Medical and Health Journal
Volume 6, Issue 1, 2026, pp. 280-288
e-ISSN: 2807-3541
Open Access: https://jos.unsoed.ac.id/index.php/mhj

Dynamic Balance in Children Aged 10-11 Years With and Without Flat Foot

Berliana Tsania Dewi[1*], Massita Dwi Yuliani[2], Nenden Nursyamsi Agustina[3]
[1]Faculty of Medicine, Jenderal Soedirman University, Purwokerto, Indonesia
[2]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Purwokerto, Indonesia
[3]Department of Pediatric, Faculty of Medicine, Jenderal Soedirman University, Purwokerto, Indonesia

ARTICLE INFO

Article history:
Received June 23, 2026
Revised July 02, 2026
Accepted August 19, 2026
Available online August 25, 2026

Keywords:
Clarke's Angle, Dynamic balance, Flat foot, Y-Balance Test

ABSTRACT

Flat foot is a condition characterized by a decrease or loss of the medial arch of the foot, which can affect the biomechanical function of the lower extremities. These changes have the potential to disrupt weight distribution, balance, and postural control. Dynamic balance is very important for school-age children in daily activities. Research on the relationship between flat foot and dynamic balance in children aged 10-11 years is still limited. This age group has a foot arch that has relatively mature so that flat foot condition can have an impact on fatigue when walking, balance disorder, increased risk of injury, and pain in the feet. This study aimed to determine the relationship between flat feet and dynamic balance in children aged 10-11 years. This study used a cross-sectional design with consecutive sampling of 50 children as the research sample. Subjects consisted of children aged 10-11 years who met the research inclusion criteria. Flat foot assessment used the Wet Footprint Test method with Clarke's Angle parameters. Dynamic balance was measured using the Y-Balance Test. Univariate analysis was performed to describe the characteristics of the research subjects. Bivariate analysis used Fisher's Exact Test to assess the relationship between flat foot and dynamic balance. The results showed that the most subjects (90%) had abnormal dynamic balance. Abnormal dynamic balance was found in 84% of subjects in the flat foot group and 96% of subjects in the non-flat foot group. The results of the Fisher Exact Test analysis showed that there was no statistically significant relationship between flat foot and dynamic balance (p=0.349; OR=4.571; 95% CI: 0.473-44.170). There is no significant relationship between flat foot and dynamic balance in children aged 10-11 years.

1. INTRODUCTION

Flat foot, also known as *pes planus*, is a condition characterized by the collapse or absence of the medial longitudinal arch, resulting in most or all of the plantar surface coming into contact with the ground. This condition can occur in children of various ages (Latifah *et al*., 2021). Lower extremity deformities are commonly observed in children, and approximately 90% of foot-related complaints are associated with flat foot. Globally, the prevalence of flat foot is estimated to range from 20% to 37%. In Indonesia, the prevalence has been reported to be 48.89% in females and 51.11% in males (Hidayati & Ramadhani, 2025). Among children aged 6–12 years, the prevalence reaches 27.5%, with a higher occurrence in boys than girls (Fitri & Faris, 2024). The variation in the reported prevalence of flat foot across studies may be influenced by differences in population characteristics, age groups, and assessment methods. The prevalence of flat foot tends to be higher in younger children and decreases with increasing age, indicating that differences in age distribution among studies may contribute to variations in prevalence estimates (Xu *et al*., 2022).

The development of the foot arch occurs gradually throughout childhood. The medial longitudinal arch develops rapidly during early childhood, slows down until approximately 10 years of age, and tends to stabilize thereafter with minimal structural changes (Pasaribu *et al*., 2025). Therefore, children aged 10–11 years represent an appropriate age group for assessing persistent flat foot, as the medial longitudinal arch has approached maturation and is less influenced by normal developmental changes seen in younger children (Yamashita *et al*., 2024).

*Corresponding author
E-mail addresses: berliana.tsn@gmail.com (Berliana Tsania Dewi)

Although flat foot may be asymptomatic in some children, alterations in foot structure and function can affect gait, mobility, physical activity, and health-related quality of life (Liu *et al*., 2024). These functional changes may also alter lower-extremity biomechanics during dynamic activities, potentially increasing mechanical demands on the musculoskeletal system (Zukauskas *et al*., 2023).

Flat foot may affect dynamic balance through changes in foot mechanics and postural control. A reduced medial longitudinal arch may alter load distribution and foot position, which can subsequently affect proprioception and the ability to maintain balance during dynamic activities. Biomechanically, the collapse of the medial longitudinal arch in flat foot can increase foot pronation and alter the distribution of plantar loading during weight-bearing activities. These changes may affect lower-extremity alignment and the sensory feedback generated by the foot, potentially impairing proprioceptive input and postural control during dynamic activities. Evidence from a systematic review and meta-analysis further supports the potential relationship between altered foot mechanics and balance in individuals with flat foot, demonstrating that interventions targeting foot mechanics can improve balance outcomes (Chinpeerasathian *et al*., 2024). Dynamic balance refers to the ability to maintain body stability while moving or during changes in body position. This ability is essential for school-aged children because it supports various physical activities, including walking, playing, and sports participation. Effective physical performance depends on coordination, motor skills, balance, flexibility, and agility (Nisa *et al*., 2024). Dynamic balance is influenced by the interaction of multiple body systems, including the musculoskeletal, proprioceptive, vestibular, visual, and neuromuscular systems (Sari *et al*., 2024).

The impact of flat foot on children's dynamic balance highlights the importance of early detection and appropriate intervention. One approach that may improve dynamic balance in children with flat foot is exercise programs focusing on strengthening foot muscles and improving posture. Flat foot may alter body posture and reduce motor performance because it affects the function of muscles, ligaments, and the body's center of gravity, all of which play important roles in maintaining balance and movement (Sativani & Pahlawi, 2020).

Given the potential influence of flat foot on postural control and dynamic balance, previous studies have investigated the relationship between foot structure and balance in children, but their findings have been inconsistent. Manik *et al*. (2023) found a significant correlation between the degree of flat foot and static balance in children aged 10–12 years, with poorer balance observed as the severity of flat foot increased. Importantly, these studies focused on static balance, leaving the relationship between flat foot and dynamic balance less clearly established, particularly among children aged 10–11 years. Further investigation using a dynamic balance assessment may provide a better understanding of whether structural changes associated with flat foot are related to functional balance during movement.

The novelty of this study lies in examining the relationship between flat foot and dynamic balance specifically among children aged 10–11 years, an age group in which the medial longitudinal arch has approached maturation. In contrast to previous studies that have primarily evaluated static balance, this study focuses on dynamic balance using the Y-Balance Test. The Y-Balance Test provides a standardized assessment of dynamic postural control during single-leg stance and reaching movements in multiple directions and has demonstrated good reliability in individuals with flexible flat foot (Zhang *et al*., 2024).

Flat foot is assessed using the Wet Footprint Test with Clarke's Angle to provide a structural measure of the medial longitudinal arch. In addition to addressing the identified research gap, this study provides empirical data on the relationship between flat foot and dynamic balance among elementary school children in Purwokerto, which may contribute to the understanding of this relationship in the local school-aged population. Understanding the relationship between flat foot and dynamic balance may support early screening of balance impairment in school-aged children and help inform appropriate corrective exercise or physiotherapy interventions to improve foot function and postural control. Therefore, this study was conducted to determine the relationship between flat foot and dynamic balance in children aged 10–11 years.

2. METHOD

This study was an analytical observational study with a cross-sectional design conducted at Al Irsyad 2 Elementary School, Purwokerto. Data collection was conducted in May 2026. The study population consisted of 136 students aged 10–11 years at Al Irsyad Al Islamiyyah 02 Elementary School, Purwokerto. A total of 50 participants were selected using a consecutive sampling technique based on the predetermined inclusion and exclusion criteria. Participants who met the eligibility criteria were recruited consecutively until the required sample size of 50 participants was achieved. The inclusion criteria were students aged 10–11 years who were willing to participate in the study and had obtained consent from their parents or guardians. The exclusion criteria included participants with a history of injuries or disorders of the lower extremities that could affect the measurement results.

Primary data were obtained through foot condition assessment and dynamic balance measurements. Foot condition was assessed using the Wet Footprint Test with the Clarke's Angle parameter. The materials used included A4-sized paper for footprint recording and clean water to wet the plantar surface, while the Angle Meter application was used to measure Clarke's Angle. The plantar surface of the foot was wetted with clean water, and the participant was instructed to step onto the A4-sized paper to obtain the footprint. After the footprint had dried, Clarke's Angle was measured by drawing two lines on the footprint and measuring the angle formed between them using the Angle Meter application. Participants were categorized as having flat foot when the Clarke's Angle was <31°, normal foot when the angle was 31°– <45°, and cavus foot when the angle was ≥45° (Nugroho *et al*., 2023). For the analysis, participants were classified into flat foot and non-flat foot groups. Clarke's Angle was measured once for each participant.

Dynamic balance was assessed using a researcher developed Y-Balance Test apparatus based on the standard Y-Balance Test protocol. Y-Balance Test measuring the maximum reach distance of each leg in the anterior (A), posteromedial (PM), and posterolateral (PL) directions. The test was performed alternately on both lower limbs, with each limb serving as the stance limb. Participants stood barefoot on one leg at the center of the apparatus while reaching as far as possible with the contralateral leg in each direction without losing balance or allowing the reaching foot to touch the floor. Before the actual measurement, participants received an explanation of the test procedure and performed 3–6 practice trials to familiarize themselves with the movement and testing procedure. These practice trials were not included in the measurement results. Each reach direction was subsequently performed for three valid trials, and the maximum reach distance was recorded to the nearest 0.5 cm. The reach distances were normalized to lower-limb length, and the Composite Score was calculated using the following formula:

$$\text{Composite Score}(\%) = \frac{(\text{A+PM+PL})}{(3 \times \text{Lower−limb Length})} \times 100 \quad (1)$$

A Composite Score of <94% was considered indicative of a higher risk of lower-extremity injury, whereas a Composite Score of ≥94% indicated good dynamic balance (Plisky *et al*., 2021). In this study, a Composite Score of <94% was categorized as abnormal dynamic balance, whereas a Composite Score of ≥94% was categorized as normal dynamic balance, based on the cut-off used in previous research. Measurements were performed by the researcher with the assistance of a research team. Before data collection, the researcher and team reviewed and practiced the standardized measurement procedures to ensure consistent understanding and application of the examination techniques. The same equipment, measurement procedures, instructions, and assessment criteria were applied to all participants to maintain measurement consistency and minimize measurement bias.

The study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Universitas Jenderal Soedirman, under ethical approval number 059/KEPK/PE/V/2026. Written informed consent was obtained from the parents or legal guardians of all participants prior to data collection. All participants were informed about the study procedures, and participation was voluntary.

Data were analyzed using IBM SPSS Statistics version 29.0. Univariate analysis was performed to describe participant characteristics, including age, sex, foot condition, and dynamic balance. Categorical variables were presented as frequencies and percentages, while age was presented as mean ± standard deviation. Bivariate analysis was conducted to determine the relationship between flat foot and dynamic balance using Fisher's Exact Test because the expected cell count in several cells was less than five. Statistical significance was established at a p-value <0.05 with a 95% confidence interval (95% CI).

3. RESULT AND DISCUSSION

Result

This study was conducted among children aged 10–11 years at Al Irsyad Al Islamiyyah 02 Elementary School, Purwokerto. A total of 50 participants who met the inclusion and exclusion criteria were enrolled in the study.

Table 1. Characteristic of Study Participants

No	Variable	Frequency (n)	Percentage (%)
1.	Age		
	10 years	17	34%
	11 years	33	66%
	Total	50	100%
2.	Sex		
	Male	23	46%
	Female	27	54%
	Total	50	100%
3.	Foot Condition		
	Flat Foot	25	50%
	Non-Flat Foot	25	50%
	Total	50	100%
4.	Dynamic Balance		
	Normal	5	10%
	Abnormal	45	90%
	Total	50	100%

Based on Table 1, the characteristics of the participants were described according to age, sex, foot condition, and dynamic balance. Most participants were 11 years old (66%), female (54%), and had abnormal dynamic balance (90%). The proportion of participants with flat foot and non-flat foot was equal, accounting for 50% each.

Table 2. Descriptive Analysis of Participants Age

Variable	Mean ± SD
Age	10.66 ± 0.479

Based on Table 2, the descriptive analysis that mean age of the participants was 10.66 ± 0.479 years. The relatively small standard deviation indicates low variability in age, suggesting that the participants had relatively homogeneous age characteristics and were consistent with the predetermined age range of 10–11 years.

Table 3. Relationship Between Flat Foot and Dynamic Balance in Children Aged 10–11 Years

Variable	Dynamic Balance				p-value	OR (95% CI)
	Normal		Abnormal			
	n	%	n	%		
Flat foot	4	16	21	84	0.349*	4.571
Non-Flat foot	1	4	24	96		(0.473-44.170)

*uji *Fisher Exact Test*

Based on Table 3, among the 25 participants with flat foot, most exhibited abnormal dynamic balance (84%), whereas only 16% demonstrated normal dynamic balance. Similarly, among participants without flat foot, 96% had abnormal dynamic balance and only 4% had normal dynamic balance. The results of Fisher's Exact Test showed a p-value of 0.349 ($p > 0.05$), indicating no statistically significant relationship between flat foot and dynamic balance in children aged 10–11 years as measured using the Wet Footprint Test and the Y-Balance Test.

The Odds Ratio (OR) was 4.571, suggesting that children with flat foot tended to have a greater likelihood of experiencing impaired dynamic balance than those without flat foot. However, the 95% Confidence Interval (0.473–44.170) included the value of 1, indicating that the association was not statistically significant. Therefore, the OR in this study should not be interpreted as a risk factor. Since this study employed a cross-sectional design, flat foot and dynamic balance were measured simultaneously, allowing the OR to describe only the strength of association rather than a causal relationship.

Discussion

Flat foot occurs due to the collapse of the medial longitudinal arch, which anatomically consists of the calcaneus, talus, navicular, and first metatarsal bones. The medial longitudinal arch functions as a weight-bearing structure, shock absorber, and stabilizer that helps distribute plantar pressure during walking and running. When the arch is reduced or absent, foot biomechanics may be altered, leading to changes in load distribution and body stability (Cho *et al.*, 2021). Flat foot is also frequently associated with excessive foot pronation, which may affect ankle stability and alter postural control mechanisms during movement. Consequently, these biomechanical alterations may reduce dynamic balance performance and increase the risk of lower extremity injuries (Setyaningrahayu *et al.*, 2024).

Dynamic balance refers to the ability to maintain body stability during movement and functional activities. Children with flat foot are often reported to have reduced postural stability and limitations in activities requiring balance. This condition is attributed to disturbances in the foot arch, which plays an essential role in supporting body weight, absorbing shock, and maintaining stability during movement (Pramita *et al.*, 2025). Furthermore, balance is the result of complex interactions between the musculoskeletal and nervous systems involving sensory, motor, and cognitive processes. The visual, vestibular, and proprioceptive systems work together to maintain postural control, while balance development in children is influenced by neurological maturation and motor experiences acquired throughout growth (Manuel *et al.*, 2025).

The present study found no statistically significant relationship between flat foot and dynamic balance among children aged 10–11 years at Al Irsyad Al Islamiyyah 02 Elementary School, Purwokerto ($p = 0.349$). Among the 25 participants with flat foot, 21 (84%) had abnormal dynamic balance and 4 (16%) had normal dynamic balance. Similarly, among the 25 participants without flat foot, 24 (96%) had abnormal dynamic balance and only 1 (4%) had normal dynamic balance. The high proportion of abnormal dynamic balance in both groups suggests that dynamic balance impairment in this population may not be explained by foot condition alone. The relatively narrow age range of the participants may have limited variation in age-related foot development and postural control, as children aged 10–11 years are generally undergoing maturation of neuromuscular and sensorimotor systems.

The odds ratio (OR) was 4.571, with a 95% confidence interval (CI) of 0.473–44.170. Although the OR indicated a higher estimated odds of abnormal dynamic balance among participants with flat foot compared with those without flat foot, this association was not statistically significant because the 95% CI included 1 and the Fisher's Exact Test yielded a p-value of 0.349. Therefore, the OR should be interpreted as an estimate of the observed association rather than evidence of a statistically significant relationship or a causal effect. The wide 95% CI also indicates low precision of the OR estimate, which may be related to the relatively small sample size of 50 participants, particularly the small number of participants with normal dynamic balance.

This finding is consistent with the study conducted by Hikmatiar *et al*. (2024), which reported no significant association between flat foot and dynamic balance among elementary school students ($p = 0.786$). Their study involved 184 students and used Clarke's Angle to assess foot posture and the Beam Balance Test to evaluate dynamic balance. Similarly, Setyaningrahayu *et al*. (2024) found no significant relationship between the degree of flat foot and dynamic balance measured using the Y-Balance Test in high school students ($p > 0.05$). These findings support the possibility that the presence of a flattened medial longitudinal arch does not necessarily result in impaired dynamic balance.

However, the findings of this study differ from those reported by Chattalia (2024), who found a significant relationship between flat foot and dynamic balance among school-aged basketball players. That study utilized the Wet Footprint Test with Clarke's Angle and the Y-Balance Test and reported significant results for both the right foot ($p = 0.045$) and left foot ($p = 0.003$). Likewise, Ramadhani and Romadhoni (2024) reported a significant association between flat foot and postural balance in children aged 7–12 years ($p = 0.031$; $r = 0.383$). Similar findings were also reported by Ramadhani and Kusumawati (2025) and Rustiana and Kusumawati (2025). Differences among studies may be attributed to variations in participant characteristics, sample size, age range, measurement methods, and balance assessment instruments.

The absence of a significant relationship in this study may be influenced by several factors. Dynamic balance is influenced by multiple systems, including muscular strength, neuromuscular control, visual, vestibular, and proprioceptive input. Physical activity is known to improve balance performance, motor coordination, and postural control, and children who engage in regular physical activity tend to demonstrate better balance abilities than those with lower activity levels (Manuel *et al*., 2025). Additionally, muscle strength and neuromuscular control contribute substantially to balance maintenance because the lower extremity muscles help stabilize the body's center of gravity during movement (Zhou *et al*., 2024). Therefore, children with flat foot may still demonstrate adequate dynamic balance when other components of postural control are sufficiently developed.

Neuromuscular compensation may also contribute to the maintenance of dynamic balance in children with flat foot. Structural changes in the foot arch do not necessarily result in balance impairment because the body can compensate through increased activation of extrinsic foot muscles, such as the tibialis posterior and peroneus longus, to maintain stability during functional activities (Sukprasert *et al*., 2024). Furthermore, adaptations within the central nervous system may enable some individuals with flat foot to maintain adequate dynamic balance through neuromuscular compensation mechanisms (Mohamed *et al*., 2025). Children aged 10–11 years are still undergoing maturation of the nervous, muscular, and sensory systems, which may influence movement control and balance performance (Dwi *et al*., 2022).

Sensorimotor function may provide another explanation for the findings because the plantar surface provides proprioceptive information that assists the central nervous system in regulating postural responses. Although altered plantar pressure distribution in flat foot may affect sensory input, its impact may vary among individuals (Ramadhani & Romadhoni, 2024). Thus, the presence of flat foot alone may not be sufficient to produce measurable impairment in dynamic balance.

Another factor that may have influenced the findings is the measurement method used in this study. Flat foot was assessed using the Wet Footprint Test with Clarke's Angle, which is a simple, practical, and highly sensitive screening tool. However, it does not directly assess anatomical foot structures and therefore may not fully reflect biomechanical alterations that potentially affect dynamic balance (Putri *et al*., 2024). The Y-Balance Test was used to assess dynamic balance,however this method also has several limitations. Measurement results may be influenced by lower-limb length and the normalization procedure used to obtain standardized scores. In addition, the Y-Balance Test evaluates overall balance performance and cannot specifically distinguish the individual contributions of sensory systems, such as the visual, vestibular, and somatosensory systems. Performance may also vary depending on participants physical ability, familiarity with the test, and motivation during the assessment (Picot *et al*., 2021).

This study has several limitations. First, the relatively small sample size and single-school setting may have limited the statistical power and generalizability of the findings. Second, the cross-sectional design does not allow causal relationships between flat foot and dynamic balance to be established. Third, potential confounding factors, including physical activity, lower-extremity muscle strength, body mass index, sports participation, joint hypermobility, footwear, and sensory function, were not measured or controlled. Finally, the use of Clarke's Angle as a screening method and the possibility of performance variation during the Y-Balance Test should be considered when interpreting the results.

Future studies are recommended to involve larger sample sizes and participants from more diverse populations to improve the generalizability of the findings. Further research should also assess and control potential confounding factors that may influence dynamic balance, such as physical activity level, lower-extremity muscle strength, body mass index, and sensorimotor function. Studies with longitudinal or experimental designs may be considered to further investigate the relationship between flat foot and changes in dynamic balance. Future research should also consider classifying flat foot according to its severity and using more comprehensive or gold-standard methods for assessing foot structure to improve the accuracy of flat foot classification.

4. CONCLUSION

This study found no statistically significant relationship between flat foot and dynamic balance among children aged 10–11 years at Al Irsyad Al Islamiyyah 02 Elementary School, Purwokerto, based on the results of Fisher's Exact Test (p = 0.349). Although the odds of abnormal dynamic balance were higher among participants with flat foot (OR = 4.571), the association was not statistically significant, with a 95% confidence interval (0.473–44.170) included 1. These findings suggest that the presence of flat foot alone may not be sufficient to explain dynamic balance impairment in children aged 10–11 years. Therefore, evaluation of dynamic balance in children should consider other contributing factors rather than foot posture alone. Further studies are recommended to use larger sample sizes, prospective designs, and multivariate analyses that control for potential confounding factors, such as physical activity, body mass index, and muscle strength.

5. REFERENCES

Chattalia, V. N. (2024). The Relationship Between Flat Foot and Dynamic Balance in Basketball Players. *International Journal of Public Health Excellence (IJPHE)*, 4(1), 59-63.

Chinpeerasathian, C., Oo, P. S., Siriphorn, A., Pensri, P. (2024). The Effect of Flatfoot on Balance in Children: A Systematic Review and Meta-Analysis. *PLOS ONE*, 19(3), 1-18.

Cho, D. J., Ahn, S. Y., Bok, S. K. (2021). Effect of Foot Orthoses in Children With Symptomatic Flexible Flatfoot Based on Ultrasonography of the Ankle Invertor and Evertor Muscles. *Annals of Rehabilitation Medicine*, 45(6), 459–470.

Dwi, S. J., Siregar, N. B., Mora, E., Nasution, S. J. (2022). Karakteristik Pertumbuhan Fisik dan Perkembangan Motorik Anak Usia Sekolah Dasar. *EDU MANAGE: Jurnal Manajemen Pendidikan Islam*, 1(1), 1-8.

Fitri K. R., Faris N. A. (2024). Hubungan Arcus Pedis dengan Keseimbangan Statis Pada Anak Usia 9-12 Tahun di SDN Gonilan 02. *Journal of Innovation Research and Knowledge*, 3(12), 22–24.

Hidayati, N. P. N., Ramadhani, R. P. (2025). Flat Foot Berdasarkan Clark's Angle dan Indeks Massa Tubuh pada Remaja Usia 11–13 Tahun. *Jurnal Terapi Wicara dan Bahasa*, 3(2), 427-433.

Hikmatiar, A. P., Tresnasari, C., Widayanti. (2024). Hubungan Flat Foot dengan Keseimbangan Dinamis pada Siswa Sekolah Dasar Mathla'ul Khoeriyah Bandung Tahun 2023. *Bandung*

Conference Series: Medical Science, 4(1), 339-344.

Latifah, Y., Naufal, A. F., Nafi'ah, D., Astari, R. W. (2021). Hubungan Antara Postur Flat Foot Dengan Keseimbangan Statis Pada Anak Usia 12 Tahun. *FISIO MU: Physiotherapy Evidences*, *2*(1), 1–6.

Liu, C., Zhang, H., Li, J., Li, S., Li, G., Jiang, X. (2024). The Effects of Foot Orthoses on Radiological Parameters and Pain in Children with Flexible Flat Feet: A Systematic Review and Meta-Analysis. *Frontiers in Pediatrics*, 12, 1-12.

Manik, N. M. M., Sugiritama, I. W., Widnyana, M., Andayani, N. L. N. (2023). Derajat Flat Foot Memengaruhi Keseimbangan Statis pada Anak Usia 10-12 Tahun. *Majalah Ilmiah Fisioterapi Indonesia*, 11(1), 106–111.

Manuel Delfa-de-la-Morena, J. M., Paes, P. P., de Oliveira, D. P. L., Mijarra-Murillo, J.-J., Júnior, F. C., Riquelme-Aguado, V. (2025). Influence of Physical Activity on Balance in Children: A Cross-Sectional Study. *Retos*, 63, 420–432.

Mohamed, S. A., Yousef, E. F., Shalaby, M. S. M., Ibrahim, M. M. (2025). Electromyographic Study of the Extrinsic and Intrinsic Foot Muscles in Flexible Flat Foot during Functional Weight-bearing Positions: Cross-sectional Study. *Egyptian Journal of Physical Therapy,* 24(1), 1-10.

Nisa, H., Nasirudin, Y., Achirda, N., Kurniawati, N. (2024). Perbedaan Pengaruh Dual-Task Training dengan Permainan Tradisional Engklek Terhadap Keseimbangan Dinamis Anak Flat Foot Usia Sekolah di SDN Jatimekar II. *Physiotherapy Health Science (PhysioHS)*, 7(2), 64–72.

Nugroho, A. N., Kamarukmi, N. E., Ghufron, A. (2023). Scales Feature Foot Scanners as Parameters of Flat Feet in Children. *International Conference on Information Science and Technology Innovation (ICoSTEC)*, 2(1), 152–156.

Pasaribu, S. R., Siregar, N. P., Pasaribu, R. H. (2025). Variasi Bentuk Lengkung Longitudinal Medial Kaki pada Laki-Laki dan Perempuan Dewasa Muda. *NJM*, 11(1), 9–13.

Picot, B., Terrier, R., Forestier, N., Fourchet, F., McKeon, P. O. (2021). The Star Excursion Balance Test: An Update Review and Practical Guidelines. *International Journal of Athletic Therapy and Training*, 26(6), 285–293.

Plisky, P., Schwartkopf-Phifer, K., Huebner, B., Garner, M. B., Bullock, G. (2021). Systematic Review and Meta-Analysis of the Y-Balance Test Lower Quarter: Reliability, Discriminant Validity, and Predictive Validity. *International Journal of Sports Physical Therapy*, 16(5), 1190–1209.

Pramita, I., Andayani, N. L. N., Saraswati, N. L. P. G. K. (2025). Towel Curl Exercise Meningkatkan Keseimbangan Dinamis pada Anak dengan Flat Foot. *JURNAL KESEHATAN TERPADU*, 9(2), 44-49.

Putri, N. S. A., Arfianti, L., Desnantyo, A. T., Wardhani, I. L. (2024). Flat Foot Based on Clarke's Angle Method and Overweight among Medical Students of Universitas Airlangga. *JUXTA: Jurnal Ilmiah Mahasiswa Kedokteran Universitas Airlangga*, 15(2), 113–118.

Ramadhani, A. N., Romadhoni, D. L. (2024). Correlation Between Flatfoot and Postural Balance in Children Aged 7-12 Years. *FISIO MU: Physiotherapy Evidences*, 5(2), 115–119.

Rustiana, Y., Kusumawati, Y. R. (2025). Hubungan Flat Foot Terhadap Keseimbangan Statis dan Dinamis pada Siswa Sekolah Menengah Pertama. *Jurnal Kesehatan Tambusai,* 6(1), 2293–2299.

Sari, A. L., Istiqomah, N., Wardani, I. K., Anugrah, A. K. (2024). Manfaat Brain Gym Untuk Meningkatkan Keseimbangan Pada Anak Sekolah Dasar: Benefits of Brain Gym to Improve Balance in Elementary School Children. *Jurnal Ilmiah Keperawatan (Scientific Journal of Nursing)*, 10(3), 588-593.

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 (JIKA)*, 2(3), 99–107.

Setyaningrahayu, F., Rahmanto, S., Multazam, A. (2024). Hubungan Kejadian Flat Foot Terhadap Keseimbangan Dinamis pada Pelajar di SMAN 3 Malang. *Physiotherapy Health Science Physio HS,* 2(2), 83–89.

Sukprasert, O., Boonyarom, O., Somthavil, S. (2024). Flexible Flatfoot: Effects of Foot Muscle Exercises on Dynamic Balance, Plantar Pressure, and Muscle Strength. *Journal of Health Research*, 38(1), 11–19.

Xu, L., Gu, H., Zhang, Y., Sun, T., Yu, J. (2022). Risk Factors of Flatfoot in Children: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 19, 1-13.

Yamashita, T., Sato, M., Ata, S., Yamashita, K. (2024). Predictors of flatfoot in 11-12-Year Olds: A Longitudinal Cohort Study. *BioMedical Engineering OnLine*, 23, 1-10.

Zhang, Y., Feng, R., Hu, W., Huang, P. (2024). Investigation of Inter-Rater and Test-Retest Reliability of Y Balance Test in College Students with Flexible Flatfoot. *BMC Sports Science, Medicine, and Rehabilitation*, 16, 1-8.

Zhou, J., Zhong, Y., Xu, W. (2024). Effects of Core Stability Exercises on Balance Ability of Children and Adolescents with Intellectual Disabilities: A Systematic Review and Meta-Analysis. *PLoS ONE*, 19(12), 1-18.

Zukauskas, S., Barauskas, V., Degliute-Muller, R., Cekanauskas, E. (2023). Really Asymptomatic? Health-Related Quality of Life and Objective Clinical Foot Characteristics Among 5-10-Year-Old Children with A Flexible Flatfoot. *Journal of Clinical Medicine*, 12(9), 1-11.