	EG	10.85	8.01	2.53	-1.052	***0.307***
	PD	14.84	8.94	2.83	-1.052	***0.307***
Left weight load index	EG	54.13	3.94	1.25	.740	***0.469***
	PD	52.99	2.86	0.91	.740	***0.469***
Right weight load index	EG	45.87	3.94	1.25	-.740	***0.469***
	PD	47.01	2.86	0.91	-.740	***0.469***
Left Foot Arch Index	EG	18.20	7.90	2.50	-1.001	***0.330***
dynamic	PD	21.44	6.51	2.06	-1.001	***0.331***
Right Foot Arch Index	EG	22.55	4.44	1.40	.993	***0.334***
dynamic	PD	19.83	7.46	2.36	.993	***0.337***
Surface_ left cm²	EG	86.60	20.05	6.34	-.361	***0.722***
	PD	89.90	20.81	6.58	-.361	***0.722***
Surface_ right cm²	EG	73.00	14.05	4.44	-.681	***0.504***
	PD	78.80	22.96	7.26	-.681	***0.506***
Surface_ left dynamic cm²	EG	111.90	17.36	5.49	-.890	***0.385***
	PD	118.70	16.80	5.31	-.890	***0.385***
Surface_right dynamic cm²	EG	115.30	16.79	5.31	-.581	***0.568***
	PD	119.90	18.56	5.87	-.581	***0.568***
Time left (ms)	EG	1138.00	391.32	123.75	-.926	***0.367***
	PD	1311.00	442.33	139.88	-.926	***0.367***
Time right (ms)	EG	1147.00	283.86	89.77	-1.218	***0.239***
	PD	**1434.00**	**688.67**	**217.78**	**-1.218**	***0.247***

Table 2 presentsthe mean scores and standard deviations for each variable in Elderly and Parkinson's Disease Group, as well as the t-value, degrees of freedom, and p-value for each independent sample t-test.

Table 3

Values recorded after the assessment of static plantar pressures

ID	Group	STATIC ARCH FOOT INDEX (%)	
		Left	RIGHT
1	EG	5.54	**0.83**
2	EG	16.12	**3.31**
3	EG	10.5	**11.46**
4	EG	12.07	**3**
5	EG	10.19	**5.38**
6	EG	24.17	**22.48**
7	EG	15.74	**7.99**
8	EG	19.9	**20.21**
9	EG	6.64	**13.39**
10	EG	22.86	**20.41**
11	PD	17.38	**20.36**
12	PD	26.37	**21.59**
13	PD	20.16	**21.2**
14	PD	14.37	**10.53**
15	PD	13.31	**7.31**
16	PD	5.01	**2.24**
17	PD	11.8	**16.18**
18	PD	11.44	**0.87**
19	PD	22.57	**25.12**
20	PD	29.45	**23**
Mean		**15.78**	**12.84**
S.D.		**6.98**	**8.51**

EG, Elderly Group, PD, Parkinson's

3.2. P-WALK Static analysis

As we can see in Table 3, according to the criteria of the P-Walk software, the subjects of the two groups recorded very different values of the plantar arches. These range in the elderly group from 0.83% heavy high arch foot to 24.17% normal plantar arch. In the group of those with Parkinson's disease, the values range from 0.87% to 29.45% slightly flat foot.

Thus, out of the 10 evaluated subjects of the elderly group, only 1 subject has normal feet (left, right), and most of them have a plantar arch on the left foot from very arched to slightly arched (8) 1 subject showing a normal left plantar arch while the right foot is slightly arched. For the right foot, 4 subjects present a very high plantar arch (heavy arch) while 5 subjects present a degree of medium to slightly arched index (high/light arch), and only 1 subject with a normal right foot.

In the group of those with Parkinson's disease (PD) of 10 subjects, for the left foot, 1 subject has a normal plantar arch, 1 subject has a slightly flat plantar arch, and the remaining 8 subjects have a

degree of arching varying from very arched to slightly arched.

Regarding the plantar arch of the right foot, 4 subjects have a normal foot, and 6 subjects have an index of the plantar arch from light to very high (light high arch foot/heavy high arch foot).

Arched foot (pes cavus), normal foot, and flat foot (pes planus) are the three major classifications that result from grouping the seven software types. Just 15% of the elderly group's feet are considered normal, and 85% have pes cavus based on these three classifications. 25% of the individuals in the PD group have normal feet, 5% have flat feet, and 70% have pes cavus.

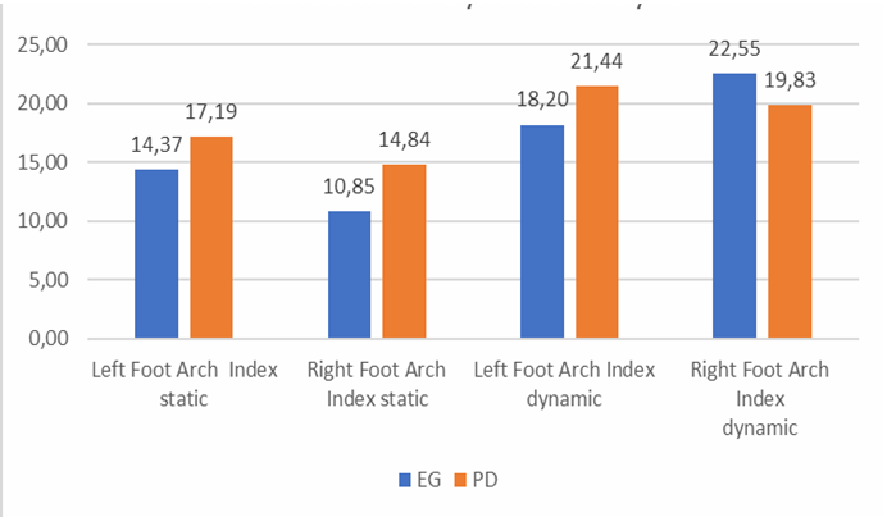

Fig. 1. *P-Walk Static vs. Dynamic Analysis*

3.2. P-WALK Dynamic analysis

Following the dynamic analysis, among the elderly group, the means recorded for the left and right arch index were 18.19 ± 7.90, respectively 22.55±4.44, the values ranging from 5.69% (pes cavus) to 29.99% (pes planus). For the Parkinson group, the means recorded for the left foot arch index was 21.44 ± 6.51, and for the right foot 19.83±7.46, the values ranging from 6.33% (pes cavus) to 29.54% (pes planus).

4. Discussions

Static and dynamic analysis using P-Walk platform showed that there were no statistically significant differences between the two groups for any of the 12 analyzed variables.

Although most studies [3],[10],[14] state that with age, the plantar arch sags, elderly people presenting with flat feet, in our research, after static analysis, the subjects presented pes cavus. In the elderly group, only 15% have a normal foot, while 85% have a pes cavus. In the PD group, 25% of subjects have a normal foot, 5% flat, and 70% pes cavus. After the two assessments carried out, the static and the dynamic one, we could notice a difference regarding the change in the

plantar arch during walking. If in the static analysis, the percentage of subjects with a normal foot was 15% for EG and 25% for PD, in the dynamic analysis this percentage changed considerably, thus for the EG it increased to 65% and for the PD group it increased to 60%. For the other categories, 5% of the elderly group have flat feet and 30% have pes cavus. For the PD group, 5% have flat feet, and 35% have pes cavus.

This study's limitations are due to sample size because it was relatively small; it is difficult to extrapolate the results to a broader group of older individuals. A wider population with a major impairment, including those who are at risk of falling, should be used for future investigations.

5. Conclusions

The identification of foot typologies through correct assessment methods is the basis for establishing a diagnosis and subsequently choosing the optimal treatment option.

Baropodometric assessment is a valuable method for evaluating foot function and detecting various foot typologies.

Further research on a broader sample of senior individuals is needed to better understand how different types of feet impact the development of foot disorders among elderly individuals. The findings of these studies have the potential to enhance the quality of life for many elderly people while also reducing the burden of foot disorders on healthcare systems.

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