The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 12, 2025

INFLUENCE OF BODY MASS INDEX ON FLATFEET AMONG YOUNG ADULTS: AN OBSERVATIONAL STUDY

Aurangzeb Khan[*1], Safdar Miran[2], Muzzammil Siraj[3]

*[*1]SBB Dewan University, Karachi*
[2]Senior Lecturer, Department of Physical Therapy, SBB Dewan University
[3]Lecturer, Department of Pharmacy ,SBB Dewan University

DOI: https://doi.org/10.5281/zenodo.18194125

Keywords
Body mass index, Obesity, Flatfeet, SPSS, IBM, Arch index

Article History
Received: 28 October 2025
Accepted: 12 December 2025
Published: 26 December 2025

Corresponding Author: *
Aurangzeb Khan

Abstract

Background: *Flatfoot (pes planus) is when the foot arch collapses, affecting the sole to touch the ground. This study scrutinizes its prevalence in young adults and the connection between flatfoot and Body Mass Index.*

Objective: *To analyze the relationship between flatfootedness and obesity.*

Methods: *An observational study was conducted with a sample of 150 young adults fitting in inclusion criteria. The targeted population of this study was undergraduates and postgraduate students of 18-35 years age young adults, having flatfeet without any congenital deformity. Different outcomes of the study that as height and weight by using standard apparatus, footprint method (Arch index), and Denis method were assessed for each subject.*

Results: *The prevalence of flat foot in a population of 18 to 35-year-old young adults was found greater in males and there was a 60% presence of bilateral pes planus in the targeted population. A significant difference was found between the body mass index and Denis method but with no significant difference in body mass index (BMI) on pes planus.*

Conclusion: *From our study, we concluded that the prevalence of flat foot in a population of 18 to 35 years young adults is higher in males and there was no significant difference according to gender. The 60% population is affected with bilateral flatfeet and a majority of subjects have flatfeet with the severity of grade 1. There is no significant relation between BMI with pes planus.*

Introduction:

The foot is the most important component of the body which can support and lift the body. To serve this purpose, feet have concavities called foot arches. In pes planus, there is the curvilinear arch of the foot at the dorsal aspect and the plantar aspect is curved inward, both medially and laterally with longitudinal and transverse direction (1-3). In adults, pes planus is defined as a condition of the foot that persists or develops after skeletal maturity and is characterized by incomplete (collapse) of the medial longitudinal arch (MLA) (4).

The degree (grade) of concavity of the foot arch is considered mainly as a component of performing daily physical activities such as standing, walking, jumping, and running. Un-properly grown foot arches can cause equilibrium problems, instability, continuous deformity, worn-out shoe soles, tiredness, overuse injury, and pain (1), which bring limitations in performing daily activities, sports achievement, and also in some occupations, especially military ones (1, 5). There are so many

different components that work in unity but the lower extremity can be seen as one of the most important functional units. Deviation of the foot can impact on knee and vice versa (1). There are two forms of foot arch abnormality pes planus and pes cavus. If the height of the arch is lower than normal then it is said to be pes planus (1) but in pes cavus, the arch height is higher than normal (6). Low arch is associated with less probity of the foot as a weight-bearing structure (7). The development of pes planus deformities may cause difficulty in walking and postural problems in different age groups persons and leads to more serious problems for older people (8).

Few authors have suggested that uncontrolled increases in weight-bearing forces caused due to obesity may have a false effect on the lower limbs and feet (9). However, it is still not evident that the increase in BMI is also included as one of the considerable factors related to pes planus or not (9). The existing knowledge of the adult flatfoot has not been mentioned, as evidenced by the absence of reliable studies analyzing the long-term sequelae of this condition (10). The flatfoot is associated with many other pathologies (e.g., congenital vertical talus, ligamentous laxity, genetic conditions, or flatfoot because of muscle imbalance), and expert opinion endorses intervention. This condition may be named pathological flatfoot (11). My study aims to evaluate the prevalence of flatfeet in young adult males and females, the relationship between the body mass index and flatfeet, and is the increased BMI have any effect on the severity of flatfeet among young adults. The significance of this study is to evaluate the impact of BMI and pes planus and to determine the burden of pes planus in a selected population. The result of this study will serve as a guide and reference for the students and researchers.

The terminology of Pes planus is incoherent which is used to explain any state in which longitudinal foot arch is typically collapsed or missing (9). Transverse arch, MLA, and lateral longitudinal arch (LLA) these three arches are existing in the foot. The arch of the foot shows as a flexible and supportive plinth of the entire body (12). Actually, in foot anatomy, MLA is considered an essential feature (13). MLA is a vital weight-absorbing arch along with the other two arches (12).

The main feature of pes planus is flexibility rather than static shape flexibility. Flexibility means the motion of the talocalcaneal joint which needs careful examination. The talocalcaneal joint will turn from valgus to neutral and a longitudinal arch (LA) will be noticed in a pes planus which is hanging in the air while the client is seated (14). Fong, Le (15) described and Queen, Mall (16) explained that the LA can also be shaped by giving flexion stretch to the big toe also known as a toe-raising test, because of the "windlass action" of the plantar fascia. The adult's flatfeet history is not clearly defined, as authentication by the absence of reliable studies analyzing the long-term sequelae of this condition (17). The abnormality may be analogous to pain, instability, and severe functional limitations (1). The adult flatfoot investigation requires a relevant client history that includes the onset of the deformity, timing of symptoms, and severity of past and present symptoms (18). In clinical practice, pes planus may be investigated by many distinct methods (19). The radiographic study can be done on clients by placing the feet in weight weight-bearing position. The client stood with their knees extended and feet positioned in front of the cassette (20). In our study, we are using the AI method (ink print mats) to evaluate the pes planus. Footprints are made using a differential pressure ink mat on a flat surface. We can also obtain footprints by many other different methods. In a past study using the National Health Interview Survey (NHIS), male gender was remarkably related to the presence of flatfoot. In previous studies, it has been shown that males were highly prone to flatfoot than females. The current study found that the acceptance of pes planus was higher in the left footprint than in the right footprint (21). In one study the reported prevalence is higher in women as compared to men but some studies also show a higher prevalence of pes planus in the male gender (19).

Methods:

This research was approved by the Ethical Review Committee of the Jinnah Postgraduate Medical

Centre. All participants providing informed consent before being enrolled in the study. The targeted population of this study was undergraduates and postgraduate students of 18-35 years age young adults, having flatfeet without any congenital deformity. All the participants were selected based on inclusion and exclusion criteria.

The inclusion criteria are:

- University students (undergraduate and postgraduate).
- Subjects having flat feet.
- Age between 18-35 years.
- Gender: Male and female.

However, the exclusion criteria are:

- Any congenital deformities.
- Any previous operation of feet.
- Any injury in the foot.
- Subjects not interested.

This research is based on cross-sectional design. And the study was conducted at the Jinnah Postgraduate Medical Centre in Karachi Pakistan for 6 months after the approval of synopsis. The calculated sample size based on the availability of patients was 150, sample size was calculated using WHO online software OPEN EPI version 3. The sampling technique are non-probability purposive sampling. The students were selected from various universities in Karachi. Participants were enrolled based on inclusion and exclusion criteria. One hundred and fifty (150) students male and female aged between 18-35 years have flatfeet. The collected data were entered and analyzed through SPSS version 21.0.

Furthermore, height and weight were measured on each individual without footwear, by using standard apparatus. Height was measured with the help of measuring tape while the subject stood with heel and the head was held in the erect position. The AI was calculated as the ratio of the area of the middle third of the foot to the entire foot area excluding the toes (AI = B ÷ [A+B+C]). 0n the footprint, the linear distance of the center of the heel (say point K) and the tip of the second toe (axis of the foot) (say point J) was measured. Next Perpendicular line was drawn tangential to the most anterior point of the main body of the footprint. Their point of intersection was marked (say point L). Next, the line LK was divided into equal three parts. Ultimately the main body of the footprint was divided into three areas from those points with the perpendiculars from the foot axis. The anterior, middle, and posterior areas were marked as A, B, and C respectively. Their areas were determined (in sq. cm). The values of AI were statistically analyzed. Before testing, subject feet were screened to identify and exclude subjects with any external factors. After taking the footprint, the footprint of subjects was classified according to Denis into 3 grades of severity: Grade 1, Grade 2, And Grade 3.

Results:

The number of subjects (n) included in this study is one hundred and fifty (150) including both genders by using the standard tools, all subjects were screened. Data were analyzed by using the software package SPSS 21.0 version to verify the results obtained. For analysis, the data was entered on the spreadsheet of excel, tabulated, and subjected to statistical analysis. The statistical test used was the Chi-square test. In this study we calculate the mean weight and height, frequency and percentage of flat feet according to the age group, the ratio of presence of unilateral or bilateral flatfeet in gender, and the significant difference in grades of BMI and DENIS method grading was also calculated. This present study also calculates the comparison between males and females to find out the prevalence of flatfoot. These additional tests were also calculated as p-value, chi-square value, and degree of freedom.

Regarding their level of BMI, 05 of the participants (3.3%) are below 18.5 BMI, 78 (52%) are normal BMI, 53 (35.3%) are overweight and 14 (9.3%) of them are obese (as shown in Table 1 and figure 1). The mean weight and height were 43.35 ± 1.78 kg and 1.47 ± 0.19 m, respectively. The majority (60%) of the participants had bilateral flat feet (shown in Table 2), while the prevalence of flatfoot was 41.7% (shown in Table 4b) with a decreasing trend with Gender

(unilateral flatfoot). Boys had a higher frequency of flatfoot than girls; however, the difference was not significant (53% vs. 46%, p > 0.052) shown in Table 4b. The test showed significant differences in the Denis grades 1, 2, and 3 among different BMI groups (p = 0.00) shown in table 6; as Grade1 90 (150) were more with chi-square 6.0 and the p-value is 0.014 and degree of freedom is 1.

Table 1 describes the frequency and percentage of flat feet according to the age group.

Table 1 Frequency of Flat feet Age Group

BMI	Frequency	Percent
Below-18.5	5	3.3
18.5-24.9	78	52
25.0-29.9	53	35.3
30 And Above	14	9.3
Total	150	100

Table 2 describes the prevalence of flatfeet with gender.

Table 2 Gender (Unilateral/Bilateral)

	Male	Female	Chi-Square	Degree of Freedom	P-Value
Unilateral	25(41.7%)	35(58.3%)	1.667[c]	1	0.20
Bilateral	48(53.3%)	42(46.7%)	.400[c]	1	0.53
Total	73(100%)	77(100%)			

Table 3 describes that the majority of the patients were suffering from grade 1.

Table 3 Denis Grade Statistics

Denis Grade	Number	Percent
Grade 1	90	60%
Grade 2	40	26.50%
Grade 3	20	13.30%

Denis Grade Test Statistics

	Grade 1	Grade 2	Grade 3
Chi-Square	6.000a	34.560a	80.667a
Degree Of Freedom	1	1	1
P-Value	0.01	0.00	0.00

Table 4 describe the total number of both males and females concerning the DENIS method and BMI.

Table 4 Denis with BMI

Denis Grade	Underweight	Normal	Overweight	Obese	Total

Grade 1	3 (50%)	50 (64.9%)	30 (56.6%)	8 (57.1%)	**91**
Grade 2	2 (33.3%)	15 (19.4%)	17 (32%)	5 (35.7%)	**39**
Grade 3	1 (16.6%)	12 (15.5%)	6 (11.3%)	1 (7.1%)	**20**
Total	**6 (100%)**	**77 (100%)**	**53 (100%)**	**14 (100%)**	**150**

Discussion:

In adulthood, pes planus is one of the most prevalent foot deformities. Flatfoot is a serious public health problem that is related to working life because these deformities have a negative influence on our daily living activities. Therefore pes planus can be treated in ergonomics-oriented studies and it has been advised that persons with these deformities should not do those jobs that require prolonged standing (22). In our study, the prevalence of flatfeet in a population of 18 to 35 years old among young adults indicates that the boys and girls as 53% and 46%, respectively, with no significant difference. Bordin et al reported that the rate of flatfoot in their study is 18% in boys and 14.6% in girls (11). In other studies, however, the prevalence of flatfoot in girls is higher than that in boys (23, 24). A higher incidence of flatfoot in girls is expected due to smaller bones and less bulky muscles. In addition, girls wear closed-toe shoes that are detrimental to the development of the arches of the foot.

In this study, the careful examination of the footprints of 150 subjects, indicates that there is a 60% presence of bilateral flatfoot. According to gender 53.3% are males and 46.7% are females having bilateral flatfeet. The previous history shows that the prevalence of flatfoot in a population of 18 to 25 years old physiotherapy students was 11.25% for all subjects affected with bilateral flatfeet. According to age 18 years were having 2.5% flatfoot bilaterally, 19 years were having 3.75% flatfoot bilaterally, 22 years were having 3.75 % flatfoot bilaterally, and 24 years were having 1.24% flatfoot bilaterally. There was no significant difference according to gender (25). Our study also shows that there is no significant influence of BMI on flat feet because most of the population lies under the normal category of BMI, having flat feet. Chen et al reported a strong significance between flatfoot and increased BMI in children (23). In another study, however, no significant relationship was found between BMI and flatfoot (26). Past studies showed that the prevalence of increased BMI is 10.3% among school children from the north of Iran, contrary to those from the south of Iran which has a reported prevalence of 15% (27). This discrepancy even in the same country shows that the condition is related to many factors including lifestyle and culture. From our point of view, increased BMI can cause extra weight bearing on the lower limbs which puts an increased load on the ligaments and soft tissues of the foot, which could induce injuries and deformities in the feet. The hypothesis argues that a positive correlation between pes planus and obesity is possibly valid for only children and adolescents, not adults and elderly people (28).

Although obesity and overweight are a temporary, it can be the cause of flatfoot. Therefore subjects should pay attention to increasing weight that may cause flatfoot and also other problems in the future. Interestingly the previous study shows that blue-collar workers had a lower prevalence of flatfoot. This would indicate the common knowledge that overuse or strenuous activities cause flatfoot. However, it has been documented that prolonged weight bearing is unlikely to cause flatfoot (29). In sum, to achieve accurate results more detailed studies are needed to be made.

Conclusion:

From this study, we concluded that the prevalence of pes planus is higher in males as compared to females in a population of 18 to 35 years young adults but the difference was not significant. The selected participants have an increased ratio of bilateral flat feet which is more common in the

male gender. The majority of the subjects are suffering from grade 1 medial arch collapse and there is a significant difference between the Denis Grades and BMI. Most of the participants lie under the category of normal BMI but have flatfeet of Grade 1 and this shows that there is no significant influence of BMI on flat feet.

Disclaimer:
None to declare.

Conflict of Interest:
None to declare.

Grants & Funding Disclosure:
None to declare.

REFERENCES

Idris FH. The growth of foot arches and influencing factors. Paediatrica Indonesiana. 2005;45(3):111-7.

King CM, Facfas D. The Kaiser Permanente Podiatry Experience: Lessons Learned in Foot and Ankle Surgery, an Issue of Clinics in Podiatric Medicine and Surgery, E-Book: Elsevier Health Sciences; 2024.

Thammongkolchai T, Termsarasab P, Katirji B, Preston DC. Neuromuscular and Electrodiagnostic Medicine Board Review, E-Book: Elsevier Health Sciences; 2023.

Lee MS, Vanore JV, Thomas JL, Catanzariti AR, Kogler G, Kravitz SR, et al. Diagnosis and treatment of adult flatfoot. The Journal of Foot and Ankle Surgery. 2005;44(2):78-113.

Cavanagh PR. The biomechanics of running and running shoe problems. Segesser B, PfÃ¶ rringer W, eds The shoe in sport Chicago: Year Book Medical. 1989.

Doral MN, Tandoğan RN, Mann G, Verdonk R. Sports injuries: prevention, diagnosis, treatment and rehabilitation: Springer Science & Business Media; 2011.

Kim D, Kim SK. Foot arch height affects the effect of BMI on gait and lower-limb joint kinematics. International Journal of Applied Sports Sciences. 2020;32(2).

LeWitt PA, Kymes S, Hauser RA. Parkinson disease and orthostatic hypotension in the elderly: recognition and management of risk factors for falls. Aging and disease. 2020;11(3):679.

Troiano G, Nante N, Citarelli GL. Pes planus and pes cavus in Southern. Annali dell'Istituto superiore di sanita. 2017;53(2):142-5.

Han Q, Zheng B, Daines L, Sheikh A. Long-term sequelae of COVID-19: a systematic review and meta-analysis of one-year follow-up studies on post-COVID symptoms. Pathogens. 2022;11(2):269.

Ludyga S, Gerber M, Pühse U, Looser VN, Kamijo K. Systematic review and meta-analysis investigating moderators of long-term effects of exercise on cognition in healthy individuals. Nature human behaviour. 2020;4(6):603-12.

Shibuya N, Jupiter DC, Ciliberti LJ, VanBuren V, La Fontaine J. Characteristics of adult flatfoot in the United States. The Journal of foot and ankle surgery. 2010;49(4):363-8.

Sadeghi-Demneh E, Jafarian F, Melvin JM, Azadinia F, Shamsi F, Jafarpishe M. Flatfoot in school-age children: prevalence and associated factors. Foot & ankle specialist. 2015;8(3):186-93.

Da Veiga GV, da Cunha AS, Sichieri R. Trends in overweight among adolescents living in the poorest and richest regions of Brazil. American Journal of Public Health. 2004;94(9):1544-8.

Fong C, Le T, Drummond CJ. Lyotropic liquid crystal engineering–ordered nanostructured small molecule amphiphile self-assembly materials by design. Chemical Society Reviews. 2012;41(3):1297-322.

Queen RM, Mall NA, Hardaker WM, Nunley JA. Describing the medial longitudinal arch using footprint indices and a clinical grading system. Foot & ankle international. 2007;28(4):456-62.

Dunn J, Link C, Felson D, Crincoli M, Keysor J, McKinlay J. Prevalence of foot and ankle conditions in a multiethnic community sample of older adults. American journal of epidemiology. 2004;159(5):491-8.

Nguyen U-S, Hillstrom HJ, Li W, Dufour AB, Kiel DP, Procter-Gray E, et al. Factors associated with hallux valgus in a population-based study of older women and men: the MOBILIZE Boston Study. Osteoarthritis and cartilage. 2010;18(1):41-6.

Chen K-C, Yeh C-J, Tung L-C, Yang J-F, Yang S-F, Wang C-H. Relevant factors influencing flatfoot in preschool-aged children. European journal of pediatrics. 2011;170:931-6.

Shibuya N, Kitterman RT, LaFontaine J, Jupiter DC. Demographic, physical, and radiographic factors associated with functional flatfoot deformity. The Journal of Foot and Ankle Surgery. 2014;53(2):168-72.

Otsuka R, Yatsuya H, Miura Y, Murata C, Tamakoshi K, Oshiro K, et al. Association of flatfoot with pain, fatigue and obesity in Japanese over sixties. [Nihon koshu eisei zasshi] Japanese journal of public health. 2003;50(10):988-98.

Atamturk D. Düz ve yüksek tabanlığın temel antropometrik değişkenlerle ilişkisi. Acta Orthop Traumatol Turc. 2009;43(3):254-9.

Cetin A, Sevil S, Karaoglu L, Yucekaya B. Prevalence of flat foot among elementary school students, in rural and urban areas and at suburbs in Anatolia. European Journal of Orthopaedic Surgery & Traumatology. 2011;21:327-31.

Eluwa M, Omini R, Kpela T, Ekanem T, Akpantah A. The incidence of pes planus amongst Akwa Ibom State students in the University of Calabar. The Internet Journal of Forensic Science. 2009;3(2):1-5.

Bhoir MT. Prevalence of flat foot among 18-25 years old physiotherapy students: cross sectional study. 2012.

Daneshmandi H, Rahnema N, Mehdizadeh R. Relationship between obesity and flatfoot in high-school boys and girls. International Journal of Sports Science and Engineering. 2009;3(1):43-9.

MOSTAJABI F. A comparative study of reference data for body mass index of school children in Shiraz (southern Iran) and CDC standards. 2007.

Janse Van Rensburg DC, Nolte K. Sports injuries in adults: overview of clinical examination and management: CPD article. South African Family Practice. 2011;53(1):21-7.

Bhoir MT. Prevalence of flat foot among 18-25 years old physiotherapy students: cross sectional study. 2009.