Correlation of hallux valgus, pes planus, and foot pain in a sample of Nigerian college students.

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Abstract

Aim: To correlate hallux valgus, pes planus, foot pain, and gender difference between the constructs among Nigerian College students.

Methods: An ex-post-facto design involving 283 consenting participants recruited consecutively. Their feet were examined for Hallux Valgus (HV), pes planus, and foot pain using the Manchester Scale, Staheli's index, and Foot function index respectively. Data collected were summarized using descriptive statistics of mean, standard deviation, and percentages. Spearman rank correlation, Pearson Chi-square, and Mann-Whitney U were used to test the hypotheses. Alpha level was set at P<0.05.

Results: The majority of the participants had no hallux valgus (80.9%), no pes planus (81.0%), and no foot pain (91.1%). On those with hallux valgus, right, left and bilateral foot had 8.8%, 5.0%, and 5.3% respectively. Amongst those who had pes planus, right, left, and bilateral foot had 10.2%, 2.8%, and 6.0% respectively. Among those with foot pain, mild and moderate pain had 7.1% and 1.8% respectively. A significant correlation exists between HV and pes planus (r=0.493, p=0.001), HV and age (r=0.195, p=0.001). However, no correlation exists between HV and foot pain (r=0.142, p=0.17), pes planus and foot pain (r=0.132, p=0.27), pes planus and age (r=0.108, p=0.070), foot pain and age (r=0.082, p=0.172). Female participants had significantly higher scores in HV and pes planus than males. However, no significant difference in foot pain between male and female participants.

Conclusion: Significant correlation exists between hallux valgus and pes planus. However, no significant correlation exists between hallux valgus and foot pain, pes planus, and foot pain.

Keywords: Hallux Valgus (HV), Pes planus, Foot pain, Correlation.

Introduction

The human foot is the region most affected by anatomical variation in the entire human body and one of the most important characteristics presenting the highest level of variability is the medial longitudinal arch, and an arch index provides a quantitative measure of the plantar arch which can be compared to other measurements [1]. Poor foot health is now recognized as a public health issue because of its negative impact on individuals and on society which includes difficulty in putting on shoes, pain, gait disorders, reduced walking speed, variation in plantar pressures, and risk of falling [2, 3].

In the general population, the prevalence of foot health problems is between 71% and 87% [4, 5]. The problems relate to claw toes, hallux valgus, hammertoes, overlapping toes, hallux extensus, pes planus, Morton's neuroma, tailor's bunions, plantar fasciitis, and pescavus [4, 5]. Although these problems are multifactorial, they may predict loss of independence, vulnerability [6] defenselessness [7], and reduced quality of life and wellbeing.

Hallux Valgus (HV) is a deformity characterized by lateral deviation of the big toe at the first metatarsophalangeal joint and is more frequent among women [8]. It is the most common foot deformity in adults, and its prevalence increases with age [9-11]. Hallux Valgus was reported to be associated with gender [9, 10, 12], age [9, 10, 13] big toe pain [10, 11], family history [12], footwear [12, 14], Body Mass Index (BMI) [12, 13], first metatarsal length [15], first metatarsal head shape [15], flatfoot [12], race [12], knee pain[10], osteoarthritis [16], and ligamentous laxity [8]. The recent increase in HV prevalence is thought to be largely due to the effect of

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footwear, including high-heeled shoes, particularly in middle-aged and older people [8].

Flat feet, also known as pes planus, is a leg structure deformity characterized by the absence of the medial arch of the foot which is usually covered by excessive fat tissue [17]. This condition occurs mainly in children, which in principle can be physiological. Therefore, it can disappear on its own without treatment [18, 19]. Flat feet are most common in children and rarely found in adults. Flat feet are reported to occur in young children as a consequence of the process of developing the medial arch [17]. Pathological flat feet can cause changes in muscle balance, gait, and alignment of joint motion [19]. The most disturbing complaint about the patient is the increasing pain.

There are 20-30% of children in the world who experience flat feet [17]. In Surakarta Indonesia, a study of 1089 elementary school students found that 299 students experienced flat feet [20]. Research conducted in primary schools in Enugu, Nigeria with 474 children aged 6-10 years old found that 106 (22.4%) students experienced flat feet with 93 (87.7%) students experiencing flat foot on one foot and 97 (91, 5%) students experience flat foot on both legs [21]. A study conducted on college students with a total sample of 240 students showed a prevalence of pes planus at 3.8% with rigid pes planus more common among the male (66.7%) than the female (50%) while the flexible type was more common among the female (50%) than the males (33.3%). Another study conducted at a school in India with a total sample of 297 students found that flat feet are found more often in children younger than 5 years old (40.32%) than in children between 5 to 10 years old (22.15%) and children older than 10 years (15, 48%) [22].

Many studies have examined associations of HV with various factors in patients, general populations, and middle-aged to older people [12, 16]. Studies have shown a relationship between pes planus and hallux valgus [23-25], in a study conducted on adults entitled "is a flat foot associated with a hallux valgus deformity?" indicates that the worsening of the flat foot will exacerbate the Hallux Valgus condition [25]. This could also be due to increased forefoot abduction that creates a non-physiologic load on the plantar medial aspect of the greater toe during heel rise, though the association between pes planus and hallux valgus is still controversial.

Based on these issues, it is important to consider illnesses and deformities of the foot, postural alterations, and other underlying diseases as factors to be taken into account when planning treatment and preventive care activities. Moreover, there is a need for care and follow-up regarding foot health for University students that so far remain unattended. Such issues need to be addressed in seeking to ensure a better quality of life and well-being for University students. Although Hallux Valgus and pes planus is common and well-publicized, there are limited data regarding their effect on one another's associations with pain [26-28], thus this study sought to determine the prevalence of hallux Valgus, pes planus and their associated foot pain among undergraduate students of college of health science, Nnamdi Azikiwe University, Nnewi and the relationship between them. At present little is known about the factors that affect the development of foot health. Foot problems are predisposing factors for the appearance of injuries in later life that could be prevented through implementing programs to improve the general condition of University students' feet.

It's a known fact that human development peaks at age 13 to 33years [29], and at this point, they tend to develop specific foot health issues like pes planus and hallux valgus that are different from other age groups 30. A study concluded that students experience flat foot [21] while other studies showed that hallux valgus is the most common deformity in adults, and its prevalence increases with age 9-10. There are limited data regarding the effect of pes planus and hallux valgus on one another and their association with pain [26-28], despite their prevalence among these study populations and most especially no such related study has been carried out in our immediate environment, so it is difficult to explain the possible foot problems experienced by young people and the factors that may contribute.

Materials and methods

Study design and sample

The study was an Ex-post facto design involving undergraduate students (aged 17-32years) of the College of Health Sciences, Nnamdi Azikiwe University, Nnewi, Anambra State Nigeria. A consecutive sampling technique was used to recruit the participants from the College. The Ethical Committee of Nnamdi Azikiwe University Teaching hospital, Nnewi, Anambra State approved the study. Except for hallux valgus, pes planus, and foot pain, participants were thoroughly screened to rule out any physical disability such as fractures, amputation, or foot deformities like equinovarus, Achilles tendon tightness, contracture, tineapedis, onychomycosis, plantar warts, and ingrown toenails. All those who met the above criteria and provided their consent after the purpose and procedure for the study had been explained to them had their age and sex noted, and the following instruments were used to obtain other relevant data.

Instruments

Manchester scale: This was used for detecting hallux valgus, it consisted of standardized photographs of four types of hallux valgus; none, mild, moderate, and severe. Research has shown that this scale has excellent interobserver repeatability with a combined kappa-type statistic of 0.86, making it a suitable instrument for clinical and research purposes [56].

Staheli index: This was used for pes planus via calculating Staheli's plantar arch index. The plantar arch index establishes a relationship between the central and posterior regions of the footprint. For calculating the plantar arch index, a tangential line was drawn connecting the medial forefoot edge and heel region. The mean point of this line was calculated. From this point, a perpendicular line was drawn crossing the footprint. The same procedure was repeated for heal tangency point. The width of the central region of the footprint was considered as A and the width of the heel region was considered B. The Plantar Arch Index (PAI) was obtained by dividing the A

value by the B value (PAI=A/B). If PAI is greater than 1.15, then it was considered as a flat foot [31].

Plantar Arch Index=A/B

A – Width of the central region of footprint (in cm)

B – Width of the heel region of footprint (in cm)

Evaluation criteria

A normal Plantar Arch Index (PI), according to the Pediatric Orthopedic Society is the one comprised within 2 Standard Deviations (SD) of the population average [32]. Thus, PI values equal to or above the sum of 2 SD with the average were considered indicative of flat foot and named threshold indexes for this condition.

Endorsing ink: It was used together with plain duplicating papers to obtain the footprints of the participants.

Plain duplicating papers: They were used together with endorsing ink to obtain the footprints of the participants.

Wooden platform: This was used to create an even surface upon which the plain duplicating paper was placed.

Buckets of water and towels: They were used for washing, and drying the feet of the participants after the data collection.

Lead pencil: This was used to trace the foot impression and meter rule and for the measurements of the selected foot dimensions

Foot Function Index: A Foot Function Index (FFI) was developed in 1991 by Budiman-mak et al [57] to measure the impact of foot pathology on function in terms of pain, disability, and activity restriction. It is a self-administered index consisting of 23 items divided into 3 sub-scales (foot pain, disability, and limitation of activities).

Foot pain sub-scale consists of the following 9 items- pain in the morning upon taking your first step, pain standing barefoot, pain walking barefoot, pain standing with shoes, pain walking with shoes, pain standing with orthotics, pain walking with orthotics, how is your pain at the end of the day, how severe is your pain at its worst.

The disability sub-scale consists of the following 9 items- difficulty in the house, difficulty when walking outside, difficulty when walking four blocks, difficulty when climbing stairs, difficulty when descending stairs, difficulty when getting out of a chair, difficulty when standing tiptoe, difficulty when climbing curbs, difficulty when running or fast walking.

Activity limitation sub-scale consists of the following 5 items- stay indoors all day due to feet, stay in bed all day due to feet, use an assistive device (stick, walker, crutches, frame) indoors, use an assistive device outdoors, limit physical activity.

Each question on a scale is scored from 0 (no pain or difficulty) to 10 (worst pain imaginable or so difficult it requires help), that best describes their foot over the past week which is recorded on a Visual Analog Scale (VAS), scores range from 0 to 100 mm, with higher scores indicating worse pain. Pain sub-scale is recorded 0-90, disability sub-scale 0-90, activity limitation 0-50 with a total score of 230points. Both total and sub-scale scores are produced. Test-retest reliability of the FFI total and subscale scores range from 0.87 to 0.69, while internal consistency ranged from 0.96 to 0.73.57.

The patient scored each question on a scale from 0 (no pain or difficulty) to 10 (worst pain imaginable or so difficult it requires help), that best describes their foot over the past week. Recorded on a Visual Analog Scale (VAS), scores range from 0 to 100 mm, with higher scores indicating worse pain. Both total and subcategory scores were calculated. Emphasis was on the pain subscale with 9 questions as follows;

Pain in the morning upon taking your first step 0-10

Pain standing barefoot 0-10

Pain walking barefoot 0-10

Pain standing with shoes 0-10

Pain walking with shoes 0-10

Pain standing with orthotics 0-10

Pain walking with orthotics 0-10

How is your pain at the end of the day 0-10?

How severe is your pain at its worst 0-10

NB: A total score of 90: Higher score indicates maximum pain.

Measurements

1. **Assessment for hallux valgus using manchester scale:** The participant's foot was compared to a photograph with four pictures showing a different level of hallux valgus; none, mild, moderate, and severe, which best described the participant's foot was marked and recorded (Figure 1).

2**. Assessment for pes planus using staheli index:** The patterns of measurements included:

a. A sheet of plain duplicating paper was placed on a wooden platform. The participant remained seated in front of the platform on which the plain duplicating paper was placed. With the aid of the researcher, each participant placed the foot (already painted with endorsing ink) on the platform, with the contralateral foot off the platform.

b. The participant was requested to stand up and perform a small flexion of the ipsilateral knee (30 degrees) and then to go back to the initial position, and remove the foot from the platform.

c. The researcher controlled the foot position on the platform, to prevent foot slip, a fact that could invalidate the test, which should show a clear footprint.

d. Calculation of the Plantar Arch Index: - Staheli's plantar index method was used. The Plantar arch Index (PI) establishes a relationship between the central and posterior (heel) regions of the footprint, and it was calculated as follows:

i. A line was drawn tangent to the medial fore-foot edge and at the heel region.

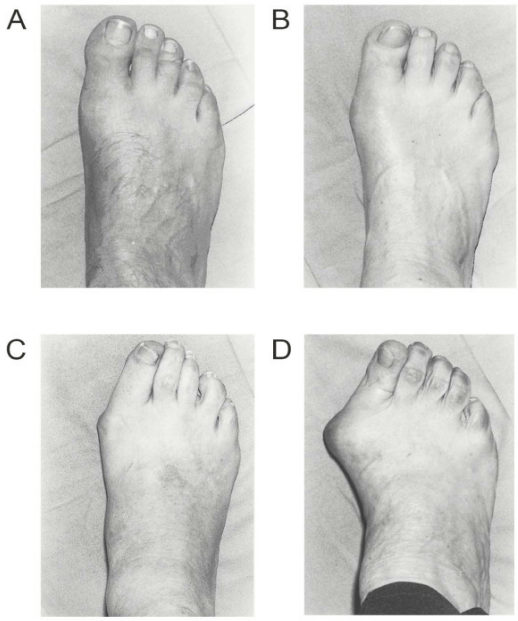

Figure 1. *Manchester scale [56].*

ii. The mean point of this line was measured and marked off. From this point, a perpendicular line was drawn crossing the footprint. The same procedure was repeated for the heel tangency point.

iii. The measurement of the support width of the central region of the foot (A), and the heel region (B) in centimeters was obtained. The Plantar arch Index (PI) was then calculated by dividing the A value by the B value: (PI=A/B).

e. **Evaluation criteria**: A normal Plantar Arch Index (PI), according to Staheli [31], Hernandez et al [32], and Engel [58], is the one comprised within 2 Standard Deviations (2SD) of the population mean PI. This PI value equal to or above the sum of 2SD with the mean was considered as indicative of pes planus (flatfoot) and threshold index for this condition in the population sample under the study.

3. Assessment for foot pain using foot function index: The FFI (questionnaire) consisted of 23 self-reported items divided into 3 subcategories based on patient values: pain, disability, and activity limitation. The patient had to score each question on the pain scale from 0 (no pain or difficulty) to 10 (worst pain imaginable or so difficult it requires help), that best described their foot over the past week. The pain subcategory consisted of 9 items and measured foot pain in different situations, such as walking barefoot versus walking with shoes. Recorded on a Visual Analogue Scale (VAS), scores ranged from 0 to 100 mm, with higher scores indicating worse pain. Both total and subcategory scores were calculated. The pain subscale with 9 questions is as follows: Pain in the morning upon taking your first step 0-10. Pain standing barefoot 0-10.Pain walking barefoot 0-10.Pain standing with shoes 0-10.Pain walking with shoes 0-10.Pain standing with orthotics 0-10.Pain walking with orthotics 0-10. How is your pain at the end of the day 0-10. How severe is your pain at its worst 0-10. A total score of 90: Higher score indicates maximum pain.

Data analysis

The data obtained from this study were analyzed using Statistical Package for Social Sciences (SPSS). The full description of the participants was summarized using mean and standard deviation. Variables such as Hallux valgus, pes planus, and foot pain were presented using frequency and percentages. Spearman rank correlation was used to correlate hallux valgus, pes planus, and foot pain on the age of the participants. Mann-Whitney U test was used to compare hallux valgus, pes planus, and foot pain on gender. Pearson Chi-square was used to show the association between age and hallux valgus. The level of significance was set at <0.05.

Results

A total of three hundred and sixty-six questionnaires were administered face to face to the undergraduates of the college of health sciences but two hundred and eighty-three were filled and returned, giving a 77.3% response rate.

Socio-demographic profiles and general characteristics of the participants: Two hundred and eighty-three (283) students participated (male 44.5%, female 55.5%); aged between 17-32years. The majority of the participants (78.8%) fell within the age range of 17-20years (Table 1).

Hallux valgus and population plantar arch index: The majority of the participants had no hallux valgus (80.9%). Those who had right, left and bilateral hallux valgus are 8.8%, 5.0%, and 5.3% respectively (Table 2).

The majority of the participants had no pes planus (81.0%), and no foot pain (91.1%). Amongst those who had pes planus, the majority had right pes planus (10.2%) and bilateral pes planus (6.0%). Among those who had foot pain, the majority had mild pain (7.1%) (Table 3).

Correlation between hallux valgus, pes planus, and foot pain on the age of the participants: A significant correlation

Table 1. *Demographic characteristics and other relevant data of the participants.*

Variable	Frequency (%)	Mean ± SD
Age		22.45±2.11
Age category		
17-20 years	223 (78.8)	-
21-24 years	19(6.7)	
25-28 years	39(13.8)	
29-32 years	2(0.7)	
Gender		
Male	126(44.5)	-
Female	157(55.5)	

Key: SD= Standard Deviation

Table 2. *Hallux Valgus.*

Variable	Frequency (%)
Halluxvalgus Prevalence	
No halluxvalgus	229(80.9)
Right halluxvalgus	25(8.8)
Left halluxvalgus	14(5.0)
Bilateral halluxvalgus	15(5.3)
Right Foot	
Normal foot	253(89.4)
Mild halluxvalgus	19(6.7)
Moderate valgus	6(2.1)
Severe halluxvalgus	5(1.8)
Left foot	
Normal foot	259(91.5)
Mild halluxvalgus	13(4.6)
Moderate valgus	6(2.1)
Severe halluxvalgus	5(1.8)

Table 3. *Summary of the population plantar arch index.*

Variable	Frequency (%)	Mean±SD
Right Foot		0.823±0.205
Left foot		0.822±0.203
PesPlanus category		
No pesplanus	229(81.0)	
Right pesplanus	29(10.2)	
Left pesplanus	8(2.8)	
Bilateral	17(6.0)	
Foot pain		1.685±6.622820
No foot pain	258(91.1)	
Mild foot pain	20(7.1)	
Moderate foot pain	5(1.8)	
Severe foot pain.	0(0)	

Key: SD= Standard Deviation

Table 4. *Correlation between Hallux valgus, Pes Planus, and foot pain on Age among the participants.*

Variable	Pes planus	Foot pain	Age
Hallux valgus	r=0.493, p<0'001*	r=0.142, p=0.17*	r=0.195, p=0.001*
Pes planus		r=0.132, p=0.27*	r=0.108, p=0.070
Foot pain			r=0.082, p=0.172

*Significant at $p<0.05$

exists between hallux valgus and pes planus, hallux valgus, and age. However, no significant correlation exists between hallux valgus and foot pain, pes planus and foot pain, pes planus, and age, foot pain, and age among the participants (Table 4).

Comparison of hallux valgus, pes planus, and foot pain on gender: Female participants have significantly higher scores in hallux valgus and pes planus than male participants while there was no statistically significant difference in foot pain between male and female participants (Table 5).

Table 5. *Comparison of Hallux valgus, Pes planus, and Foot Pain on gender.*

Variable	Mean ranking	U-value	P-value
Halluxvalgus	Male= 129.37 Female=152.13	8300.00	0.002*
Pesplanus	Male= 134.37 Female= 148.20	8917.00	0.038*
Foot pain	Male= 140.49 Female= 143.21	9700.5	0.578

*Significant at $p<0.05$

Discussion

This study aimed to correlate hallux valgus, pes planus, and foot pain among undergraduate students of the College of Health Sciences, Nnamdi Azikiwe University, Nnewi. Two hundred and eighty-three (126 males, 157 females) students participated with a mean age of 22.45 ± 2.11 (Table 1). The study reported a low prevalence of Hallux valgus which is in concordance with several previous studies [11, 33, 34] and may increase with age [11, 33]. The reason for a low prevalence of Hallux valgus among the studied participants could be a result of the participants being younger adults (students), as opposed to the findings by Cho [13] which reported a high prevalence of hallux valgus among older Korean adults. This study also reported that the Right hallux valgus was the most common (8.8%). However, this differs from a previous study which revealed that the left hallux valgus was most common; (5.9%) and (5.8%) had hallux valgus on the left and right foot respectively [11].

The prevalence of pes planus was also found to be low among the participants (81.0% having no pes planus) which concord with a previous study carried out in southeast Nigeria among primary school pupils aged 8-12 years which revealed that the prevalence of pes planus was not high [35]. Another study [1, 36-38] also showed a low prevalence of pes planus at 11.25%, 17.1%, 34.7%, and 3.8% respectively. These similar results could be attributed to the fact that these studies were carried out among the younger population. The majority of the participants (13%) had unilateral pes planus (Table 3) in line with the report of previous studies [1, 36-39] but in contrast with the study from Jayabandara et al [38] which reported a high incidence of bilateral pes planus (73.5%). This difference could be a result of the reduced number of participants as Jayabandara et al [38] conducted their study among 533 participants. The results from this study revealed that the prevalence of foot pain among the participants was very low with only 5.5% mild foot pain and no severe foot pain. (Table 3) The results from this study differ from a Cross-Sectional Study carried out by Getie et al [40] This difference in results could be due to the difference in the study areas as one was carried out among University undergraduates and the other among nurses and also, and nurses have been known to wear footwear for a long time, which could result in a high incidence of foot pain recorded. However, this present result is similar to another study done by Spahn et al [41]. It revealed that the prevalence of foot pain among a total of 2368 adolescents evaluated was very low (14.0%). This could imply that as one grows older, the tendency of having foot pain increases.

A significant correlation was found to exist between pes planus and hallux valgus among the participant. However, a study aimed to determine whether the degree of pes planus was associated with hallux valgus severity and hallux valgus surgery outcomes revealed that Pes planus in adult patients is not significantly associated with hallux valgus severity and recurrence, radiographic outcomes, or clinical scores [28]. This difference could be due to their difference in population age group and population size since this present study had almost twice the population size of the study done by Suh et al [28] and also, older people participated in the study done by Suh et al [28]. However, a study by Nguyen et al [12] showed that Hallux valgus in men was associated with pes planus and high body mass index. Another study done by Atbasi et al [26] showed that a significant correlation was found to exist between pes planus and hallux valgus which are in agreement with this present study.

This study revealed that no significant correlation was found to exist between hallux valgus and foot pain and pes planus and foot pain among the participant. This suggests that the foot pain felt by the participants was not a result of hallux valgus or pes planus. The foot pain may be a result of other problems such as general health and physical activity levels. This is in line with a study by Molgaard [42], which showed that there was a significant association between foot pain and pain elsewhere in the leg and low back. This study is in line with other studies which also show no significant correlation exists between hallux valgus and foot pain and no correlation was also found between pes planus and foot pain [13, 43, 44]. However, self-report measures showed that hallux valgus was associated with higher levels of foot pain [9] which is in contrast with this study. The likely reason could be due to differences in sample size, geographical level, or a result of the difference in the instrument used. Otsuka et al [45] also found flat foot to be significantly associated with the presence of pain and fatigue in women. This was observed in his study carried out on Japanese to assess the association of flatfoot with pain, fatigue, and obesity.

Furthermore, this study also shows a statistically significant influence of gender on Hallux valgus which is in agreement with previous studies which showed that hallux valgus was more common among women than among men [10, 11, 12, 46]. This might be because the female first metatarsal tends to be more adducted than that in the male skeleton, and ligamentous laxity and first ray hypermobility are more common in women [47]. This study also reveals that a significant correlation was found to exist between hallux valgus and the age of the participant with higher prevalence among the age group

between 17-20 years. This is similar to a study that revealed that a significant correlation was found to exist between hallux valgus and the age of the participant, however, it differs in the fact that a higher prevalence of hallux valgus could be seen in the older age group than in the younger age group [33]. This difference in their prevalence could be linked to the fact that the majority of those who participated in this present study were within the 17-20 years age category. However, another study showed that the prevalence of hallux valgus did not correlate with age, and moderate or greater hallux valgus was significantly more common in women [13]. This difference could be related to the difference in the study area.

The findings from this study also demonstrated that there is a statistically significant influence of gender on pes planus. This finding is in agreement with these studies [1, 48-50] and differs from the study carried out by [21, 51]. Although the sample size in these studies and the age of the study population could have been factors as both studies were done on primary school students. Conversely, the higher prevalence among females may also be because adult females tend to have small bones and less bulky muscles since both factors help in the maintenance of the arches of the foot [52]. It could also be a result of footwear worn by females as females have been known to be more fashionable than males. Therefore the dangers of ill-fitted and uncomfortable shoes should be preached among the female gender. This however opposes a previous study that shows no significant association between gender and pes planus [34, 35]. The age of the participants included in this study was from 17-32years with a mean age of 22.45 ± 2.11. (Table 1). According to the results, there is no statistically significant correlation between age and pes planus ($p=0.070$). A study done by Jayabandara [38] among university students shows no correlation between age and pes planus which is in concordance with this study. This could be a result of a similar population as both studies were carried out on university students. However, in a study by Sadeghi-demneh [54], the prevalence of flat foot decreased with age. Alsuhaymi [55] also noted that age has a significant relationship with pes planus. Both types of research were carried out on school-age children and this could be the reason for a different result. With this, one can say that as age increases, the prevalence of pes planus decreases.

This present study also shows no significant correlation was found to exist between gender and foot pain and between age and foot pain. A study by Hill [56] showed that foot pain was associated with increasing age and the female gender. The difference in results could be a result of geographical area (South Australia) and the number of participants (3206). According to Molgaard [42] women had a significantly higher prevalence of foot pain. This could also be a result of geographical area and population size. With this, one can say that the black population is less susceptible to foot pain. In another study by Menz [10], age affected both pain intensity and functional limitation. The discrepancy between this present study and that of Menz [10] may be due to the difference in the instrument used.

Conclusion

Based on the findings of the study, the majority of the participants did not report hallux valgus, pes planus, and foot pain. A significant correlation exists between hallux valgus and pes planus, hallux valgus, and age. However, no correlation exists between hallux valgus and foot pain, pes planus and foot pain, pes planus, and age, foot pain, and age. Female participants have significantly higher scores in hallux valgus and pes planus than male participants. There's no significant difference in foot pain between male and female participants. Participants in the age range between 17-20 years have a significant association with hallux valgus.

Recommendations

Based on the findings of the study, it is recommended that participants between the age range of 17-20 years especially females should routinely undergo foot bio-mechanic examination to spot and rule out possibly chances of hallux valgus and pes planus and institute an appropriate treatment plan.

Limitations

The appropriate sampling technique was meant to be a stratified sampling technique but this study was carried out during Christmas and exams period so students were either not around or were busy studying for their exams. The number of participants was not up to the estimated sample size because some students could not consent to putting their legs into a tray of ink.

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