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Original research article

Association between flatfoot and age is mediated by sex: A cross-sectional study

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ABSTRACT

Introduction: Flatfoot (*pes planus*) is one of the most frequently encountered pediatric foot deformities. In spite of the numerous evidences for adverse implications of flatfoot to the locomotive system and musculoskeletal health of patients, in the continuum of developmental milestone, the age to which patients should be monitored for flatfoot remains debatable.

Aim: We investigated the prevalence and pattern of flatfoot in a Nigerian population ranging from 6 to 25 years of age in order to describe the triad of age-sex-flatfoot preponderance.

Material and methods: This was a cross-sectional study among 620 participants using the footprint method and the planter arch index – Staheli arch index criteria for flatfoot diagnosis.

Results and discussion: Flatfoot prevalence in the study population was 27.4%; children had the highest prevalence (28.3%) and adults had the lowest (20.0%). Most of the flatfoot was unilateral (60.0%) and was the flexible form (73.8%). The transition from childhood to adulthood was associated with a significant decrease in prevalence of flatfoot among the male participants, but there was no association between prevalence of flatfoot and age beyond 9 years among the female participants.

Conclusions: The incidence of flatfoot in the Nigerian population is high. Monitoring for flatfoot into adulthood is advisable particularly for the male patients.

1. Introduction

Concern over flatfoot is a common reason for frequent clinical consultations.[1] There is also controversy over the clinical characterization of flatfoot, the degree of disability it causes in adulthood, and the requirement and choice of treatment.[2,3] Additionally, there is evidence that flatfoot may cause gait disorders in adulthood.[4–7]

Increased age is associated with a decreased prevalence of flatfoot.[8–11] However, whether this decrease differs between the sexes, particularly as patients approach adulthood, is

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unknown.[12] In addition, reports of sex predisposition to flatfoot have been inconsistent.[11–15] Although this inconsistency could be due to ethnic variations, some studies of patient populations of uniform ethnicity have produced contradicting findings. In a Nigerian population, for instance, Eluwa et al.[14] reported a higher prevalence of flatfoot in female patients, but male patients had a higher prevalence in a study by Ezema et al.[11] Interestingly, participants in the study by Eluwa et al. were much older, raising the question of whether a change in gender predisposition to flatfoot truly occurs between children and adults. At what age does this occur, if there is indeed a change?

A study in a population composed of children, adolescents, and adults may provide information regarding age and sex differences associated with flatfoot prevalence and guide a hypothesis regarding a possible change of sex prevalence between children and adults.

2. Aim

The aim of this study was to investigate the prevalence and patterns of flatfoot in a representative Nigerian sample including children and adults. Our secondary aim was to determine the triad of age-sex-flatfoot preponderance.

3. Material and methods

3.1. *Study design and participant*

We employed a cross-sectional design with 620 participants. Participants were voluntary sample of children, adolescents, and adults in age ranging from 6 to 25 years of age recruited from public schools in Enugu metropolis. Physical examinations and subjective assessments, as well as discussions with the students, were done in order to rule out those who had foot deformities or other criteria excluding them from participating in this study. Students with evidence of previous foot operations or who had injuries requiring a non-weight-bearing period at the time of the study were excluded. Students with lower limb paralysis or paresis were also excluded. Subjective assessments included queries regarding diagnoses of metabolic syndrome or any other conditions that could impair objective measurement of any of the anthropometrics of interest, thus forming exclusion criteria.

Physical examinations included inspection for open injuries, foot ulcers, lower limb fractures or dislocations, previous foot surgeries, swelling or inflammation, neurological sequelae, or any other conditions that could impair the objective diagnosis of flatfoot and form exclusion criteria. Included were participants without any lower limb disorder that would hamper accurate measurement of the plantar arch. The presence of symptomatic flatfoot was not an exclusion criterion if an accurate footprint could be obtained.

3.2. *Procedure for data collection*

Following ethical approval by University of Nigeria Teaching Hospital Research Ethics Committee, visits were made to the various schools on prescheduled days during which the purpose, procedures, and relevance of the study were explained to the participants before their informed consent was requested and obtained. All adult participants signed a voluntary informed consent form appropriate for the study. The school guardians of the children and adolescents gave consent for those who voluntarily agreed to participate. Participants' privacy and confidentiality were maintained by secluding the assessment areas, using code numbers instead of names in data presentation, and keeping the records confidential.

To have representative samples of different age groups, recruitment involved two sampling techniques. For the children and adolescents, a stratified multistage sampling was used. Final inclusion from each school was by proportional random sampling based on the population of students aged 6–17 years who met the eligibility criteria. For the adults, a convenient sample was drawn from two representative institutions of higher education in Enugu metropolis.

3.3. *Measurement*

Participants' height (cm) was obtained using a height meter, while their weight (kg) was measured with a weighing scale. BMI was obtained through a mathematical calculation based on height and weight (weight/height^2, kg/m^2). For participants 15 years of age and younger, an age-and sex-specific BMI calculation was used.

To obtain the arch measurement the footprints method was used. Participants' feet were first cleaned thoroughly. Each participant was seated and asked to dip the foot to be studied onto a cyclostyling ink pad. The foot was removed from the cyclostyling ink and the participant was asked to stand and print the foot firmly onto a sheet of paper attached to a wooden platform, at the same time flexing the ipsilateral knee slightly (up to 30°).[11,13,16] Each footprint was obtained with the participant in the standing position with the limb bearing about 50% of the body weight. These procedures were repeated for the contralateral foot.

To calculate the plantar arch index (PI), the Stahelli arch index crieteria[16] was employed. A pencil line was drawn tangential to the medial forefoot edge and the heel region. The midpoint of this line was determined. From this point, a perpendicular line was drawn crossing the footprint.[17,18] The same procedure was repeated for the heel tangent point. The perpendicular distance (A, the perpendicular line representing the width covered by the ink from the medial edge to the lateral edge of the midfoot) was noted. A second perpendicular distance (B, the perpendicular line representing the width covered by the ink from the medial edge to the lateral edge of the rearfoot) was also obtained. The PI was derived by dividing the value of A by the value of B (Fig. 1). A PI value greater than 1.15 was considered evidence of flatfoot.[16]

A heel-rise test (tiptoe standing) to differentiate between flexible and rigid pesplanus was conducted for all participants diagnosed with flatfoot by the foot impression test.[19] Participants stood with their full body weight borne on the leg not being tested and held the ankle of the leg being tested in plantar flexion (tiptoe position). If an arch appeared, flexible pesplanus was indicated. If an arch did not appear, rigid pesplanus was diagnosed.