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Flat Foot based on Clarke's Angle Method and Overweight among Medical Students of Universitas Airlangga

Nelsya Safira Aulia Putri[1], Lydia Arfianti[2,3*], Andre Triadi Desnantyo[4,5], Indrayuni Lukitra Wardhani[2,3]

[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.
[3]The Indonesian Association of Physical Medicine and Rehabilitation (PERDOSRI) East Java Chapter, Surabaya, Indonesia.
[4]Department of Orthopaedic and Traumatology, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.
[5]Indonesian Orthopaedic Association (PABOI) East Java Chapter, Surabaya, Indonesia.

* Corresponding author: lydia.arfianti@fk.unair.ac.id

ABSTRACT

Introduction: A flat foot is an arch deformity, and being overweight is one of the risk factors. It can cause problems such as fatigue, pain in the ankle and back, foot pain (especially during long walks or sports), and disturbances in balance and walking patterns. This study examined the relationship between flat feet (measured using Clarke's angle) and overweight students at the Faculty of Medicine, Universitas Airlangga.

Methods: This study used an observational analytic design with a cross-sectional method, gathering primary data directly from the research sample. The data were analyzed using the International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) version 26 with a $p<0.05$ considered statistically significant.

Results: Of the 56 samples meeting inclusion criteria, most flat foot cases occurred in males. A total of 36 research subjects were overweight or obese, evenly split between females and males. Among the 112 samples, 19 had flat feet, and 93 did not. Chi-square test analysis indicated a highly significant ($p=0.001$), suggesting a significant relationship between flat feet and overweight.

Conclusion: Flat feet (measured using Clarke's angle) had a significant relationship with overweight. Most subjects in this study were overweight based on body mass index (BMI), and most had a non-flat foot arch type. All cases of flat foot were found in subjects with overweight BMI.

Highlights:
1. Being overweight can be one of the causes of flat foot.
2. A person with flat feet may experience pain in the medial malleolus area and discomfort when tiptoeing.

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Introduction

The bones in the feet are not in a single horizontal plane but form an arch that absorbs and distributes the body's weight when standing upright and moving on different surfaces. The foot arch also facilitates the foot's efficient function.[1,2] The foot's structure is an inherent factor that can influence biomechanics and motoric performance, affecting postural control and potentially causing balance disturbances. When this is disrupted, it can increase the potential risk of injuries to the lower extremities, particularly the ankle, followed by the knee, hip, and thigh.[3] An abnormality in the foot arch, known as flat foot, can lead to various issues, including fatigue and pain in the ankle and back, pain in the foot, especially in the ankle area, during long walks or sports activities, and disturbances in balance and walking patterns.[4] A flat foot can be caused by the collapse of the longitudinal arch in the foot, which reduces its ability to function as a rigid lever system for propelling the body during the push-off phase of walking, resulting in complaints of fatigue and limiting walking activities.[5] In the study conducted by Kennedy, *et al.* (2023), it was found that flat or normal arch foot did not significantly correlate with agility.[6] Several factors can influence the development of a flat foot, including congenital factors, muscle or ligament weakness, prolonged use and type of footwear, overweight, and obesity.[7]

According to the 2016 data from the World Health Organization (WHO), 39% of adults aged 18 years old and above, with 39% being men and 40% women, were reported to be overweight.[7] Additionally, there has been a significant rise in the prevalence of overweight and obesity among children and adolescents aged 5-19 years old, escalating from just 4% in 1975 to over 18% in 2016.[8] Factors influencing the occurrence of overweight and obesity include a lack of physical activity, an unbalanced diet, excessive intake of macronutrients, a habit of consuming fast food, and a family history of obesity.[9] According to a previous study, sleep duration influenced excess body mass index (BMI).[10] Overweight represents an abnormal accumulation of lipids, posing potential health risks.[11–13]

The prevalence of flat foot incidence in a single country is not yet clearly known. Several studies have been conducted to determine the number of flat foot cases on a small scale, such as a study in Ethiopia, Africa, involving 823 subjects aged 11-15, which found a prevalence of 17.6% for flat feet.[14] A study conducted on students in Medan, Indonesia, revealed that 43 out of 76 students (56.6%) had flat feet.[1] Early detection of the flat foot has been performed in various places, including a study conducted by Aulia (2018) on elementary school students aged 6-10 years old in Cibentang, Indonesia, using the Chippaux-Smirak index method, and a study conducted by Rejeki, *et al*. (2018) on kindergarten students aged 5-6 years old in Surabaya, Indonesia, using Clarke's Angle.[15,16] Additionally, a study by Alsuhaymi et al. (2019) screened flat feet using the Staheli index on children between the ages of 7 to 14 years old in Al-Madinah al-Munawwarah, Saudi Arabia.[17]

Various procedures can be employed to determine the type or shape of someone's foot arch, such as clinical diagnosis, X-ray examinations, and footprint analysis. Footprint analysis is considered a cost-effective, faster, more efficient, widely available, and more straightforward diagnostic approach for diagnosing flat feet. The standard techniques for analyzing footprints include Clarke's angle, the Chippaux-Smirak index, and the Staheli index.[3]

Given the absence of research conducted using Clarke's angle method and the lack of research concerning the relationship between flat foot and overweight in Surabaya, this study aimed to investigate whether there was a correlation between flat foot based on Clarke's angle method and overweight among the medical students of Universitas Airlangga batch 2020.[3]

Methods

This study used an observational analytical design with a cross-sectional method to determine the relationship between flat feet based on Clarke's angle method and overweight. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.[18]

The population of this study consisted of the medical students of Universitas Airlangga batch 2020. Consecutive sampling was the sampling technique that involved selecting samples that met the research criteria until the predetermined sample size was reached. The minimum required sample size for this study to assess the relationship between variables, based on the formula for comparing two proportions, was 48 students. Inclusion criteria for research subjects were active medical students at Universitas Airlangga, aged 18 to 22 years old, who expressed a willingness to participate in the study. Exclusion criteria for research subjects included non-intact skin on the sole and anatomically incomplete feet.

This study used primary data, including height, weight, BMI, and footprint measurements. Weight (kilograms/kg) was measured using a standardized digital scale, while height (centimeters/cm) was measured using a microtome adhering to the device's instructions. These data were manually calculated to derive BMI. Body mass index was computed by dividing the weight (kilograms) by the square of the height (measured in meters).[11] This study categorized BMI into two groups: overweight and non-overweight. The overweight category included overweight, obesity 1, and obesity 2, while the non-overweight category encompassed underweight and normal weight.

Footprints were obtained using the wet footprint test technique, using skin-safe ink and paper. After capturing the footprints, angle measurements were taken to determine the foot arch type using Clarke's angle method. A previous study found that measuring the angle of the foot arch using Clarke's angle method had the highest sensitivity compared to other methods, such as the Chippaux-Smirak index and the Staheli index, which were also used to measure the angles from footprints.[3] The sensitivity of Clarke's angle method was 97%. The foot arch type in this study was divided into two categories: flat foot

and non-flat foot. The flat foot category encompassed only flat feet, while the non-flat foot category included normal and cavus feet. The minimum required sample size for this study, as determined by the formula for comparing two proportions, was 48 students.

Data Analysis

The analysis of data in this study was conducted using the International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) version 26.[19] This study utilised bivariate analysis, employing the Chi-square test, for the statistical examination.[19]

Results

A total of 56 students were willing to participate. Students who met the inclusion criteria were enrolled in this study, meeting the minimum sample size of 112 footprints as determined previously using the formula for comparing two proportions.

Table 1. Characteristics of research subjects (n=56)

Characteristics	Type Variables	n (%)
Sex	Female	36 (64.3%)
	Male	20 (35.7%)
Age (years old)	19	1 (1.8%)
	20	27 (48.2%)
	21	23 (41.1%)
	22	5 (8.9%)
Body mass index	Overweight	36 (64.3%)
	Non-overweight	20 (35.7%)
Foot arch type*	Flat foot	19 (17%)
	Non-flat foot	93 (83%)

*measure both feet
Source: Research data, processed

The majority of the 56 subjects in this study were females, totalling 36 students (64.3%). Based on age, most subjects were 20 years old, totaling 27 students (48.2%). After processing and calculating BMI, it was found that 36 students (64.3%) met the criteria for being overweight (Table 1).

Table 2. Distribution of body mass index based on gender and age (n=56)

Distribution	Overweight	Non-Overweight
Sex	**n (%)**	**n (%)**
Female	18 (32.1%)	18 (32.1%)
Male	18 (32.1%)	2 (3.6%)
Total	36 (64.3%)	20 (35.7%)
Age (years old)	**n (%)**	**n (%)**
19	0 (0%)	1 (1.8%)
20	20 (35.7%)	7 (12.5%)
21	14 (25%)	9 (16%)
22	2 (3.6%)	3 (5.4%)
Total	36 (64.3%)	20 (35.7%)

Source: Research data, processed

The age group with the highest overweight incidence was 20 years old, with a total of 20 students (35.7%), and there were no subjects with overweight at 19 years old.

The number of females and males overweight was equal, totaling 18 students (32.2%). In the non-overweight category, there were 18 females (32.2%) and 2 males (3.6%) (Table 2).

Table 3. Distribution of foot arch types based on gender, age, and body mass index (n=112)

Distribution	Foot Arch Type	
	Flat Foot	Non-Flat Foot
Sex	**n (%)**	**n (%)**
Female	5 (4.5%)	72 (64.3%)
Male	14 (12.5%)	21 (18.7%)
Age (years old)		
19	0 (0%)	2 (1.8%)
20	13 (11.6%)	41 (36.6%)
21	4 (3.6%)	42 (37.5%)
22	2 (1.8%)	8 (7.1%)
Body Mass Index		
Overweight	19 (17%)	40 (35.7%)
Non-overweight	0 (0%)	53 (47.3%)

Source: Research data, processed

Gender with the flat foot category was most commonly found in males, with 14 students (12.5%). Meanwhile, gender with the non-flat foot category was most commonly found in females, with 72 students (64.3%) from the footprint samples. Table 3 shows that the age group with the flat foot category was most commonly found at 20 years old, with a total of 13 students (11.6%). Meanwhile, the age group with the non-flat foot category was most commonly found at 21 years old, with 42 students (37.5%).

Table 4. Additional data

Question	Answer	n (%)
Ever experienced pain in the medial malleolus area (within the last month)	Yes	3 (30%)
	No	7 (70%)
Ever experienced pain when tiptoeing (within the last month)	Yes	2 (20%)
	No	8 (80%)
Ever had the sole of a shoe worn out only on one side (on the medial part)	Yes	4 (40%)
	No	6 (60%)
The soles of the feet appear flat since birth	Yes	1 (10%)
	No	4 (40%)
	Do not know	5 (50%)
Types of shoes used daily (during classes)	Formal	3 (30%)
	Casual	7 (70%)

Source: Research data, processed

The additional data in this study was collected after the initial data collection, and it was known which arch type each research subject had. This additional data was only collected from research subjects with a flat foot arch type.

Table 5. The result of the analysis test

Body Mass Index	Foot Arch Type		*p*-value[A]
	Flat Foot	Non-Flat Foot	
Overweight	19 (17%)	53 (47.3%)	< 0.001
Non-overweight	0 (0%)	40 (35.7%)	
Total	19 (17%)	93 (42%)	

A: according to the Chi-square test
Source: Research data, processed

Discussion

This study found that most students with flat feet were males, with 14 male students (12.5%) having flat feet compared to 5 female students (4.5%). These results are consistent with the study conducted by Adiputra, *et al*. (2022) in the 18-24 years old age group, which revealed a greater prevalence of flat feet in males in contrast to females, with 11 males and 4 females having flat feet.[20] However, these findings differ from the study conducted by Jayabandara, *et al*. (2021) in the 19-26 years old age group, where they found a higher proportion of flat feet in females compared to males, with 75% females and 25% males from 533 participants having a flat foot.[21] Raj, *et al*. (2022) found no relationship between gender and flat foot, either flexible or rigid.[22] The data was analyzed using Pearson's Chi-square and Fisher exact tests.[22]

The students included in this study were approximately 19 to 22 years old, during which the foot arch did not undergo significant changes. Xu, *et al*. (2022), who utilized systematic review and meta-analysis research techniques, concluded through meta-analysis that the prevalence of flat feet in children was 25% in the last 20 years, and the proportion of flat feet decreased with age.[23] As people age, flat feet gradually decrease, aligning with the normative physiological development observed in flat foot conditions. However, the development of foot arches may not follow a continuous developmental process like height or weight growth patterns.[24] Among the 56 research subjects with 112 study samples, the highest percentage of flat foot cases was found among 20 years old, with 13 study samples (11.6%).[24]

Based on body mass index calculations, 36 students (64.3%) were found to be overweight or obese, with an equal number of males and females experiencing overweight (18 students or 32.2%). Regarding age, the highest occurrence of overweight was at 20 years old, with 20 students (35.7%). Data from the Ministry of Health of the Republic of Indonesia indicated that the prevalence of overweight and obesity among infants, children, and adolescents is increasing in many countries.[15] In 2016, there was a more than threefold increase in the prevalence of excess weight compared to 1975, with over 1.9 billion adults aged 18 years old and older being overweight and more than 650 million people being obese in 2016.[8] Among the 112 study samples, the highest occurrence of flat foot was observed in the overweight category, which included obesity, with 19 students (17%). This data is supported by a study conducted by Azzahra *et al*. (2020), which concluded that the highest occurrence of flat foot was found in individuals with overweight and obesity based on BMI.[24] In that study, 58 samples from the overweight and obesity categories experienced flat feet.[24] Both of these results align with the findings from the study by Amir, *et al*. (2021), which indicated that individuals with an overweight BMI were 5.4 times more likely to be at risk of developing flat feet than those with a normal BMI.[25]

After conducting the wet footprint test on both the right and left foot and measuring manually using Clarke's angle method and the integrated circuit (IC) measure application, out of 112 students, 19 samples (17%) were classified as flat foot, and 93 samples (83%) were categorized as non-flat foot (normal and cavus foot). In this study, students could have different arch types in their right and left foot, which differs from the study conducted by Ramadany and Pasaribu (2021), where they found flat feet in 56.6% of subjects, normal feet in 42.1%, and cavus foot in 1.3%.[1] In their study, subjects had the same arch type in both right and left foot.[1] No research has explained why right and left foot arch types differ. Even so, it is assumed that someone may be more dominant in using one foot for support, which can affect the arch type and result in differences between the arch types of an individual's right and left foot.[26]

Additional data from 10 research subjects with flat foot arches revealed that 3 students (30%) experienced pain in the medial malleolus area, and 2 (20%) of 10 students experienced pain when tiptoeing the previous month. These findings are similar to an earlier study that found 7 (21%) out of 41 subjects with flexible flat feet experienced pain.[27] That study also concluded no significant relationship between flexible flat foot and foot pain.[27] Only 1 student (10%) had a flat foot since birth, while the remaining 9 students (90%) either answered "no" or "do not know." This could not be excluded because the authors conducted cross-sectional subject selection at the current time. The everyday footwear used by students with flat feet was casual shoes, with 7 students (70%). A previous study has indicated that a flat foot can be managed by installing medial arch support in the shoe insole.[27] Medial arch support aims to support the foot, thereby improving longitudinal arch stability and functioning as a weight-bearing point on the foot. The study found that using medial arch support for children with flat feet effectively decreased pain and valgus index.[28]

The relationship between flat feet and overweight among medical students of Universitas Airlangga batch 2020 in this study was analyzed using the Chi-square test. The Chi-square test results indicated a p-value of less than 0.001 ($p<0.05$), leading to the conclusion that there was a significant relationship between flat feet and overweight. These findings align with the study of Amir, *et al*. (2021), which also found a significant relationship between being overweight and the risk of developing a flat foot. In that study, individuals with an overweight BMI were 5.4 times more likely to be at risk of developing flat feet compared to those with a normal BMI.[25] Similar results were also found in a study by Ramadany and Pasaribu (2021), who discovered a significant correlation between BMI and arch index values in the research sample of medical students from Universitas Islam Sumatera Utara (UISU).[1]

Strength and Limitations

One notable strength of this study is that it is the first to evaluate the relationship between flat feet and overweight in Surabaya. This study used Clark's angle method, which has higher sensitivity than others. However, it is essential to recognize the limitations of this study. The subjects in this study were limited to medical students of the Faculty of Medicine, Universitas Airlangga, and did not represent a

population study. Furthermore, there were uncontrolled confounding variables in this study that could be causative factors for both flat feet and overweight, such as physical activity, footwear type, specific medical history, and dietary patterns.

Conclusion

There was a significant relationship between flat feet measured using Clarke's angle method and being overweight. The majority of research subjects had an overweight BMI, and most had a non-flat foot arch type. All instances of flat feet were found in subjects with an overweight BMI. Future research needs to be conducted in multiple centers to enable flat foot screening in a broader population and to screen for flat feet among overweight students.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Ethical Clearance

This study had received ethical clearance from the Ethics Committee of the Faculty of Medicine, Universitas Airlangga (No.227/EC/KEPK/FKUA/2022) on 11/30/2022.

Authors' Contributions

Conceptualization by NSA, LA, and ATD. Methodology by NSA, LA, and ATD. The NSA conducted formal analysis and investigation. The original draft was prepared by NSA, LA, ATD, and ILW. NSA, LA, ATD, and ILW were responsible for the writing, review, and editing. Resources from LA, ATD, and ILW. Supervision by LA, ATD, ILW. All authors reviewed and approved the final version of the manuscript.

References

1. Ramadany A, Pasaribu SR. Pengaruh Indeks Massa Tubuh terhadap Indeks Lengkung Telapak Kaki Mahasiswa dan Mahasiswi FK UISU. *J Kedokt Ibnu Nafis* 2021; 10: 93–100. [Journal]
2. Buldt AK, Forghany S, Landorf KB, *et al*. Foot Posture is Associated with Plantar Pressure during Gait: A Comparison of Normal, Planus and Cavus Feet. *Gait Posture* 2018; 62: 235–240. [PubMed]
3. Juniartha I, Tinduh D, Nugraheni N, *et al*. The Validity and Reliability of Various Footprint Analysis in Flatfoot Diagnosis of Competitive Athletes. *Bali Med J* 2023; 12: 851–856. [Journal]
4. Kumala MS, Tinduh D, Poerwandari D. Comparison of Lower Extremities Physical Performance on Male Young Adult Athletes with Normal Foot and Flatfoot. *Surabaya Phys Med Rehabil J* 2019; 1: 6–13. [Journal]
5. Antara KA, Adiputra IN, Sugiritama IW. The Correlation between Flat Foot with Static and Dynamic Balance in Elementary School Children 4 Tonja Denpasar City. *Maj Ilm Fisioter Indones* 2017; 5: 23–26. [Journal]
6. Kennedy B, Tinduh D, Utami DA, *et al*. Comparison of Agility between the Flat Foot and Normal Foot in East Java Puslatda Athletes. *Bali Med J* 2023; 12: 369–373. [Journal]
7. Imania DR, Haq AN. Pengaruh Short Foot Excercisedan Tibialis Posterior Strengthening terhadap Keseimbangan Dinamis pada Penderita Flat Foot Remaja Narrative Review. *J Phys Ther UNISA* 2021; 1: 8–14. [Journal]
8. Vaamonde J, Alvarez de Mon M. Obesidad y Sobrepeso. *Med - Programa Form Médica Contin Acreditado* 2020; 13: 767–776. [PubMed]
9. Banjarnahor RO, Banurea FF, Panjaitan JO, *et al*. Faktor-Faktor Risiko Penyebab Kelebihan Berat Badan dan Obesitas pada Anak dan Remaja: Studi Literatur. *Trop Public Heal J* 2022; 2: 35–45. [ResearchGate]
10. Yogiswara N, Fatmaningrum W, Herawati L. Sleep Duration Determines Excess Body Mass Index among Young Adults in Surabaya. *JUXTA J Ilm Mhs Kedokt Univ Airlangga* 2022; 13: 18–21. [Journal]
11. Zafar U, Haque MUU, Naeem FJ, *et al*. Blood Pressure and Anthropometry Obesity Indices in First Professional Medical Students at a Private Medical College of Pakistan - A Cross-Sectional Study: Blood Pressure and Anthropometry Obesity Indices. *J Community Med Public Heal Res* 2022; 4: 14–24. [ResearchGate]
12. Putri SN, Santoso B, Budiono B. Sedentary Lifestyle and Overweight in Relation to the Risk of Polycystic Ovary Syndrome in Senior High School Students in Surabaya. *JUXTA J Ilm Mhs Kedokt Univ Airlangga* 2022; 13: 57–61. [Journal]
13. As'ad MRF, Liben P, Herawati L. Mechanism of Physical Exercise on Lowering Levels of C-Reactive Protein (CRP) in Overweight and Obese. *Folia Medica Indones* 2021; 57: 82–89. [Journal]
14. Abich Y, Mihiret T, Yihunie Akalu T, *et al*. Flatfoot and Associated Factors among Ethiopian School Children Aged 11 to 15 Years: A School-Based Study. *PLoS One* 2020; 15: e0238001. [Journal]
15. Aulia R. *Hubungan Indeks Massa Tubuh (IMT) terhadap Kaki* Flatfoot *pada Siswa-Siswi Sekolah Dasar Negeri 01 Cibentang Bogor*. Faculty of Medicine Universitas 'Aisyiyah Yogyakarta, (2019). [Website]
16. Rejeki PS, Irwadi I, Widiarti W, *et al*. Correlation Between Body Mass Index and Medial Longitudinal Arch of The Foot in Children Aged 5–6 Years. In: *Proceedings of Surabaya International Physiology Seminar (SIPS)*. Surabaya: SciTePress Digital Library, pp. 230–233. [Proceeding]
17. Alsuhaymi AM, Almohammadi FF, Alharbi OA, *et al*. Flatfoot among School-Age Children in Almadinah Almunawwarah: Prevalence and Risk Factors. *J Musculoskelet Surg Res* 2019; 3: 204–208. [ResearchGate]
18. Cuschieri S. The STROBE Guidelines. *Saudi J Anaesth* 2019; 13: S31–S34. [PubMed]

19. Nie NH, Bent DH, Hull CH. Statistical Package for the Social Sciences (SPSS), (2018). [Website]
20. Adiputra R, Wahyuni OD. Hubungan Indeks Massa Tubuh (IMT) terhadap Flat Foot pada Mahasiswa Universitas Tarumanagara. *Ebers Papyrus* 2022; 28: 58–66. [Journal]
21. Jayabandara A, Rodrigo D, Nadeeshan S, *et al*. Prevalence of Flatfoot and Its Correlation with Age, Gender and BMI among Undergraduates at the Faculty of Allied Health Sciences, General Sir John Kotelawela Defence University. *J Pharm Pharmacol*; 9. 28 August 2021. [ResearchGate]
22. Raj R, Appaji A, Ajoy S. Flat Foot in 14-16 Years Old Adolescents and Its Association with BMI and Sports Activity. *J Clin DIAGNOSTIC Res*; 16. 1 June 2022. [ResearchGate]
23. Xu L, Gu H, Zhang Y, *et al*. Risk Factors of Flatfoot in Children: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health*; 19. July 2022. [PubMed]
24. Azzahra S, Purwaningastuti DA, Citrawati M. Hubungan Indeks Massa Tubuh yang Tinggi (Obesitas) dengan Kejadian *Flat Feet* pada Mahasiswa Fakultas Kedokteran UPN Veteran Jakarta Tahun Ajaran 2019/2020. *Anat Med JOURNAL| AMJ* 2020; 3: 128–136. [Journal]
25. Amir TL, Maulidina H, Novianti ND, *et al*. Hubungan antara Overweight dengan Risiko Terjadinya. *Indones J Physiother Res Educ* 2021; 2: 46–53. [Journal]
26. Yu P, Liang M, Ren F. Locomotion Variations of Arch Index and Interlimb Symmetry in Shod and Barefoot Populations. *Appl Bionics Biomech* 2020; 2020: 7610789. [PubMed]
27. Akbar MF. *Hubungan Flexible Flat Foot terhadap Nyeri Kaki pada Mahasiswa Program Studi Kedokteran Fakultas Kedokteran UIN Syarif Hidayatullah Jakarta*. Universitas Islam Negeri Syarif Hidayatullah Jakarta, (2020). [Website]
28. Hidayat WT. *Efektivitas Arch Support terhadap Anak dengan Gangguan Flat Foot: Narative Review*. Faculty of Medicine Universitas 'Aisyiyah Yogyakarta, (2021). [Website]