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RESEARCH REPORT

Flat foot and associated factors among primary school children: A cross-sectional study

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Abstract Prevalence of flat foot and its associated personal characteristics among public primary school students was investigated. This cross-sectional study involved 474 public primary school students (253 females and 221 males) between the ages of 6 and 10 years. Flat foot diagnosis was made using Staheli plantar index (PI), where values >1.15 were indicative of flat foot. The number of children diagnosed with flat foot was 106, yielding a prevalence rate of 22.4%. Flexible flat foot accounted for 93 (87.7%) of the positive diagnoses, whereas bilateral flat foot was present in 97 (91.5%) of the cases. There was a significant relationship between higher prevalence of pes planus and older age, with the 6-year-old group showing the highest prevalence. Boys were twice as likely to be diagnosed with flat foot as girls, and obese participants were three and a half times more likely to have flat foot compared with those of normal weight. In summary, about one in every five public primary school children aged 6–10 years would be diagnosed with flat foot anomaly, and obesity further increased the risk. Preregistration flat foot screening, and periodic observation for onset of symptoms of progression, should be made available for primary school children.

Introduction

Foot posture is an established factor in determining the function of the lower limb and may therefore have a role in a predisposition to repetitive injury [1–3]. Flat foot deformity is frequently encountered in paediatric orthopaedic and rehabilitation practices. Flat foot (pes planus) is a biomechanical problem consisting of a constellation of physical features that includes excessive

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eversion of the subtalar complex during weight-bearing, with plantarflexion of the talus, plantar flexion of the calcaneus in relation to the tibia, dorsiflexion and abduction of the navicular, supination of the forefoot, and valgus posture of the heel [4,5].

Flexible flat foot tends to disappear when the lower limb is not weight-bearing and rarely causes disability or requires treatment, although overuse may cause pain [5]. In contrast, rigid flat foot is a pathological foot condition that may arise from acquired or congenital causes ranging from structural abnormalities, collagen disorders, musculoskeletal abnormalities, trauma, spastic conditions, or neuromuscular conditions [5,6]. People with flat foot are at higher risk of foot pain, knee pain, foot injury, stress fracture, and poor exercise performance [7]. The prevalence of flat foot varies across different studies. Some researchers have shown that prevalence of pes planus decreases with age [8,9]. Others have a pointed sex preponderance [10,11].

Therefore, paediatric flat foot remains a controversial topic in the clinical community [12—22]. Substantial knowledge gaps still exist in the field [23]. In particular, the controversy around whether or not and when it is necessary to treat a nondevelopmental asymptomatic flat foot in children is yet to be resolved [24]. Also, there is a dearth of research on the prevalence of flat foot among school-aged children in Nigeria. Such information will highlight the need for school-wide screening and continuous monitoring for school-aged children at risk. Similarly, since the critical time for the development of the plantar arch is just prior to the age of 6 years [25], a study sample of participants $<$6 years may overestimate the prevalence of flat foot. Therefore, this study was aimed at investigating the prevalence of flat foot and its associated personal characteristics in a sample of Nigerian primary school children aged 6—10 years.

Materials and methods

Research design

The study employed a cross-sectional descriptive design with 474 participants. A multistage sampling technique was used (Fig. 1). A list of all local governments in Enugu metropolis was drawn. This was followed by a list of every layout in each of the three local governments listed. Then, two layouts from each of the three local governments were chosen by the simple random technique, bringing a total of six layouts. This was followed by another simple random sampling selecting one school from each of the six layouts. A list of all children aged 6—10 years in each of the six primary schools selected was compiled. Physical examination and subjective assessment, 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.

Physical examination included inspection for open injuries, foot ulcers, lower limb fractures or dislocations, or previous foot surgery, swellings/inflammation, neurological sequels, or any conditions that may impair objective diagnosis of flat foot and form exclusion criteria. The students were subjectively examined for any pain perception on passive and active movements of the ankle, subtalar joints, and metatarsophalangeal joints, and on limb weight-bearing. A list of eligible students was made for each of the six primary schools. A proportional, random sampling was used to allocate the number of pupils to be included from each school, according to the population of pupils aged 6—10 years who met the eligibility criteria described.

Participants

A total of 474 primary school children between the ages of 6 years and 10 years, attending public primary schools in Enugu metropolis and who met the inclusion criteria, participated in the study. Ethical approval was obtained from the Enugu State Education Board. Participants were fully informed about the data collection procedures and protocol, after which the headmasters/mistresses gave their informed consent on behalf of the students who volunteered to participate. Only those who volunteered to participate in the study were recruited. To be included, an individual had to be a student of one of the six primary schools selected, be between 6 years and 10 years of age, and not have any lower limb disorder that would hamper accurate measurement of the foot plantar arch. Students with evidence of foot deformity or previous foot surgery, or those with injuries that require a period of non-weight-bearing at the time of the study, were excluded from participating. Students with lower limb paralysis or paresis were also excluded.

Measurement

The height of the individuals (in cm) was measured with a height meter and their weight (kg) was obtained using a weighing scale. The feet were first cleaned thoroughly. The participant was placed in a sitting position and then asked to dip the foot to be studied into a tray filled with ink. The foot was then removed from the tray and the participant was asked to stand up to print the foot firmly on a sheet of paper attached to a wooden platform, while at the same time flexing the ipsilateral knee slightly (up to 30°) [10,12,26—30]. Each foot print was obtained in the standing position with the limb bearing about 50% of the body weight. The above procedures were repeated for the contralateral foot.

The footprints were then used to calculate the plantar arch index (PI). Using a lead pencil, a line was drawn tangent 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 [28,29]. The same procedure was repeated for the heel tangency 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 measured. Also, 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 measured. The PI was then calculated by dividing the value of A by the value of B [29,30] (Fig. 2). An individual was considered to have flat foot, if his/her PI