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The Prevalence of Pes Planus Among Yorubas of the Southwest of Nigeria – A Pilot Study

Akinlolu Abdulazeez ADELAJA*, Mbaka GODWIN, Ayannuga Ayodeji OLUGBENGA, Shallie Philemon DAWUDA, Akpan Hellen BASSEY, Adefule Adebayo KEHINDE and Adedayo Babalola EJIWUNMI

Department of Anatomy, Faculty of Basic Medical Sciences, Olabisi Onabanjo University, Remo Campus, Ikenne, Ogun State, Nigeria

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ABSTRACT: A total of 207 Yorubas of Nigeria comprising of 115 males and 92 males volunteered for the study. All volunteers involved in the study had no deformities or previous fractures of the lower extremities' especially of the foot. They were aged between 13 and 32 years. For each volunteer, bilateral plantar prints were obtained using the ink procedure method. All prints were counted, separated into sexes and the incidence of flat footedness calculated for both sexes. Employing the visual method as a predictor of pes planus, 34 individuals were bilaterally flatfooted comprising of 17 males and 17 females. The overall prevalence of pes planus was found to be 10.8%; with a prevalence of 14.8% amongst males and 18.5% amongst females. Overall prevalence was found to be more than those of other African populations earlier studied i.e Port-Harcourt (2.88%) and Uganda (3.88%). When the footprint ratio or arch index method was employed, 115 individuals were bilaterally flat arched (flatfooted), comprising of 98 males and 87 females. The prevalence of pes planus was found to be 65.22% amongst males and 94.60% amongst females. The overall prevalence of pes planus using footprint ratio was 89.37%, which was more than that of any other population earlier reported employing same method i.e Kenya 43.1% and USA (25%). No study in Nigeria has earlier employed the footprint ratio as a predictor of pes planus. Further studies should be carried out among other tribes in Nigeria using the visual, planimeter and footprint ratio methods.

Key Words: Visual method, Arch index, Yoruba, Nigeria, Pes planus.

Introduction

Man is adapted to continuous erect posture and locomotion to a degree not reached by other mammals (1). For these purposes, the foot has two important functions: to support the body weight as a result of the upright posture and to serve as a lever to propel the body forward in walking and running (2). The foot is able to carry out these functions because it is shaped like an arch.

*To whom correspondence should be addressed.
E-mails: a3laja@yahoo.com, a3ade@myself.com
Phone Number: +2348062765308

The foot arches are often said to be mainly dependent on osseous shapes and ligamentous ties, the associated muscles, playing a secondary role (3). But clinical experience, points to muscular insufficiency as the commonest cause of flat foot in which ligaments elongate and bones, in consequence, alter in shape (2). Some authors describe the term flatfoot (pes planus) as a nebulous mixture of anatomical variations as well as a small core of pathological conditions, but no study has objectively defined flatfoot (4, 5).

Pes planus is a condition where the arch or instep of the foot collapses and comes in contact with the ground. In some individuals, this arch never develops. It is normal in children due to fat deposit. The symptoms include the absence of positive medial longitudinal arch of the foot when standing, foot pain and an excessive shifting of the heel away from the midline of the body. Flat feet may be associated with aversion of the foot and a leaning inward of the ankle bones toward the midline. Most flat feet do not cause pain or other problems. Flexible flat feet that are painless do not require treatment. If pain due to flexible flat feet occurs, an orthotic (arch supporting insert in the shoe) can bring relief. With the increased interest in running, many shoe stores carry shoes for normal feet and pronated feet. The shoes designed for pronated feet make long distance running easier and less tiring as they correct for the positional abnormality. The prevalence of pes planus has been found to vary within and between races, hence the need for this study.

The use of footprints has been recommended in assessing foot structure characteristics such as arch height (6 - 8). However, this view is not uniformly held. Other authors (9 – 11), have argued that footprints are not good indicators for foot type since other than arch height, other factors, especially muscles, soft tissues, and the axial rotation of the tibia, may influence it. On the other hand, Cavanagh and Rodgers, 1987 (6) have shown that the arch index (defined as the ratio of the area of the middle third of the toeless footprint to the total footprint area) is useful in assessing the structural characteristics of the foot when the dynamic footprints of the subjects are used. The arch index has also been shown to be a valid predictor of arch height by McCrory et. al 1997 (8). They showed that the arch index was strongly associated with navicular height as measured by radiography ($r = 0.67$). Moreover, the arch index of a given population can be used to determine the incidence or prevalence of flat footedness in the population (4, 5).

Reports on the incidence or prevalence of pes planus are available for Caucasians (12 - 14), and a few African studies of Nigerians and Ugandans (15, 16) using planimetry and visual methods respectively, for their estimates and a Malawian study that employed the foot print ratio as a predictor of pes planus (17). Nigeria with a population of over 115 million, is easily the most populous of all African countries and the largest black nation in the world (26). Nigerian studies would, therefore, probably present a more accurate report on the prevalence of pes planus among Africans. None of the studies on the incidence of pes planus in Nigerians employed the foot print ratio method. The aims of the present study were to determine the arch index, classify the foot arch type, and report on the incidence of pes planus in indigenous Nigerians employing both the visual and the foot print ratio methods. This information would help foot and ankle surgeons and sports clinicians in managing patients with abnormal foot structure and may enable one to predict the likelihood of symptoms later in life (7). Our findings are discussed in the light of previous reports from other countries using similar methods.

Materials and Methods

The Visual Method

A total of 207 individuals comprising of 115 males and 92 males volunteered for the study. All volunteers involved in the study had no deformities or previous fractures of the lower extremities' especially of the foot. They were aged between 13 and 32 years. For each volunteer, bilateral plantar prints were obtained using the ink procedure method (18). All prints were clear enough to be classified into normal or flat as shown in Fig 1. All prints were counted, separated into sexes and the incidence of flat footedness calculated for both sexes.

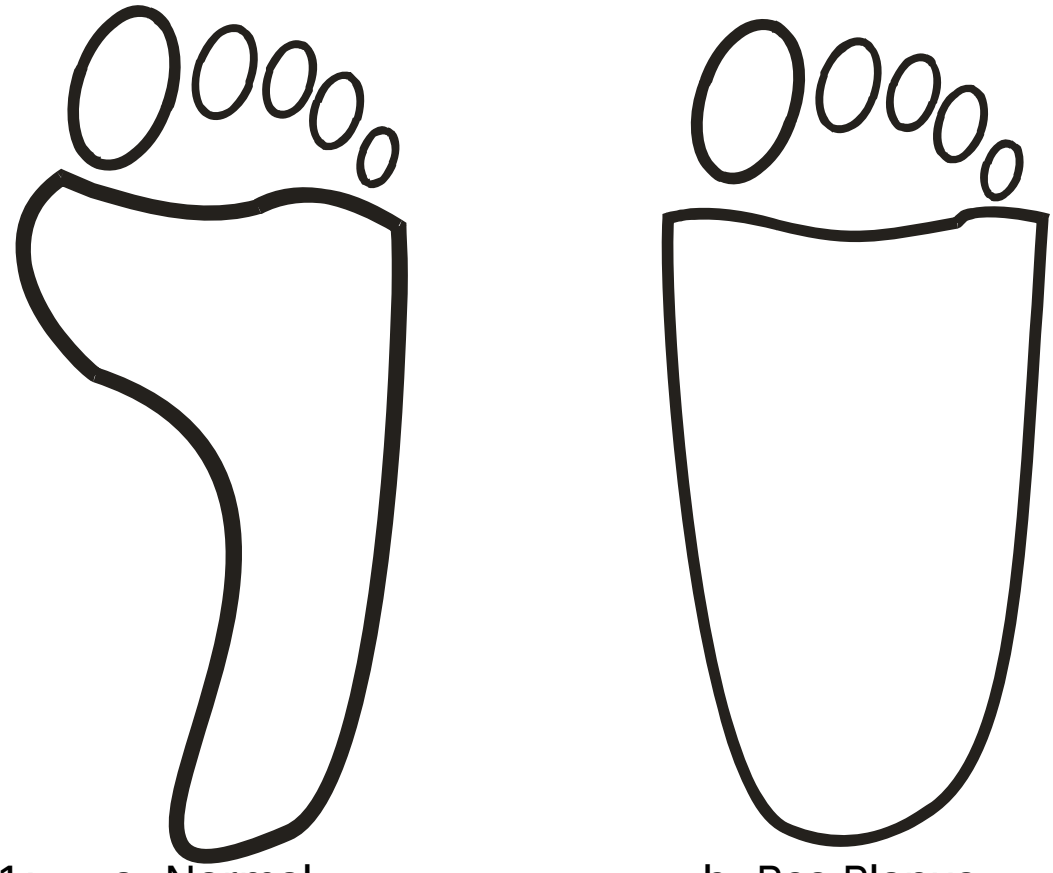

Fig. 1: a. Normal b. Pes Planus

The Footprint Ratio Method

Dynamic footprints were taken from all 207 individuals used in this study. All subjects were confirmed to be free from foot pain or discomfort in normal weight bearing activities. The subjects stepped on an ink-soaked cloth followed by walking on clean A3 papers as described by Cavanagh and Rodgers (6). The foot was then trisected (excluding toes) into three equal lengths, consisting of the forefoot, midfoot and hindfoot and each area was calculated using a grid with 1-cm^2 boxes. The arch index was calculated from the ratio between the midfoot area and the whole foot area (fig 2). To test for reliability a pilot run of the method was conducted on 10 subjects on 2 successive days. The arch indices (AI) were obtained and the data from these two trials were analyzed separately by the same investigators. The within-day correlation of AI was .96 and the between – day value was .94, and these results appeared reliable.

Using the indices, the arches were classified into high, normal and low, and the incidence of flat footedness was compared with results from previous studies. The arch index $AI \leq 0.21$ was indicated as high arch, $0.21 < AI < 0.26$ as normal arch, while $AI \geq 0.26$ was designated as a flat arch.

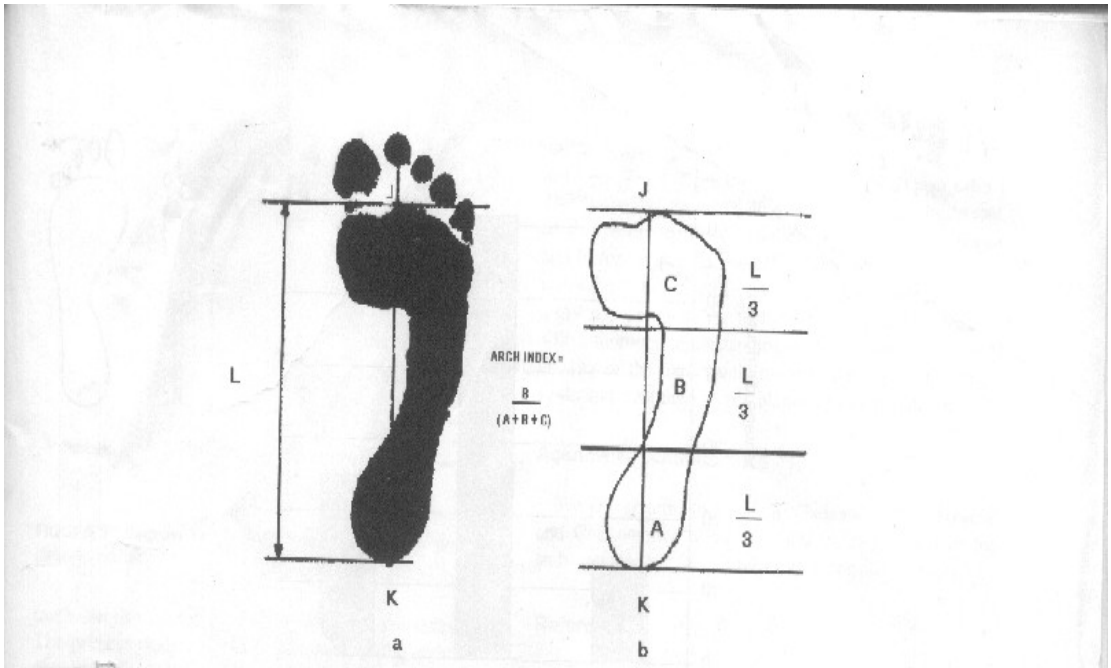

FIGURE 2 Diagrams of the foot to illustrate how the arch index was calculated. *a*, The points J and K represent the length of the footprint (L) excluding toes. *b*, A, B, and C represent equal thirds of footprint divided by parallel lines perpendicular to line JK. The arch index is calculated as the ratio of the midfoot area (B) to the area of the entire footprint excluding the toes (A + B + C).

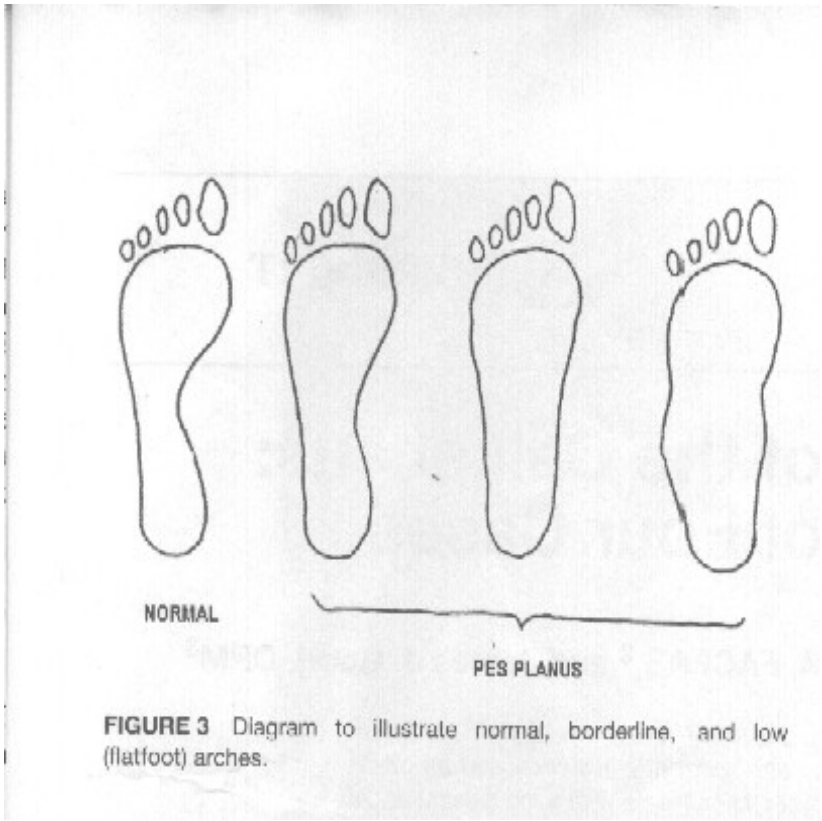

FIGURE 3 Diagram to illustrate normal, borderline, and low (flatfoot) arches.

Results and Discussion

The results are shown in Tables 1 – 3. The questions of evaluating the structure, shape and dynamic functions of the foot have interested foot and ankle surgeons and sport clinicians for a long time. This is partly because the human foot shows such a wide range of structural variations (6). Apart from gross anatomical and radiological methods, studies on the foot print have added a new dimension to the list of physical anthropometric methods currently employed. This method is simple, noninvasive, and cheap, and yet reliable in providing information about the foot. The 1987 report by Cavanagh and Rodgers (6) and by McCrory et. al, 1997 (8) resolved that the dynamic as opposed to the static foot arch evaluated foot function and pathology better.

The overall prevalence of pes planus was found to be more than a Port-Harcourt school pupil population with an overall incidence of 2.82% (15) and that of a Ugandan student population with an overall incidence of 3.88% (16). When footprint ratio or arch index method was employed, the overall incidence reported in this study was found to be more than that of any other population earlier reported, including those that employed the footprint ratio method (Table 3) i.e of Kenya (432 per 1,000 population) (23), of Tanzania (203 per 1,000 population) (23) and of Malawi (242.6 per 1000 population) (17) of Turkey (30 per population) (25) and USA (250 per 1,000) (6).

The prevalence of pes planus was found to be higher in females (18.48% using the visual method and 94.57% using the arch index method) than males (14.78% and 85.22% respectively). The possible explanation for this may be because females tend to have smaller bones and less bulky muscles. Since both factors help in the maintenance of the arches of the foot females are, therefore, more prone to developing pes planus.

The prevalence of pes planus was found to reduce in older subjects compared to younger subjects in both sexes. Using the visual method, the prevalence of pes planus in males reduced from 16.18% (in the 13 – 19 age group) to 13.89% (in the 20 -26 age group) and 9.09% (in the 27 -32 age group). However, in females, the prevalence of pes planus increases from 17.14% (in the 13 – 19 age group) to 22.22% (in the 20 -26 age group) and 25% (in the 27 -32 age group). This observation could be due to the low level of sensitivity of the visual method in determining the prevalence of pes planus. Using the arch index method, the prevalence of pes planus in males reduced from 94.11% (in the 13 – 19 age group) to 80.56% (in the 20 -26 age group) and 45.45% (in the 27 -32 age group) while in females, the prevalence of pes planus reduced from 98.57% (in the 13 – 19 age group) to 88.89% (in the 20 -26 age group) and 50% (in the 27 -32 age group). This could be due to the effects of shoe-wearing by older subjects, which tend to reduce the prevalence of pes planus in older subjects by making the feet firmer.

It has also been shown that in adults, flat feet are often free of symptoms but they are more liable than normal feet to suffer foot strains (24). They are also more prone in later life to osteoarthritis of the tarsal joints consequent upon their mal-alignment (24). The fact that the subjects are young adults without any apparent deformities tends to support the above assertion.

There are both anatomical and physiological causes of pes planus. The anatomical causes include limb rotation, genu valgum, equinus and varus deformities as well as congenital factors. The physiological causes include infantile flat foot, postural, middle age and temporal flatfoot (19). Most of these factors do not apply to the subjects of this study who are young adults with no apparent deformities. The prevalence of pes planus in this study may be largely due to congenital factors. Developmental flatfeet are present at birth and it is likely that intrauterine forces and fetal position initially creates abnormal bony relationships between anatomically normal bones. This bony relationship is said to be present even before the child takes the first step (20). Thus, foot print analysis could be used effectively for screening studies, as has been elucidated by Kanatli *et al* 2001(21).

This pilot study of pes planus suggests that the condition may be very common in Yorubas. It apparently does not result in much pathlogy. Nevertheless, because it appears to be much more prevalent in this population than in others which have been similarly tested, a layer study is imperative. Other ethnic groups in Nigeria should also be tested. Finally, the influence of weight on flat footedness should also be considered since body mass index has been shown to correlate with the presence of flat footedness.

Table 1: Prevalence of Pes Planus in Males and Females (in Different Age Groups) Using the Visual Method.

TOTAL STUDY POPULATION	TOTAL NUMBER OF PES PLANUS	PREVALENCE OF PES PLANUS	PREVALENCE OF PES PLANUS IN AGE GROUP (13 – 19)	PREVALENCE OF PES PLANUS IN AGE GROUP (20 – 26)	PREVALENCE OF PES PLANUS IN AGE GROUP (27 – 32)
MALE 115	17	14.8%	11	3	3
FEMALE 92	17	18.5%	10	6	1
TOTAL 207	34	10.8%	21	9	4

Table 2: Prevalence of Pes Planus in Males and Females (in Different Age Groups) Using the Footprint Ratio Method

TOTAL STUDY POPULATION	TOTAL NUMBER OF PES PLANUS	PREVALENCE OF HIGH ARCH	PREVALENCE OF NORMAL ARCH	PREVALENCE OF FLAT ARCH	PREVALENCE OF PES PLANUS IN AGE GROUP (13 – 19)	PREVALENCE OF PES PLANUS IN AGE GROUP (20 – 26)	PREVALENCE OF PES PLANUS IN AGE GROUP (27 – 32)
MALE 115	98	0%	14.78%	85.22%	64	29	5
FEMALE 92	87	0%	5.34%	94.57%	71	16	0
TOTAL 207	185	0%	20.12%	89.37%	135	45	5

Table 3: Prevalence of Pes Planus in Different Population Groups

COUNTRIES	PREVALENCE/1000 POPULATION	METHOD OF STUDY	AUTHORS
Nigeria (Blacks)	108.00	Visual	Present Study
Nigeria (Blacks)	893.7	Visual	Present Study
Nigeria (Blacks)	22.20	Planimeter	Didia *et al*, 1987[15]
Uganda (Blacks)	38.80	Visual	Igbigbi and Mpango, 1998[16]
Malawian (Blacks)	242.62	Arch index	Igbigbi and Msamati, 2002[17]
Kenya (Blacks)	431.82	Arch index	Igbigbi and Msamati, 2005[23]
Tanzanian (Blacks)	203.09	Arch index	Igbigbi and Msamati, 2005[23]
Turkey(Eurasian)	30.00	Arch index	Olcay, 1993[25]
USA (Whites)	250.00	Arch index	Cavanagh and Rogers, 1987[6]

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