THE RELATIONSHIP BETWEEN FLATFOOT AND STATIC BALANCE IN SCHOOL-AGED CHILDREN

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Abstract

***Introduction**:* Flatfoot is one of musculoskeletal deformities in the foot that is commonly seen in children. Previous study found that children with flatfoot have balance differences during standing as well as fatigue compared with children with normal feet that are associated with falling. Therefore, the purpose of this study was to investigate the correlation between flatfoot and static balance in children with flatfoot.
***Method**:* This was a cross sectional study design with purposive sampling data. The total sample was 16. Children were assessed using Chippaux-Smirak Index (CSI). The one-legged stance balance was used to assess static balance. Spearman correlation was conducted to examine the relationship between flatfoot and static balance in children.
Results: The mean age of the participants was 7.94 years old in which they tend to have a second degree of flatfoot. There were significant differences in static balance between eyes open and eyes close in which the subject can maintain their balance longer while eyes open. However, there was no correlation between flatfoot and static balance in children.
***Conclusion**:* Flatfoot in school-aged children affects the balance performance where visual input plays an important role, even though there was no correlation between flatfoot and balance ability.

Keyword: Flatfoot, static balance, one-leg standing, children

Introduction

Flatfoot is a common occurrence in children and a regular source of concern for parents. Even though the majorities of cases are physiologically normal and improve with growth and development, it can be challenging to distinguish between flat feet that resolve and those that don't without therapy (Abolarin, T. O. et al., 2011). The flatfoot is known as the collapse or excessively flattening of the medial longitudinal of the foot (Smith, M. A. et al., 1990). From the first five years of the golden era onward, normal arch conditions start appearing. At the ages of two to six, the age range of development of the arch reaches a critical stage, and at the age of ten, an intact arch forms (Campbell, S.K., Palisano, R.J., Orlin 2012).

According to Pande Ketut (2012) about 18% or 6 out of 33 children have a flat foot tendency, this result was obtained from a survey conducted at SDN Coblong 2 Bandung. As a result, flatfoot is commonly a source of concern for parents because no test can predict whether a child will develop a foot arch or will have persistent flatfoot (Chang C-H et al., 2021). Some flatfeet can have a detrimental effect on quality of life and may be linked to foot issues like hallux valgus, hammer toes, and osteoarthritis. Additionally, flatfeet have long been connected with military recruits who are *"unfit for active service"* (Gijon-Nogueron, G. et al., 2018).

One of the fundamental and necessary motor skills for kids is balance which is the capacity to keep the center of mass above the base of support (Sharma P, Metgud D., 2017). The impact of flat feet on an imbalance or irregular gait might cause symptoms and signs of other problems. Due to their inability to maintain balance and the barriers they encounter when walking, children have lower motor skills and are more prone to falling. (Sahabbuddin, 2016).

As a result of their poor balance, children are more likely to fall and stumble when walking over things. Obstacles to walking in children during growth and development will have an impact on how well their needs are met, starting with disorders of active movement, play, and daily activities (ADL), which will then have an effect on diminishing children's productivity.

Since children frequently use their feet to support their body weight during various activities, understanding how the foot's arch develops can help prevent future abnormalities and help with early diagnosis, care, and growth prediction. It's likely that the body will frequently fall if the support is flimsy and unstable, which will harm the body's overall structure (Ariani Liza, Ari Wibawa 2015). Therefore, the purpose of this study is to investigate the relationship between flatfoot and static balance in school-aged children.

Method

This study was an analytic observational study with cross sectional design comprising 16 children (8 boys and 8 girls). The age range of children was between 5 and 13 years old. All participants were selected from Posyandu Ibu dan Anak Majeluk, Mataram. Participants were categorized as either having flatfoot or normal foot using the Chippaux-Smirak Index (CSI) in which flatfoot grade 1 was 45.1-50.0%; degree 2 with a value of 50.1-60.0%; and degree 3 with a value of 60.1-100%. According to estimates made from footprints, CSI is the ratio of the narrowest point on the foot arch to the greatest width across the metatarsal heads (Chen et al., 2011).

Each participant was instructed to create a footprint by dipping their feet into inked HVS paper. The CSI index was used by the researchers to classify the level of flatfoot. A one-legged stance is used to examine static balance. Participants hold this posture as long as they can while switching between keeping their eyes open and close. The participant's ability to stand on one leg for an extended period of time will be measured by the researcher.

Data was analyzed using SPSS version 17. Flat foot and static balance data obtained were analyzed by normality tests using the Shapiro-Wilk method. The Wilcoxon test has been used to test the difference between eyes closed and eyes open, while the Spearman Kendall correlation test was used to analyze the correlation between flatfoot and static balance.

Results

The mean age of the participants was 7.94 years old in which they tend to have a second degree of flatfoot (Table 1). There were significant differences in static balance between eyes open and eyes closed in which the subject can maintain their balance longer while eyes open (Table 2). However, there was no correlation between flatfoot and static balance in children (Table 3).

Table 1. Demographic data

Parameters	Mean±SD	Minimum	Maximum
Age (years)	7.94±2.56	5	13
CSI score, (%)			
Right foot	60.76±13.46	42.8	81.8
Left foot	62.93±18.58	38.4	90.0

Table2. Comparison of ability in maintaining balance between eyes open and eyes close

	Mean±SD	Minimum	Maximum	*p*
Right foot				
EO	19.50±10.27	11	53	.000
EC	2.69±.873	2	5	
Left foot				
EO	21.25±13.60	12	62	.000
EC	3.00±1.15	2	5	

Table3. Correlation between flat foot and static balance

Balance task	Flatfoot	
	FF-Right	FF-Left
EO-Right	.883	
EC-Right	.362	
EO-Left		.560
EC-Left		.374

$p < 0.05$

Discussion

The purpose of this study was to investigate the relationship between flatfoot and static balance in school-aged children. This study revealed that the average age of the participants having flatfoot was around 7 years old in which in this age group the prevalence of flatfoot is higher (Sadeghi-Demneh et al., 2015), as the process of bony maturation in children occur within the first ten years of life (Brisch-Fritz & Marlene Mauch, 2013). Age, obesity, and a child's lack of footwear use in infancy are some of the factors that contribute to flat feet (Sachini N.K, Kodithuwakku Arachige, Harish Chander 2019).

Children are born with a fat pad on the plantar surface of the foot in which it will decrease as the increasing age brings the medial longitudinal arch out to adapt to the ground surface during standing and walking (Brisch-Fritz & Marlene Mauch, 2013). During standing, the ability of maintaining the center of mass (COM) in relation to the base of support could be predicted by the foot posture due to the role of the foot as the base of support. This ability is also known as balance in which it is crucial for any individual as the basic function (Vittore et al., 2009).

This study found that there was no correlation between flatfoot and static balance while the ability to maintain balance in eyes open was significantly different with eyes closed. Previous study conducted in youngsters aged 9 to 12 years old revealed that the ability to maintain static balance differed significantly between normal feet arches and flat feet arches. In the one-legged stance test, normal arch conditions outlasted flat foot arch circumstances for a longer period of time, indicating that they had greater static balance (M. Syafi'i, Sri Surini Pudjiastuti 2016). In addition, there were significant correlations between foot posture and postural stability (Szczepanowska-Wolowiec, B. et al., 2019) as the COP was higher in the flatfoot person than in normal foot (Kim, J. A et al., 2015). However, in our study, we do not compare the ability of maintaining balance between normal and flat feet children.

A cohort study conducted in the UK measuring the balance in children aged 7 and 10 years found that during single leg standing the balance was better in eyes open (Humphriss et al., 2011). Foot type affects how much force is applied to the plantar surface

of the foot during walking and running. The medial longitudinal, lateral longitudinal, and transverse arches contribute to maintaining stability throughout functional tasks by serving as shock absorbers for body weight. Particularly when standing on one flat foot, postural control requires coordination of the somatosensory system, vestibular system, and visual condition (Sung, P. S et al., 2017). During single leg standing, the base of support is reduced thus resulting in more challenges in maintaining balance. Diminishing the visual input would make the children more difficult in maintaining one leg standing for a longer duration (Blanchard et al., 2007).

Flat foot has been found to be correlated with a high prevalence of lower extremity injuries in children (Levinger P et. al, 2010). Although physiological mechanisms account for the majority of common kinds of flat feet, the development of the deformity to a more severe level will result in subjective symptoms like pain and have an impact on declining foot function (Homayouni et. al, 2015). Early diagnosis, treatment, and management of flat feet are so important as a child's motor development may be delayed if this problem is not properly treated (Sachini N.K, Kodithuwakku Arachige, Harish Chander 2019).

There were several limitations on this study. The research uses a cross sectional study design, which makes it impossible to establish a causal connection between variables in a cross sectional study. The outcomes of statistical tests may also be impacted by the small number of participants. More samples must be used in research and more suitable instruments must be developed in order to achieve the best results.

Conclusion

There were significant differences in static balance between eyes open and eyes close in which the subject can maintain their balance longer while eyes open. However, there was no correlation between flatfoot and static balance in children. Flatfoot in school-aged children affects the balance performance where visual input plays an important role, even though there was no correlation between flatfoot and balance ability.

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