

Exploring Arch Types and Dynamic Balance Function: A Literature Review

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Abstract

Background: Problems arise if the position of the sole bones shifts or loses alignment because this will affect the structure of the body. A decrease in the curvature of the soles of the feet causes a person to experience a problem known as flat feet. If this happens, an individual will not only have difficulty walking, but will also experience balance problems. However, the type of foot arch does not determine a person's ability to move because individuals who have high or low foot arches can still move without problems. **Method:** The research design used in this research was the literature review method. This technique is carried out with the aim of revealing various theories that are relevant to the problems being faced or researched as reference material in discussing research results. **Results:** Balance plays an important role in starting to completing functional activities in daily life. Physiologically, sports injuries occur due to an imbalance between workload and the ability of the body's tissues to carry out sports activities. One cause of lack of balance is flat feet. Flat feet cause balance problems, instability, continued deformity, complaints of fatigue when walking for a long time, shoes on the heels wear out quickly, excessive surface injury, and pain. **Conclusion:** Based on the results of this study, it is concluded that there is a relationship between flat feet and static balance in 12 year old children, and there is a difference in the influence of flat feet and normal feet on dynamic balance.

Keywords: Type, arch, dynamic

1. Introduction

Twenty per cent of adults have flat feet and almost all newborns do not have an arcus like a normal adult. arches like normal adults. People who have normal arches are said to be better because the pressure from the body weight is distributed equally to the entire sole of the foot which makes them more stable (Abdurrahman, 2003). (Abdurrahman, 2003). In general, the bones of the human foot are slightly curved. This condition provides more strength to withstand body weight and movement. However, the type of arch of this foot bone is not a determinant of a person's ability to move because individuals with high or low foot arches can still move without problems (Jamaluddin, 2007). without problems (Jamaluddin, 2007).

Problems arise when the position of the foot bones shifts or loses its alignment because it will affect the structure of the body, (Hsieh Chin Hsing, 2007) A decrease in the curvature of the foot bones causes a person to experience a problem known as flat foot. A study conducted in Taiwan found that 8700 adults aged 30 years and above experienced various problems due to complications with the foot. This is because foot abnormalities develop slowly and complaints may only appear after 5-10 years (Hsing, 2007).

Not all flat feet conditions cause a person to experience balance problems because physiologically children's body balance is determined by the neurological functions of the brain system and the vestibular system (balance device), which in this group of students both functions are developing normally. In addition, children have been playing games that require body balance since kindergarten (Purnomo, 2000).

People with flat foot often complain of anterior knee pain (Gross et al., 2011) as well as low back pain (Khamis & Yizhar, 2007) and walking impairment, so physiotherapists play a role in preventing this. Flat foot has a chain effect on the body structure where flat foot results in ankle overpronation which then causes internal rotation of

the tibia and femur which further induces a shift in pelvic alignment towards the anterior around (Khamis & Yizhar, 2007).

When the body structure changes, the COG (Centre of Gravity) will change. COG functions to distribute body mass evenly on the Base of Support so that the body is in a state of balance (Juriansari et al., 2020; Naufal et al., 2019). However, if there is a change in posture, the COG also changes which causes balance disturbances (Syafi'i et al., 2016). Based on the above background, researchers are interested in conducting research on the relationship between flat foot posture and static balance in 12-year-old children.

The arch is the gap between the inside of the foot and the ground, flat feet is a condition where the foot does not have a normal arch of the sole, this condition can affect one or both feet, a person with a low arch or no arch usually leads to a condition called flat feet (Flat feet, or fallen arches). The main clinical features of excessive pronation (Anonymous, 2004). thus causing the child to feel uncomfortable when walking, get tired quickly and the soles of the shoes always run out one side.

A normal foot is one that has sufficient arches. When viewed from the rear, the Achliles tendon forms a straight line at a 90-degree angle to the anvil. When walking, the foot will perform a heel strike and fall on the anvil on the outside of the heel, followed by an inward turn in order to cushion the impact while walking. In flat feet, this does not happen as it does in normal feet, making it easy to become tired (Malau, 2007). Although many people have flat feet (25% in the US) without any complaints, flat feet can cause inability to function due to pain.

Balance plays an important role in starting and completing functional activities in daily life. Physiologically, sports injuries occur due to an imbalance between the workload and the ability of the body tissues that perform sports activities. One of the causes of lack of balance is flat foot. Flat foot causes impaired balance, instability, continued deformity, complaints of fatigue when walking for a long time, rapid wear of heel shoes, over-surface injuries, and pain.

Based on the above background, researchers are interested in knowing the effect of flat feet and feet with normal arches on dynamic balance.

2. Material and Method

The research design used in this study is to use the Literature review method. In this study, the authors chose quantitative research articles with a cross sectional or case control design. The author uses a database that is used as a search source related to the research, namely Google Scholar. In searching the source of the article, the author used Indonesian keywords, namely: characteristics, thyroid nodules, prevalence, size, complications of thyroid nodules. After searching through a predetermined database, the findings were selected using inclusion and exclusion criteria. The inclusion and exclusion criteria are presented.

A. Inclusion Criteria

- Research results in the form of articles with primary research data.
- Articles are full-text articles that are free and accessible.
- Articles using cross-sectional or case control or experimental designs.
- Articles were in Indonesian or English.

B. Exclusion criteria

- Research articles in the form of theses and theses not in the form of published articles.
- The article used is paid.
- Research articles did not use research designs other than cross sectional or case control or experimental.
- Articles using languages other than Indonesian and English.

3. Result

Table. 1 Literature Review Search Results

Title	Author	Method	Research Results
Beda pengaruh kondisi kaki datar dan kaki dengan arkus normal terhadap keseimbangan statis pada anak usia 8–12 tahun di kelurahan karangasem, surakarta	(Dody Lendra et al., 2009)	The type of research conducted uses a non-experimental survey approach, descriptive cross-sectional research design, where exposure (cause) and outcome (impact) are studied at the same time.	The results showed that there was no difference in the effect between boys and girls with flat feet and normal arches to static balance in children aged 8-12 years in Karangasem Surakarta area. with flat feet and normal arches to static balance in children aged 8-12 years in Karangasem Surakarta.

Kejadian Flat Foot Terhadap Keseimbangan Pada Atlet Bulutangkis Junior	(Imam & Untung, 2022)	Analytical descriptive research, with a cross sectional analytical research design, namely measurement and observation carried out at one time with total sampling technique.	A total of 262 patients were included with a mean age of 13.77 ± 3.7 years. Thyroid antibodies were positive in 119/262 (45.4%) patients. Thyroid US was reported as abnormal in 210/262 (80%) patients. Thyroid nodules were found in 33.6% ($n=88/262$) of patients with goitre and in 41.9% ($n=88/210$) of patients with abnormal thyroid results. Patients with positive antibodies had more glandular heterogeneity and hypervascularity on thyroid US ($P<0.001$). On the other hand, thyroid nodules were more likely to appear in patients with antibody negative thyroid ($P=0.025$). Heterogeneity in the thyroid positive group was significantly correlated with elevated TPOAb ($P<0.001$) and TSH levels ($P<0.028$). Heterogeneity in AS had a positive predictive value ($P=0.041$), whereas hypervascularity had a low predictive value for thyroid nodules ($P=0.022$). Age, gender, family history of thyroid disease, antibody status and echogenicity in AS showed no significant association with thyroid nodules. Papillary thyroid carcinoma was diagnosed in six patients and one of these patients was thyroid antibody positive.
Hubungan kejadian flat foot terhadap keseimbangan dinamis pada pelajar di sman 3 malang	(Setyaningrahayu et al., 2020)	This study is observational with a cross-sectional approach. 26 respondents in this study were taken using purposive sampling technique.	The Spearman test was used to analyse the research data. Spearman's test showed the results of sig. 2 tailed dynamic balance of right foot = 0.104 and left foot = 0.197 with α value 0.05 which means H_0 is accepted. There is no relationship between flat foot incidence and dynamic balance in students at SMAN 3 Malang.
Hubungan Antara Postur Flat Foot Dengan Keseimbangan Statis Pada Anak Usia 12 Tahun	(Latifah et al., 2021)	This type of research is correlational research with a cross sectional approach, with sampling techniques using purposive sampling.	Spearman rank correlation test results obtained $p = 0.000$ and correlation value $r = 0.716$. Conclusion: There is a relationship between flat foot and static balance in 12-year-old children.
The effect of foot posture on static balance, ankle and knee proprioception in 18-to-25- year-old female student: a cross-sectional study	(Ghorbani et al., 2023)	We used a cross-sectional approach involving a questionnaire survey, which focused on the participants' living habits, and a physical examination that included anthropometry and ultrasound imaging.	The prevalence of thyroid nodules was significantly associated with female gender (OR 2.569, 95%CI 1.937 to 3.405, $p<0.001$) and increasing age (OR 1.054, 95%CI 1.041 to 1.066, $p<0.001$). This association was more pronounced in patients with multiple thyroid nodules. For men under 60 years, not smoking was inversely correlated with the prevalence of multiple thyroid nodules (OR 0.321, 95%CI 0.149 to 0.69, $p<0.05$). In women under 60 years, diastolic blood pressure (DBP) was significantly associated with the prevalence of thyroid nodules (OR 0.978, 95%CI 2.614 to 2.705, $p<0.05$).
Hubungan flat foot dengan keseimbangan statis dan dinamis Pada anak sekolah dasar negeri 4 tonja kota Denpasar	(Antara et al., 2017)	This study was analytical in nature with a cross sectional approach.	In the calculation of Spearman's rho data analysis, it is known that the significance value (2-tailed) is 0.000 for static and dynamic balance, which means the significance value $< \alpha$. Furthermore, the Correlation Coefficient is 0.933 for static balance, and 0.828 for dynamic balance. Based on the data output, it can be concluded that there is a strong, significant, and unidirectional relationship between flat foot and static and dynamic balance in elementary school children of 4 Tonja in Denpasar city.
Perbedaan efektivitas strengthening ball roll exercise dan strengthening heel raises exercise terhadap keseimbangan statis pada anak flat foot usia 9-10 tahun di kecamatan wonokerto	(Nisa & Aktifah, 2020)	This study used a quasi-experimental design (two group pre test and post test without control group design) consisting of two groups, each group consisting of 31 respondents.	Wilcoxon in group I shows a p value of <0.001 in ball roll strengthening exercises and heel raises strengthening exercises, meaning that there is an effect of ball roll strengthening exercises and heel raises strengthening exercises on the static balance of respondents. on the static balance of respondents. The Mann Whitney U test used

			Mann Whitney U test used as a difference test resulted in $p = 0.114$ in the right leg and $p = 0.547$ in the left leg. This means that there is no difference in the effectiveness of ball roll strengthening exercises and heel raises strengthening exercises on static balance in respondents.
Perbedaan kelincahan antara normal foot dan flat foot pada anak usia 10-12	(Anak Agung Ayu Arsinta Maharani, 2020)	This study was an analytical cross sectional study conducted in April 2019 at SD Negeri 8 Dauh Puri, Denpasar.	Hypothesis testing with Independent T-Test found $p=0.000$ ($p<0.05$) with a mean value of agility in the normal foot group of 9.84 seconds and flat foot of 11.41 seconds. The conclusion of this study is that there is a difference in agility between normal foot and flat foot in children aged 10-12 years. Agility in children with normal foot is better, compared to flat foot.
Perbedaan gait parameter terhadap tipe arkus pedis (normal foot, flat foot dan cavus foot) pada anak sekolah dasar usia 10-12 tahun di denpasar barat	(Githa et al., 2020)	The method used was analytical cross sectional conducted in March 2019.	Data normality test using Kolmogorov Smirnov Test and homogeneity test using Levene's Test. After that, the Kruskal Wallis test showed a significant difference between the three groups ($p=0.001$). In this study it can be concluded that there are differences in gait parameters on the type of arch pedis (normal foot, flat foot, and cavus foot) in elementary school children aged 10-12 years in West Denpasar.

4. Discussion

Some literature states that children with flat feet have poor balance compared to children with normal foot arches (Hsing, 2007; Anse, 1999; Pryce, 2006; Meidy, 2007; Naylor, 1999; Abdurrahman, 2003; Ferry, 2006). However, some argue that balance function depends on the function of the mechanism of the semicircular canal, kinesthetic sensation in muscles, tendons, and joints, as well as visual perception when the body moves, and the ability to coordinate the three sources of stimuli (Anonymous, 2004).

Maintaining the equilibrium function when the position does not change or the movement function is also influenced by the inner ear mechanism, visual perception, kinesthesia (Karen, 2004). Broadly speaking, a person's balance cannot be seen from one side only (kinesthetic sensation in muscles, tendons and joints) but many other things also affect it. This is also because physiologically children's body balance is determined by the neurological functions of the brain system and the vestibular system (balance device), which in this group both functions are developing normally. In addition, children have been playing games that require body balance since kindergarten (Purnomo, 2000). There are facts or evidence stating that the ability to balance is very easy, whether it is static balance or dynamic balance depending on the function of the mechanism of the semicircular canal, kinesthetic sensation in muscles, tendons, and joints, visual perception when the body performs movements, and the ability to coordinate the body's movements. movement, and the ability to coordinate the three sources of stimuli. Balance is an important ability that is used in our daily activities, such as walking and standing, as often found in games and sports (Johnson, 1974; Anonymous, 2004).

Although in general balance is considered sufficient in everyday life (able to walk, able to run, jump, able to ride a bicycle), but for the balance score of standing on one leg (Stork stand test) the children studied were considered to have poor balance seen from the standard score of boys with a minimum score of 35 (1 second) and a maximum of 80 (in 73 seconds) the research subjects were only able to achieve an average score of 41.18 (within 10 seconds). While the score of girls is at least 38 (1 second) and a maximum of 90 (in 62 seconds) where the research subjects were only able to achieve an average score of 46.88 (11 seconds), the low balance score on the research subjects may be due to the pattern of children's games now that tend to do more passive games (Play Station, Computer games), as well as the pattern of upbringing of parents who prefer when their children stay at home and study compared to when their children play outside (Jaivin, 2006).

However, the type of arch of the foot is not a determinant of a person's ability to move as individuals with high or low arches can still move without problems (Jamaluddin, 2007). Some people with flat feet can walk as comfortably and easily as people with normal arches as long as there is no heel cord contracture (Anonymous, 2007). In fact, flat feet that have no arch at all are rare, most people with flat feet have a flexible arch, where when

the foot does not support the weight of the body the foot appears to have an arch, while when resting on the foot the arch is not visible. (Hendrickson, 2005)

After data collection, the results were in accordance with what was written by Hendrickson in 2005 where the research subjects with flexible flat feet were 13 boys (92.9%), while the rigid flat foot type was only 1 child (7.1%), as well as in the female flat foot group where the flexible type was 9 girls (90%), while the rigid type was only 1 child (10%). This is also in line with Polsdorfer's 2007 statement that most flat feet are flexible where there are no problems and do not require treatment, while some are rigid where this condition causes symptoms and appropriate treatment. Rigid flat feet require treatment which can be seen from the symptoms with foot exercises.

The problem faced by those with flat foot is when the position of the sole of the foot shifts or there is no alignment between the two soles of the foot. This condition will affect the structure of the body. In addition, the altered body alignment also causes changes in the body's centre of gravity which functions to distribute body mass evenly. In the human body, the main support for body weight is this centre of gravity point, so that the body can be maintained in a balanced state. Conversely, when there is a change in posture, the centre of gravity point will also change as a result and will cause balance disturbances.

Balance plays an important role in starting and completing functional activities in daily life. Physiologically, sports injuries occur due to an imbalance between the workload and the ability of the body tissues that perform sports activities. One of the causes of lack of balance is flat foot. Flat foot causes impaired balance, instability, continued deformity, complaints of fatigue when walking for a long time, rapid wear of heel shoes, over-surface injuries, and pain.

In flat foot conditions, the intrinsic muscles tend to work harder, resulting in overuse to stabilise the arch due to loss of passive support from the ligaments, resulting in foot fatigue and pain (Dabholkar & Agarwal, 2020). Weakness of the intrinsic muscles of the foot such as the abductor hallucis, flexor hallucis brevis, flexor digitorum brevis, and interosseus muscles that act as dynamic stabilisers of the medial longitudinal arch cause a lower ability to absorb external pressure and postural instability. In addition, the pressure in the plantar area is centred on metatarsals II and III compared to the normal foot during dynamic activities such as walking. As a result, the plantar pressure distribution changes, increasing the risk of injury.

Although there is no definitive reason for individuals with flat foot to have poor static and dynamic balance, it may be due to structural and functional changes in the foot and the foot's inability to absorb external forces (Kim & Kim, 2016). The foot has sensory receptors in the form of the nervous system in the plantar fascia, ligaments, joint capsule, muscles and tendons in the plantar area that function as elements of walking sensation and balance. Sensory receptors in the intrinsic muscles of the foot can be more active if given stretching exercises so that they can provide information about changes in foot posture (McKeon et al., 2015). Foot alignment that is not anatomical causes additional pressure on the muscle spindles and tendons of the talocalcaneal joint resulting in proprioceptive disorders in the foot.

5. Conclusion

Based on the results of this study, it is concluded that there is a relationship between flat foot and static balance in 12-year-old children, and there are differences in the influence between flat foot and normal foot on dynamic balance.

6. Suggestion

Many theories reveal that dynamic balance is influenced by many factors, therefore it is hoped that future researchers can consider other factors that can affect dynamic balance and take primary data to the field. Please note, this research has other limitations that the research only uses the literature review method so it is not specific to the conditions/situation at a location. Future researchers are expected to better control the effectiveness of measuring children's static balance.

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