(RESEARCH ARTICLE)

Evaluation of the type of plantar footprint in a public institution in Cuenca

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Abstract

To identify the type of plantar footprint in adolescents between 10 and 15 years of age in a public institution in Cuenca. Methods: The study was quantitative, descriptive and cross-sectional. The type of plantar footprint was determined by means of a photo-podoscope. Data were tabulated using Excel and SPSS 22.0. The population was selected by non-probabilistic sampling, evaluating 75 students who met the inclusion and exclusion criteria. Results: Within the population studied a higher percentage of pes cavus was found with 56% in the right foot and 45.3% in the left foot. In the right foot there was a higher percentage of pes cavus in women (61.9%) than in men (38.1%); in the left foot, the normal/cavus foot predominated in men (90%) and in women the pes cavus foot (76.5%). In the relationship between plantar footprint and age, in the right foot there was 23.8% of pes cavus at the age of 10 years and in the left foot 29.4% at the age of 12 years. Finally, in relation to plantar footprint and Body Mass Index (BMI), in the right foot 73.7% of pes cavus was observed in normal weight and in the left foot 67.6%. Conclusions: The predominant plantar footprint type in the students evaluated was pes cavus.

Keywords: Plantar Footprint; School Children; Flat Foot; Pes Cavus; Photo-Podoscope

1. Introduction

The feet are the support base of the human body and thanks to its multiple structures such as bones, ligaments, tendons, muscles and nerves, they allow us to perform multiple activities, being able to support our body weight, reaching a force of 120% of our weight during ambulation and approximately 275% during running. The distribution of foot loads during weight bearing is determined as follows: heel 60%; midfoot 8%, forefoot 28% and toes 4% (1).

In addition, it is constituted by a medial longitudinal arch, a lateral longitudinal arch and a transverse arch, where its main function is the absorption and cushioning of the pressure of the loads when the foot contacts the surface of the ground (2). These arches are of great importance because they are responsible for the shape of the plantar footprint, where this is characterized by being the image of the surface of the foot that contacts the ground (3), and as we grow it tends to change. At the age of 4 to 5 years the child's foot has a flattened shape and as it develops, the medial longitudinal arch intensifies being characteristic at the age of 6 to 8 years (4, 5), and it is not until 10 years of age that children present a fully mature and formed foot, at which time the characteristic foot type of the child can be defined (6, 7).

When the medial longitudinal arch is altered, the distribution of loads is modified causing an imbalance in the structure of the foot, which leads to an alteration of the plantar footprint. The latter can be affected by extrinsic factors such as the type of footwear or the place of residence, as well as by intrinsic factors such as sex, age, size and weight (8). Within the modifications that can generate the alteration of the arch in the footprint we have two characteristic types: flat foot, which is a decrease of the arch presenting a depression in the plantar vault, while the pes cavus, is an increase in both altitude and amplitude of the arch (9).

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Therefore, once the arch of the foot is developed, it is possible to know by means of the evaluation if there is any alteration or not, since if they are present, these change the morphology and biomechanics of the same, modifying the proper functions that the foot provides, so it is necessary to identify the type of plantar footprint of school children for a timely action by the health area, and this is why, our research question is the following: "What is the most frequent type of foot in school children from 10 to 15 years of age in a public institution of the city of Cuenca?".

The ages between 10 to 15 years are a suitable age range to evaluate the plantar footprint due to the maturation and complete development of the same, so it will allow us to obtain reliable and safe data, resulting in the characterization of the most common type of foot in the population. To achieve this, there is an innovative device called photo-podoscope, which supplants the primitive methods, being easy to use and reliable, allowing us to obtain accurate data on the type of footprint of the person being evaluated (10, 11).

2. Methods

The study is quantitative, descriptive and cross-sectional. The research was carried out with 75 students where the inclusion criteria were: schoolchildren belonging to the institution, schoolchildren between 10 and 15 years of age, schoolchildren with the authorization of parents or legal guardians, schoolchildren who participate voluntarily, while the exclusion criteria were: schoolchildren with any disability (visual, auditory or physical), schoolchildren with any malformation in the lower limbs, schoolchildren with neuromusculoskeletal diseases or injuries, schoolchildren who have had any surgical intervention in the lower limbs. The study population was selected by non-probabilistic sampling and to obtain data, a TCS electronic scale was used to take weight and height measurements, which was calibrated every 5 students, and for the evaluation of the plantar footprint, a photo-podoscope was used to capture images of the footprint together with a DELL Inspiron 15 3000 laptop computer with the Hernández Corvo Index program to characterize the type of foot. The data were processed and tabulated using Microsoft Excel and SPSS 22.0. Quantitative variables were analyzed using central tendency statistics such as mean, median and mode, while qualitative variables were represented by simple tables, percentages and frequencies.

As part of the procedure, the first thing that was done was training in the use of the photo-podoscope, after which each student was given informed consent and assent to participate in the research voluntarily. During the evaluation, a form was used for data collection and weight and height measurements were taken with the electronic scale and the BMI was analyzed according to percentiles, which were calculated from the growth charts for children and adolescents; in addition, an assessment of the plantar footprint was made using the photo-podoscope by placing the feet on it and images were captured with the help of a computer in which the program was installed. Finally, the data obtained were processed and tabulated using Excel and the SPSS 22.0 program, where the following results were obtained.

3. Results

A total of 75 legal guardians and their children gave their informed consent and assent to be included in the study, and a total of 150 feet were examined to determine the type of plantar footprint each child possessed.

Table 1 Distribution of students evaluated according to the type of right and left plantar footprint. Period 2022-2023

Type of footprint	Right plantar footprint		Left plantar footprint	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	4	5.3	5	6.7
Flat/normal foot	3	4	1	1.3
Normal foot	7	9.3	9	12
Normal foot/cavity	13	17.3	10	13.3
Pes cavus	42	56	34	45.3
Strong pes cavus	6	8	10	13.3
Extreme pes cavus	0	0	6	8
Total	75	100	75	100

Source: IBM SPSS 22.0 database

Interpretation: most of the students present an altered plantar footprint, where the cavus foot is the predominant one, being shown in 56% of the right feet, while in the left foot it is shown in 45.3%. The prevalence of flat feet is 5.3% in the right foot, while in the left foot it is 6.7%. There is only a small percentage of normal feet, 9.3% in the right foot and 12% in the left foot.

Table 2 Distribution of students evaluated according to the relationship of the type of right plantar footprint and sex. Period 2022-2023

Right plantar footprint				
Type of footprint	Sex			
	Man		Woman	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	1	25	3	75
Flat/normal foot	0	0	3	100
Normal foot	6	85.7	1	14.3
Normal foot/cavity	6	46.2	7	53.8
Pes cavus	16	38.1	26	61.9
Strong pes cavus	3	50	3	50
Extreme pes cavus	0	0	0	0

Source: IBM SPSS 22.0 database

Interpretation: with respect to the relationship between the right plantar footprint and sex, the most relevant is the pes cavus, occurring in men (n=16) with 38.1%, while in women (n=26) with 61.9%. This indicates that women have a greater alteration in their plantar footprint.

Table 3 Distribution of students evaluated according to the relationship of the type of left plantar footprint and sex. Period 2022-2023

Left plantar footprint				
	Sex			
Type of footprint	Man		Woman	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	2	40	3	60
Flat/normal foot	1	100	0	0
Normal foot	5	55.6	4	44.4
Normal foot/cavity	9	90	1	10
Pes cavus	8	23.5	26	76.5
Strong pes cavus	4	40	6	60
Extreme pes cavus	3	50	3	50

Source: IBM SPSS 22.0 database

Interpretation: with respect to the relationship between the left plantar footprint and sex, in men the most relevant is the normal/cavus foot (n=9) with 90%, and with respect to women it is the cavus foot (n=26) with 76.5%. This indicates that women have a greater alteration in their plantar footprint.

Table 4 Distribution of students evaluated according to the relationship between the type of right plantar footprint and age. Period 2022-2023

Type of footprint	Right plantar footprint					
	Age					
	10		11		12	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	3	75	0	0	1	25
Flat/normal foot	2	66.7	0	0	1	33.3
Normal foot	1	14.3	3	42.8	2	28.6
Normal foot/cavity	3	23.1	3	23.1	5	38.4
Pes cavus	10	23.8	9	21.4	9	21.4
Strong pes cavus	1	16.7	2	33.3	2	33.3
Extreme pes cavus	0	0	0	0	0	0

Type of footprint	Right plantar footprint					
	Age					
	13		14		15	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	0	0	0	0	0	0
Flat/normal foot	0	0	0	0	0	0
Normal foot	0	0	1	14.3	0	0
Normal foot/cavity	1	7.7	1	7.7	0	0
Pes cavus	7	16.7	5	11.9	2	4.8
Strong pes cavus	1	16.7	0	0	0	0
Extreme pes cavus	0	0	0	0	0	0

Source: IBM SPSS 22.0 database

Interpretation: with respect to the right plantar footprint and age, in 10-year-old students there is a higher prevalence of pes cavus (n=10) with 23.8%, while at 15 years of age it decreases, presenting only 4.8% (n=2), indicating that there is a greater number of pes cavus at the age of 10 years.

Table 5 Distribution of students evaluated according to the relationship between the type of left plantar footprint and age. Period 2022-2023

Left plantar footprint						
Type of footprint	**Age**					
	10		11		12	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	2	40	0	0	2	40
Flat/normal foot	1	100	0	0	0	0
Normal foot	3	33.3	4	44.4	2	22.2
Normal foot/cavity	4	40	2	20	1	10
Pes cavus	9	26.5	7	20.6	10	29.4
Strong pes cavus	1	10	2	20	3	30
Extreme pes cavus	0	0	2	33.3	2	33.3

Left plantar footprint						
Type of footprint	**Age**					
	13		14		15	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	0	0	1	20	0	0
Flat/normal foot	0	0	0	0	0	0
Normal foot	0	0	0	0	0	0
Normal foot/cavity	2	20	0	0	1	10
Pes cavus	3	8.8	4	11.8	1	2.9
Strong pes cavus	3	30	1	10	0	0
Extreme pes cavus	1	16.7	1	16.7	0	0

Source: IBM SPSS 22.0 database

Interpretation: with respect to the left plantar footprint and age, in this case, in 12-year-old students there is a higher prevalence of pes cavus (n=10) with 29.4%, while at 15 years of age it decreases with only 2.9% (n=1), indicating that there is a greater number of pes cavus at the age of 12 years.

Table 6 Distribution of students evaluated according to the relationship between the type of right plantar footprint and BMI. Period 2022-2023.

Right plantar footprint						
Type of footprint	**BMI**					
	Normal		Overweight		Obesity	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	1	25	2	50	1	25
Flat/normal foot	2	66.7	0	0	1	33.3
Normal foot	5	71.4	2	28.6	0	0
Normal foot/cavity	8	61.5	3	23.1	2	15.4
Pes cavus	31	73.7	6	14.3	5	12
Strong pes cavus	3	50	1	16.7	2	33.3
Extreme pes cavus	0	0	0	0	0	0

Source: IBM SPSS 22.0 database

Interpretation: with respect to the relationship between the right plantar footprint and BMI, 73.7% (n=31) of cavus feet were in the normal weight category, 14.3% (n=6) were overweight and 12% (n=5) were obese, indicating that there were more children with normal weight.

Table 7 Distribution of students evaluated according to the relationship between the type of left plantar footprint and BMI. Period 2022-2023

Left plantar footprint						
Type of footprint	**BMI**					
	Normal		Overweight		Obesity	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Flat foot	3	60	1	20	1	20
Flat/normal foot	1	100	0	0	0	0
Normal foot	6	66.7	2	22.2	1	11.1
Normal foot/cavity	4	40	2	20	4	40
Pes cavus	23	67.6	7	20.6	4	11.8
Strong pes cavus	8	80	1	10	1	10
Extreme pes cavus	5	83.3	1	16.7	0	0

Source: IBM SPSS 22.0 database

Interpretation: with respect to the relationship between the left plantar footprint and BMI, pes cavus is present in 67.6% (n=23) in normal weight, 20.6% (n=7) in overweight and 11.8% (n=4) in obesity, indicating that there is a greater number of children with normal weight.

4. Discussion

The evaluation of the plantar footprint of school children aged 10 to 15 years using the photo-podoscope showed that the most frequent type of foot was pes cavus, with 56% of right feet and 45.3% of left feet. These data agree with the study by Castro Serpa D. et al. (2) who mentioned that in both the right foot (49.1%) and the left foot (46.2%) there was a higher percentage of pes cavus in their study population.

On the other hand, with respect to sex, the study by Castro Serpa D. et al. (2) indicates that in women there is a higher percentage of pes cavus with 56.4% in the right foot and 47.3% in the left foot, while in men, the right foot has 41.2% and the left foot 42%. This study presents similar data to our findings, since we obtained a high percentage of pes cavus in women, with 61.9% in the right foot and 76.5% in the left, while in men, the percentage of the right plantar footprint was 38.1% and 23.5% in the left.

Arco-Luna J.A. et al. (12), indicate that the age with the highest prevalence of pes cavus is 10 years, with a total of 26 cases, while as the years go by, this frequency decreases, with only 1 case at the age of 13 years. These results are similar to our research, since at the age of 10 years there was a higher prevalence with 9 cases in the right foot, while in the left foot, the age of 12 years showed a total of 10 cases, however, at the age of 15 years, there was a significant decrease of cases with pes cavus.

The relationship between the type of plantar footprint and BMI in the study by Castro Serpa D. et al. (2) shows that individuals with normal weight have pes cavus, with a percentage of 30.2% in the right foot, 1.8% in overweight and 7.1% in obesity, while the left foot has 30.7% in normal weight, 10.4% in overweight and 5.2% in obesity. Our findings are similar since in the right plantar footprint we obtained a total of 73.7% with pes cavus in normal weight, 14.3% overweight and 12% obese, while in the left footprint we obtained 67.6% of pes cavus in normal weight, 20.6% overweight and 11.8% obese.

The latter data (relationship between plantar footprint and age and BMI) may be due to the fact that, both in the articles cited and in our study, the number of participants in the different age and weight categories varied, so it would be very useful if in a future study the number of participants, according to the study variables, were the same or close to the same in order to obtain more accurate results.

5. Conclusion

Of the 75 students who participated in the study, it was possible to conclude that: there was a higher percentage of bilateral pes cavus; the predominant sex in presenting foot alterations was female, where pes cavus was more relevant; the age of 10 years presented a higher prevalence of pes cavus in the right lower extremity, while in the left it was in the age of 12 years; and, there were more cases of pes cavus in normal weight than in the other categories.

Bioethical Aspects

In order to carry out the research, as a first step, the respective permission was requested from the principal of the institution, and subsequently, from the parents/legal guardians and students through informed consent and assent. The research was free of charge since the device to be used was provided by the Telemedicine Laboratory of the University of Cuenca. All data and results obtained in the study were for the exclusive use of the researchers. On the other hand, during the printing of the footprint, the participant could have presented some fear when exhibiting his feet, in addition to the fact that, at the moment of placing himself on the photo-podoscope, he could have slightly lost his balance, for which reason all the safety measures were taken. With respect to the benefits, the participant had the opportunity to know the type of foot he/she had, and in the case of any type of alteration, recommendations were given to avoid it. Our study had no conflict of interest on the part of the authors.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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