

Correlation between Flatfoot and Postural Balance in Children Aged 7-12 Years

¹Alinda Nur Ramadhani, ²Dea Linia Romadhoni

^{1,2}Program Studi DIV Fisioterapi, Fakultas Ilmu Kesehatan, Universitas 'Aisyiyah Surakarta

Email: alinda.ramadhani@aiska-university.ac.id

Submission : 2024-02-04 ; Accepted : 2024-02-20; Published : 2024-06-01

ABSTRACT

Flatfoot is characterized by a decrease or flattening of the medial longitudinal arch of the foot. Flatfoot can also occur physiologically, which is then referred to as flexible flatfoot. Normally the arch of the foot is formed in the first five years of life at an age range of 2-6 years. The arch of the foot plays an important role in absorbing ground reaction forces and supporting the body's weight during activities.

The research design uses a cross-sectional study approach, which aims to find or study the relationship between flatfoot and balance in children aged 7-12 years. A total of 32 respondents aged 7-12 years who met the inclusion criteria were obtained through flatfoot examination using a wet footprint examination and balance examination using the Pediatric Balance Scale.

The results of the Pearson Correlation Test show a significance value of 0.031 ($p < 0.05$) between the variables flatfoot and balance, which means there is a relationship between flatfoot and balance in children aged 7-12 years. The correlation coefficient value is 0.383, which means that the strength of the relationship between the two variables is quite strong with the direction of the relationship being positive, which means that the higher the degree of flatfoot in the child, the lower the child's balance.

Keywords: flatfoot; postural balance; children.

ISSN 2722 – 9610
 E –ISSN 2722 - 9629

INTRODUCTION

The feet play a role in supporting body weight. One of the impairments that occur in the the feet is flatfoot, and commonly found in children (Sativani *et al.*, 2020). Flatfoot is characterized by a decrease or flattening of the medial longitudinal arch of the foot. Flatfoot in children in general can cause certain clinical manifestations. In general, flatfoot can also occur physiologically, which is then referred to as flexible flatfoot (Xu *et al.*, 2022).

Foot deformity in the form of flatfoot in the long term will cause pain in the soles of the feet, ankles and knees. Apart from that, it will cause repeated acute trauma resulting in foot deformity. Foot deformities occur due to disturbances in the process of forming the foot arch or due to weakness of the muscles and ligaments laxity in the foot (Sativani *et al.*, 2020; Xu *et al.*, 2022). Flatfoot is a condition that is mostly caused by physiological factors and does not require

surgery. Normally the arch of the foot is formed in the first five years of life at an age range of 2-6 years. The arch of the foot plays an important role in absorbing ground reaction forces and supporting the body's weight during activities (Sativani *et al.*, 2020).

Flatfoot also known as pes planus, is a foot deformity characterized by the absence of the medial arch of the foot, which is usually covered by excessive fatty tissue (Uden *et al.*, 2017). This condition occurs mainly in children, which in principle can be physiological. The formation of foot arches begins in the first 5 years of life with a range of 2-5 years. Flatfoot most often occur in children and are rarely found in adults (Romanova *et al.*, 2022). Anatomical manifestations of changes in the medial longitudinal arch are ligament laxity, torsional deformity and vertical talus. This condition caused by several factors such as overweight, obesity, type of footwear, weakness of the

muscles that support medial arch, foot injuries and congenital deformities (Curtin *et al.*, 2019; Medina-alcantara *et al.*, 2019; Nozaki *et al.*, 2020)

Pathological flatfoot can cause changes in muscle balance, changes in gait, pain and result in decreased physical capacity in adulthood (Mulyoto *et al.*, 2022; Sagat *et al.*, 2023), and in general it can affect the quality of life, especially in physical activity and foot function domain (De *et al.*, 2014).

Several studies have examined the relationship between flatfoot and child development, especially motor development. This study aims to determine the relationship between flatfoot and postural balance in children aged 7-12 years.

METHOD

This research is qualitative research with an observational research design. The research design uses a cross-sectional study approach, which aims to find or study the relationship between the dependent and independent variables studied at the same time. This research was conducted at SD Muhammadiyah 7, Surakarta in May-July 2023.

The sampling method used was purposive sampling by applying the following inclusion, exclusion and dropout criteria. Inclusion criteria: 1) Children 7-12 years old; 2) Children with flatfoot based on wet footprint examination; 4) Children with balance disorders based on the Pediatric Balance Scale (PBS) examination, with a score below 56. Exclusion criteria: 1) Children with a history of bone, muscle or ligaments injury in lower extremity; 2) Children with neuromuscular or congenital disorders that affect postural balance. The number of subjects obtained was 32 children.

The Wet Footprint Test is an examination carried out to determine the height and low of the arch on the feet through footprints using ink or plain water (wet test). In the wet footprint test, the shape of the arch of the foot is determined by wetting the foot, then placing it on a piece of paper so that the paper Footprints will appear. In previous research, validity and reliability tests were carried out on 77 respondents, obtaining a

Cornbach's alpha result of 0.77 (Banwell *et al.*, 2018).

The Chippaux-Smirak Index (CSI) is used to measure the degree of flatfoot. Chippaux-Smirak Index (CSI) is the ratio between the widest (segment A) and narrowest (segment B) areas to the border, passing through the metatarsal heads. The results of measuring degrees with CSI are 0 (excessive arch), 0.01-0.29 (normal feet), 0.30-0.39 (moderate arch), 0.40-0.44 (slight arch), ≥ 0.45 (flatfoot) (Traumatologia and Castrovillari, 2023).

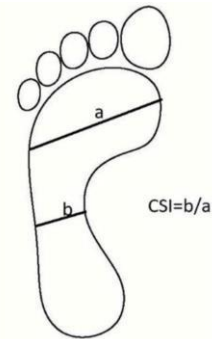


Figure 1. Chippaux-Smirak Index

Pediatric Balance Scale (PBS) is a measuring tool that has 14 items with a scale value of 0-4 (a scale based on the quality and time needed to complete the test) which is used to assess balance in children. The interpretation of this measuring instrument is that the lowest score is zero (0) and the highest score is 56 points. This measuring tool can detect balance disorders in children and can also monitor the progress of therapy programs (Article, 2015).

Univariate analysis used to present data obtained from data collection in the form of frequency distribution tables. Subject characteristics included age, gender, degree of flatfoot and postural balance. Bivariate analysis is used to describe the cross tabulation between each independent and dependent variable and look for correlations between the two variables. In this study, the Pearson Correlation Test was used to determine the relationship between the two variables. The correlation coefficient has a value of -1 to 1 with the meaning that if the correlation value approaches 1, the correlation between variables is stronger.

RESULTS AND DISCUSSION

Characteristics of Respondents Based on Age

Table 1 shows that the research subjects were 32 children aged 7-12 years with the highest frequency distribution being in the age range 7-9 years (84.4%). The results of this study show that flatfoot conditions are often found at a younger age. In a cross-sectional study, it was found that the younger the child, the greater the possibility of the child experiencing flatfoot (Abich *et al.*, 2020). In several studies, it is known that the prevalence of flatfoot in children and adolescents has decreased in trend from 72.6% to 37.9% at the age of 7-12 years. This means that the prevalence of flatfoot in adolescents is greater than in children (Peng *et al.*, 2020).

Table 1. Characteristics of Respondent Based on Age

Age	Frequency (n)	Percentage
7-9 y.o	27	84,4%
10-12 y.o	5	15,6%
Total	32	100%

Characteristics of Respondents Based on Gender

Table 2 shows that the research subjects with the highest frequency distribution were men with a percentage of 56.3%, while women were 46.8%.

Table 2. Characteristics of Respondent Based on Gender

Gender	Frequency (n)	Percentage
Male	18	56,3%
Female	14	46,8%
Total	32	100%

Degree of Flatfoot Based on Chippaux-Smirak Index Measurement

Based on table 3, the results showed that there were 26 (68.8%) subjects with grade 1 flatfoot and 6 subjects (31.2%) with grade 2 flatfoot. The research results showed that all research subjects experienced flexible flatfoot with degrees 1 and 2. Flexible flatfoot in children is related to the physiological development process of immature foot structures. With gradual development and

growth, the plantar fat gradually decreases, the valgus condition decreases and the longitudinal and transverse arches begin to develop significantly (Carr, Yang and Lather, 2016; Xu *et al.*, 2022).

Table 3. Degree of Flatfoot Based on Chippaux-Smirak Index

Flatfoot Degree	Frequency (n)	Percentage
1	22	68,8%
2	10	31,2%
3	0	0%
Total	32	100%

Postural Balance Score

Based on table 4, the results showed that subjects with a balance score of 53-54 were 15 children (46.9%), a score of 55 was 12 children (37.5%) and 50-52 was 15.6%.

Table 4. Pediatric Balance Scale Score

Score	Frequency (n)	Percentage
50-52	5	15,6%
53-54	15	46,9%
55	12	37,5%
Total	32	100%

Bivariate analysis in this study was used to determine the correlation between flatfoot and balance in children aged 7-12 years.

Table 5. Pearson Correlation Test Results

Variables	Pearson Correlation	Sig. (2-tailed)	N
Flatfoot-Balance	0,383	0,031	32

The results of the Pearson Correlation Test show a significance value of 0.031 ($p < 0.05$) between the variables flatfoot and balance, which means there is a relationship between the condition of flatfoot and balance in children aged 7-12 years. The correlation coefficient value is 0.383, which means that the strength of the relationship

between the two variables is quite strong with a positive relationship direction, which means that the higher the degree of flatfoot in the child, the lower the child's balance. The results of this study are in line with several previous studies, that flatfoot conditions are related to static or dynamic balance in children (Biomedika *et al.*, 2020; Latifah *et al.*, 2021).

The type or structure of the foot influences how much force or pressure is exerted on the plantar surface of the foot when walking and running. The medial, lateral longitudinal and transverse arches contribute to maintaining stability through their functional role as absorbers of compressive forces for body weight. When standing on one flat foot, postural control requires coordination of the somatosensory, vestibular and visual systems. When standing on one leg with a change in the flat surface of the foot causes the base of support to decrease, resulting in more challenging conditions for maintaining body balance (Mulyoto *et al.*, 2022; Park *et al.*, 2020).

The results of biomechanical studies that combine kinematic and kinetic parameters of walking show that flatfoot can result in different rotational forces predominantly in the lower limbs and slower muscle activation (Sagat *et al.*, 2023). Flatfoot can cause the lower leg to tend to overpronate, resulting in excessive internal rotation, especially in the tibia. This can cause a shift in pelvic alignment towards the anterior. Changes in foot alignment can affect the center of gravity (COG), where if the center of gravity changes it can cause balance disorders (Syafii, Pudjiastuti and K., 2016; Latifah *et al.*, 2021).

CONCLUSION

The research results show that there is a correlation between flatfoot and postural balance in children aged 7-12 years with a significance value of 0.031 ($p < 0.05$), with a correlation value of $r = 0.38$, which means the strength of the correlation between the two variables is low.

ACKNOWLEDGEMENT

The author would like to express gratitude to Universitas 'Aisyiyah Surakarta, which has

provided funding for this research with contract number: 183/III/P3M/2023.

REFERENCES

- Abich, Y. *et al.* (2020) 'Flatfoot and associated factors among Ethiopian school children aged 11 to 15 years: A school-based study', 8, pp. 1–14. doi: 10.1371/journal.pone.0238001.
- Lim, H. (2015) 'Correlation between the selective control assessment of lower extremity and pediatric balance scale scores in children with spastic cerebral palsy'. *Phys Ther Sci*; 27(12):3645-9. doi: 10.1589/jpts.27.3645.
- Banwell, H. A. Paris ME, Mackintosh S, Williams CM. (2018) 'Paediatric flexible flat foot : how are we measuring it and are we getting it right? A systematic review'. *J Foot Ankle Res*; 11:21. pp. 1–13. doi: 10.1186/s13047-018-0264-3.
- Biomedika, J. *et al.* (2020) 'Hubungan pes planus dan keseimbangan statis pada anak sekolah dasar', 3(2), pp. 84–89. doi: 10.18051/JBiomedKes.2020.v3.84-89.
- Carr, J. B., Yang, S. and Lather, L. A. (2016) 'Pediatric pes planus: A stateofthe-art review', *Pediatrics*, 137(3). doi: 10.1542/peds.2015-1230.
- Curtin, B. *et al.* (2019) 'Foot and Ankle Changes in Dynamic Plantar Pressure for Children with Tarsal Coalition as Compared to Normal Children'. *Int J Foot Ankle*; 3:028, pp. 1–8.
- De, I. *et al.* (2014) 'Colombia Médica The impact of foot arch height on quality of life in 6-12 year olds', 45, pp. 168–172.
- Latifah, Y. *et al.* (2021) 'Hubungan Antara Postur Flat Foot Dengan Keseimbangan Statis Pada Anak Usia 12 Tahun'. *Fisiomu*; 2(1), pp. 1–6. doi: <https://doi.org/10.23917/fisiomu.v2i1.10039>
- Medina-alcantara, M. Morales-Asencio JM, Jimenez-Cebrian AM, Paez-Moguer J, Cervera-Marin JA, Gijon-Nogueron G, Ortega-Avila AB. (2019) 'Influence of Shoe Characteristics on the Development of Valgus Foot in Children'. *J Clin Med*; 8(1):85. doi: 10.3390/jcm8010085.

- Mulyoto, R. R., Jannah, S. M. and Supinganto, A. (2022) 'The Relationship Between Flatfoot And Static Balance In School-Aged Children'. *Academic Physiotherapy Conference Proceeding: Universitas Muhammadiyah Surakarta*.
- Nozaki, S. *et al.* (2020) 'Annals of Anatomy Sex- and age-related morphological variations in the talar articular surfaces of the calcaneus', *Annals of Anatomy*, 229, p. 151468. doi: 10.1016/j.aanat.2020.151468.
- Park, J. Y. *et al.* (2020) 'Effect of schroth rehabilitation exercise program on scolio-me-ter readings, lumbar lordosis and calcaneal valgus angle in patients with idiopathic scoliosis', *Iranian Journal of Public Health*, 49(4), pp. 808–809. doi: 10.18502/ijph.v49i4.3191.\
- Peng, Y. *et al.* (2020) 'Immediate effects of medially posted insoles on lower limb joint contact forces in adult acquired flatfoot: A pilot study', *International Journal of Environmental Research and Public Health*, 17(7). doi: 10.3390/ijerph17072226.
- Romanova, E., Kolokoltsev, M. and Vorozheikin, A. (2022) 'Comprehensive program for flat foot and posture disorders prevention by means of physical education in 6-year-old children'. *Journal of Physical Education and Sport*; 22(11), pp. 2655–2662. doi: 10.7752/jpes.2022.11337.
- Sagat, P. Bartik, P., Stefan, L. *et al.* (2023) 'Are flat feet a disadvantage in performing unilateral and bilateral explosive power and dynamic balance tests in boys? A school-based study', *BMC Musculoskelet Disord* 24, 622. pp. 1–9. doi: <https://doi.org/10.1186/s12891-023-06752-9>
- Sativani, Z. Pahlawi, R. (2020) 'Latihan Penguatan Kaki terhadap Keseimbangan Postural dan Kemampuan Fungsional Kaki pada Anak Usia 6-10 Tahun dengan Flexible Flatfoot', *Jurnal Ilmiah Kesehatan*; 2(3), pp. 99–107. doi: <https://doi.org/10.36590/jika.v2i3.69>
- Syafii, M., Pudjiastuti, S. S. and K., P. P. (2016) 'Beda Pengaruh Arkus Kaki terhadap Keseimbangan Statis Anak Usia 9-12 Tahun di SD Negeri Mojolegi, Teras, Boyolali', *Jurnal Kesehatan*, 7(3), p. 351. doi: 10.26630/jk.v7i3.215.
- Traumatologia, D. O. E. and Castrovillari, O. Di (2023) 'Flat Foot in the Children: a Review of Literature (Expert Opinion) *Journal of Pediatrics & Neonatal Biology*, 8(1), pp. 145–150.
- Uden, H., Scharfbillig, R. and Causby, R. (2017) 'The typically developing paediatric foot : how flat should it be ? A systematic review'. *J Foot Ankle Res*: 10:37. doi: 10.1186/s13047-017-0218-1.
- Xu, L. Gu, H. Zhang, Y. Sun, T. Yu, J. (2022) 'Risk Factors of Flatfoot in Children : A Systematic Review and Meta-Analysis'. *Int J Environ Res Public Health*; 19(14):8247. doi: 10.3390/ijerph19148247.