The Effect Insole Usage on Children Balance with Flatfoot Condition

Kerub Dion Sihwening Narastiti[1*], Dwi Setyawan[1], Cica Tri Mandasari Ningsih[1]
[1]Prosthetic and Orthotics Department, Polytechnic of Health Sciences Surakarta, Indonesia

Correspondence*:
Address: Banyuanyar RT03 RW09, Banjarsari, Surakarta, Central of Java, 5713 | e-mail: kerubdion263@gmail.com

Abstract

Background: Flatfoot conditions cause children to experience balance problems due to musculoskeletal disorders of the foot. Cases of flatfoot are prevalent in many children and can interfere with their growth and development, potentially reducing their quality of life in the future. Therefore, efforts are needed to improve children's balance. This study aims to determine whether the usage of insoles has an effect on the balance of children with flatfoot conditions at Banyuanyar 3 Elementary School.

Methods and Subjects: By implementing gross motor training for children and utilizing arch support insoles, the study seeks to enhance children's balance ability. The research design is a quantitative experimental design with Randomized Controlled Trials (RCT), employing Single Blinding, and data collection through Pre-test and Post-test. The purposive sampling technique was used, with an intervention period of 30 days. The subjects included students from SD Negeri Banyuanyar 3, with a selected sample of 30 children from a population of 119 with flatfoot conditions. Standard interventions, such as rhythmic gymnastics, function as efforts to improve children's balance abilities and are applied to both the control and intervention groups, each comprising 15 children. The Pediatric Balance Scale (PBS) was used in this study to measure the level of functional balance in children.

Results: The Wilcoxon test results for the treatment group indicated a P-value of 0.002 (<0.05), signifying a difference in balance ability between the pre-test and post-test in the treatment group. This indicates an improvement in balance among children using EVA insoles. Conversely, the control group's test results showed a P-value of 0.067 (P>0.05), suggesting no difference in balance ability between the pre-test and post-test in the control group. Therefore, based on this study, it can be concluded that the use of EVA insoles with arch support was found to improve the balance of children with flatfoot conditions.

Keywords: Insole, flatfoot, balance, children, Pediatric Balance Scale

Introduction

Balance is a motor skill that is very important for daily life, especially during the mass growth and development of children, balance has many factors including Base of Support (BoS) refers to the area beneath an object or person that includes every point of contact that the object or person makes with the supporting surface, Center of Gravity (CoG) of the human body is a hypothetical point around which the force of gravity appears to act, Line of Gravity (LoG) is an imaginary vertical line from the centre of gravity to the ground or surface the object or person is on. And the three elements above which are interrelated with each other (R. Fitri & Imansari, 2020).

Body structure indirectly affects balance in children, one of the factors is the musculoskeletal structure of the foot, especially in the Medial Longitudinal Arch (MLA).The shape of the soles of human feet can be classified into three types, namely pes planus, normal foot, and pes cavus according to the shape of the arcus or the shape of the arch of the sole of the foot (Nugroho & Nurulita, 2013) Normal foot is a condition of the normal arch pedis. Pes planus or also called flat foot is a condition of the sole of the foot that has a flat foot arch or disappears, while pes cavus is a condition of the pedis arch or high foot arch (Nurohman, 2017). Some factors that affect flat feet are gender, body mass index, physical activity, and age. The arch of the foot that does not grow normally causes fatigue when walking too long, disruption of balance and pain when walking too long (Maharani *et al.*, 2020).. It was found that 75.3% of children with flat feet were unable to stand on one leg for a long time due to the instability of the subtalar joint and the eversion position of the subtalar joint that disrupted stability during standing with one leg raised and resting on the other leg (I. Fitri & Ariyanto, 2018).

Flatfoot can cause excessive pressure on the sub talar joint which causes successive internal rotations of the tibia and femur which induces a shift in the arrangement or alignment of the pelvis anteriorly by about 10º. Changes in the alignment of the body structure are followed by changes in the COG (Centre Of Gravity) which plays a role in the distribution or distribution of body mass related to the BOS (Base of Support) to achieve body balance (Latifah *et al.*, 2021) if there is a change in the position of the body, 2021), if there is a change in the position of the COG against the BOS, there is a decrease in the level of body balance, with the following mechanism Flat foot causes constant overpronation which affects the structure of the foot which causes the entire foot to experience internal rotation and this also affects the tibia bone and causes an alignment shift of as much as ten degrees (Latifah *et al.*, 2021). In flat feet there is three dimensional damage, namely the valgus state of the calcaneus, the collapse of the arcus longitudinalis and the abduction of the forefoot (Nurohman, 2017).

Flatfoot cases have a relatively high incidence rate, according to the Indonesian Ministry of Health (2016), flatfoot cases in Indonesia in primary school children aged 7-12 years are 27,574,728 children. In urban areas, it was found that the incidence of flat foot cases was 30% (Anisafitri, 2021).Insole with arch support is able to support a low medial arch. Wearing insoles, especially insoles with arch support, is an effort to improve the balance ability of children with flatfoot conditions. The use of an insole can provide support to the foot, and can improve the position of the resting calcaneal when stance phase or when focusing, and the insole can increase the medial angle of the longitudinal arch that can be observed with radiographic measurements (Chen et al., 2019).

As we already know that flatfoot affects children's posture and has an impact on balance which certainly affects their performance in daily activities. In this study we can see how impactful flatfoot is on the child's functional balance ability, to reduce the influence of flatfoot in the child's balance and improve the child's balance and the child's quality of life,

researchers sought to research this issue. This study aims to determine the effect of using EVA insoles as arch support on the functional balance ability of children with flexible flat foot conditions.

The role of the insole in this case is to support the medial longitudinal arch. The use of arch support insole can make the stance phase shorter, arch support insole can help absorb shock or shock absorption on the medial heel when walking uphill, downhill, and on flat surfaces, and provide propulsion to the thumb when walking on inclines and flat surfaces, and the 2nd metatarsal to the 4th metatarsal there is propulsion when walking on a flat road compared to wearing a flat insole. In addition, the arch support insole provides a more even contact area across the entire foot surface (Huang et al., 2020). The above shows that the insole can provide support to the flatfoot according to the hypothesis of this study, namely the use of EVA insoles can improve the functional balance of children with flatfoot conditions.

Methods

This study used the RCT (Randomization Control Test) method with single blinding, the research subject does not know the difference in treatment given by the researcher and the division of treatment groups and control groups using random lottery techniques and divided into 15 children per group. The population flat foot involved in this study was 119 children and the sample size was 30 children, The population includes data on the total number of children with flexible flat foot conditions in grades one to six at SD Banyuanyar 3 Surakarta However, samples that meet the inclusion and exclusion criteria are found in grades four to six. The sample of this study is in accordance with the inclusion and exclusion criteria. the following are the inclusion criteria: a) aged 10-12 years, b) ideal body mass, c) children with flexible flatfoot, d) willing to be research subjects, and with the following exclusion criteria: a) subjects with injuries to the soles of the feet, b) body weight is not ideal, c) subjects refuse to participate in the study, d) subjects with rigid flatfoot, d) aged less than 10 years and more than 12 years.

The inclusion and exclusion criteria above are made for sampling purposes. One of the influencers of balance ability is weight, so the study subject must have weight in the same category. The growth of the medial longitudinal arcus occurs at the age of six years to eight years, but at the age of nine years to ten years, the growth of the arcus is mature, aka it has begun to form, in this case we can know that the child really has a medial arches growth disorder after the age of 10 years (Nisa & Aktifah, 2020). And the condition of the subjects' feet must be in a healthy state in the sense that there are no injuries or injuries, because if the feet are in an unhealthy state can make the results of the study biased because the balance can be affected.

This study uses the Pediatric Balance Scale (PBS) as a research instrument to measure the level of functional balance of children and this test is suitable for testing the balance of children who have pediatric disorder, in this case flatfoot is one of the disorders in children. This test is a modified form of the Berg Balance Scale which is used to test functional balance ability especially at school age. This scale consists of 14 types of assessments with scores ranging from 0 (lowest function) to 4 (highest function) with a maximum score of 56 points. Because the Berg Balance Test instructions are difficult for children to understand, they are modified by clinical experts to remain suitable for children and test results that have a fixed reliability value (Darr et al., 2015). This test has a data limit or cut off value for ages 7 years to 13 years 7 months with a minimum value of 54.6 points. This cut off score has been determined to be applicable and the outlier range for each age group has 95% Continuous Integration (CI). Which means this score is the lower limit of the average 95% Continuous Integration (CI). This means that if the score is answered 54.6 points have decreased

functional balance ability, in which case it requires further clinical examination to be able to analyse it. PBS also has test-retest (intraclass correlation coefficient, ICC [2,1] = 0.923), interrater reliability (ICC = 0.972), as well as with intra-rater reliability (intraclass correlation coefficient, ICC = 0.923), interrater reliability (ICC = 0.972), and interrater reliability (ICC PBS also has a potential point differentiator = 0.895-0.998) with normative data mean total 55. 2 ± 1.74 points standard deviation for ages 7 years to 13 years 7 months (Franjoine et al., 2010).

Balance measurements were carried out before and after the intervention in both sample groups, namely the treatment group using the Arch Support Insole and the control group, with the standard intervention of doing rhythmic exercises as an effort to improve balance ability with intensity 2 times a week for 30 days of intervention.

Test the hypothesis of the level of balance of children using insoles. To analyse whether there is any influence before and after using the insole against the child's functional balance with flexible flatfoot condition. Data can be said to be normally distributed if the p value≥ 0.05 is then processed using a parametric hypothesis test that is called the paired t-test. If the data is abnormally distributed, if p value < 0.05 is then processed with a non-parametric hypothesis test, namely Wilcoxon Test.

Results

This research has been in accordance with the research code of ethics with informed consent that has been approved by the research subject and the school responsible party, and this research has been declared ethical worthy by the Health Research Ethics Commission of Dr. Moewardi Surakarta Regional General Hospital with ethical clearance number 486/III/HREC/2023. The results of this study data were processed with SPSS and tested using the Wilcoxon test in the treatment group showed a P-value of 0.002 (<0.05) which means there was a difference in balance ability in the Pre-

test and post-test in the treatment group. While in the control group the Wilcoxon test results showed a P-value of 0.067 (P>0.05) which means that there was no difference in balance ability in the Pre-test and post-test in the control group, this shows that the use of insole (arch support insole) can improve the balance of children with flatfoot conditions.

Table 1. Wilcoxon test in the Treatment group

	Pretest – posttest
Z	*-3,089*
Asymp.Sig. (2 tailed)	*0.002*

Source: Primary Data, 2023

Table 2. Wilcoxon test in control group Primer.

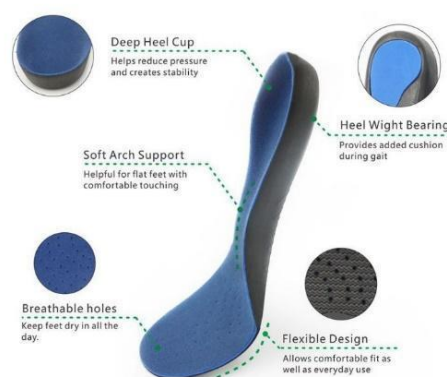|	Pretest – posttest
Z	-1,833
Asymp.Sig. (2 tailed)	0.067

Source: Primary Data, 2023

Figure 1. EVA insole with Arch Support

Discussion

From the results of this study, we can find out the benefits of using the insole as arch support in children, namely increasing the balance ability of the child's body which can support the improvement of the quality of life of children with flat foot conditions with the following characteristics of research subjects. The characteristics of the subjects in this study consisted mostly of men with a percentage of

56% with a total of 17, while female subjects numbered 13 with a percentage of 44%. This happened because the subjects who met the inclusion and exclusion criteria were men. With Body Mass Index (BMI) the subjects of this study were all normal with a BMI range of 18.5-25.0; because subjects who have normal BMI are one of the inclusion criteria. Body Mass Index is one of the factors affecting the level of balance (Nayarti et al., 2021). This is done so that there is no bias in the measurement results of the subject's balance level, because body weight is one of the factors affecting balance.

The subjects of this study had an age range of 10 to 12 years because at that time the medial arch should have begun to form. At this age, early detection of flatfoot can be done with the Clarke's angle method. In this study there were ten-year-old samples as many as 11 children, as well as at the age of 11 years there were 11 subjects, and at the age of 12 years there were 8 subjects. This shows that the arch can grow over time (Nisa & Aktifah, 2020).

All subjects followed the standard intervention in the form of rhythmic gymnastics as a physical activity with intensity twice a week. This is done as an effort to improve gross motor skills (Candra et al., 2019), especially as an effort to improve the balance ability of the research subjects.

Based on the results of the Wilcoxon test in the treatment group, the P-value is 0.002 (<0.05), which means that there is a difference in balance ability in the pre-test and post-test in the treatment group. While the control group has the following results the Wilcoxon test results show a P-value of 0.067 (P>0.05) which means there is no difference in balance ability in the Pre-test and post-test in the control group. This shows that the use of arch support insoles can improve the balance ability of children with flexible flat foot conditions.

In this study, researchers used the Pediatric Balance Scale research instrument which is a functional balance test in children with a combination of 14 test categories in which there are static and dynamic balance tests, because in everyday life these two balance abilities are very important. In the research that has been conducted, researchers obtained results, namely, the treatment group with arch support insoles for 30 days showed an increase in balance ability. There is also a theory in research conducted (Fattahi et al., 2020) regarding the instant effect of insole use on the balance of adolescents with flatfoot and pes cavus conditions, with the results that there is an effect of using medical insole on static balance and dynamic balance.

In observations during this study, there were quite visible differences during the pretest and post-test of the treatment group, the level of body stability in the subject when doing the pretest and post-test in the test category standing on one leg and standing with parallel legs / in a straight line, the subject seemed more unstable before receiving the intervention than after the intervention. In the control group there was no significant difference in the category test.

The above occurs because Insole can help joint alignment return to its normal position and cause joint movement to be more stable, so that balance ability increases, this is in accordance with the results of the average PBS balance score of 54.93 points in the treatment group after using the insole and undergoing intervention for 30 days with data limits or cut off values for ages 7 years to 13 years 7 months with a minimum value of 54.6 points. This shows that the use of Arch support can improve balance ability in children with flexible flatfoot.

This study is also in accordance with the results of research that has the results of an increase in balance ability that will arise due to the long-term effect of insole use on kinetic pattern parameters in girls with flexible flatfoot, which shows an increase in quality of life due to long-term insole use in children with Flatfoot conditions according to research conducted by Nadia (Radwan et al., 2020). The above shows

that the use of an insole is useful for improving balance in children with flatfoot conditions.

Conclusion and Recommendation

This study proves that there is an increase in functional balance ability in children aged 10-12 years with flexible flatfoot conditions after wearing EVA-based Insole arch support for 30 days. The use of insoles with EVA-based arch support is the right tool for children with flexible flatfoot to support the quality of daily activities that need to be accompanied by active physical activities. Parents can consult with health professionals to find out the child's overall physical condition and health, and if the child is diagnosed with flexible flatfoot are advised to wear insoles every time you put on shoes with EVA-based arch support and continue to exercise regularly to improve gross motor skills, especially balance.

For future researchers, it is expected to pay attention to factors such as body weight, gender, and so on. Researchers can further examine with increased attention to the similarity of children's Body Mass Index ranges despite the overall ideal, age, gender, children's daily activities such as sports and other activities. As well as increasing the number of samples and increasing the intensity of supervision of daily activities on respondents and ensuring the use of insoles is carried out correctly and routinely, and in future research please examine the durability of the Eva Insole and the duration of its effective use. Researchers are also expected to be able to review the impact of wearing insoles for a long time and regarding the durability of insoles and the effectiveness of using EVA-based insoles for a longer time. By taking to account other factors affecting balance, as well as using other types of flatfoot classification tests.

For institutions This research is expected to be an additional reference material for the science of prosthetic orthotics in the management of flat foot cases in children using EVA-based Insole arch support with standard rhythmic gymnastics interventions as an effort to improve balance ability.

References

1. Anisafitri. (2021). *Hubungan Bentuk Kaki Flat Foot Terhadap Keseimbangan Pada Anak Usia 7-10 Tahun : Narrative Review Terhadap Keseimbangan Pada Anak Usia 7-10 Tahun : Narrative Review*.
2. Candra, R., Sulaiman, I., & Siregar, N. M. (2019). Model Latihan Senam Irama Rc One Untuk Gerak Dasar Lokomotor Anak Sekolah Dasar. *Segar*, 7(2), 96–106.
3. Darr, N., Franjoine, M. R., Campbell, S., & Smith, E. (2015). *Psychometric Properties of the Pediatric Balance Scale Using Rasch. September.* https://doi.org/10.1097/PEP.0000000000000178
4. Fattahi, A., Koreili, Z., & Ameli, M. (2020). Instantaneous Effect of Insole on the Balance of Adolescents With Flat Foot and Pes Cavus. *Journal of Sport Biomechanics*, 6(1), 44-53. https://doi.org/10.32598/biomechanics.6.1.6
5. Fitri, I., & Ariyanto, A. (2018). Perbedaan pengaruh core stability exercise dengan ankle strategy exercise terhadap keseimbangan pada bentuk arkus flat foot di universitas 'aisyiyah yogyakarta. *Universitas Aisyiyah Yogyakarta*, 1–17.
6. Fitri, R., & Imansari, M. L. (2020). Permainan Karpet Engkle: Aktivitas Motorik untuk Meningkatkan Keseimbangan Tubuh Anak Usia Dini. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, 5(2), 1186–1198. https://doi.org/10.31004/obsesi.v5i2.754
7. Franjoine, M. R., Darr, N., Held, S. L., Kott, K., & Young, B. L. (2010). The performance of children developing typically on the pediatric balance scale. *Pediatric Physical Therapy*, 22(4), 350–359.

https://doi.org/10.1097/PEP.0b013e318 1f9d5eb

8. Huang, Y. P., Peng, H. Te, Wang, X., Chen, Z. R., & Song, C. Y. (2020). The arch support insoles show benefits to people with flatfoot on stance time, cadence, plantar pressure and contact area. *PLoS ONE*, *15*(8 August), 1–12. https://doi.org/10.1371/journal.pone.0 237382

9. 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. https://doi.org/10.23917/fisiomu.v2i1.1 0039

10. Maharani, A. A. A. A., Wibawa, A., & Adiputra, I. N. (2020). Perbedaan Kelincahan Antara Normal Foot Dan Flat Foot Pada Anak Usia 10-12. *Majalah Ilmiah Fisioterapi Indonesia*, *8*(3), 7. https://doi.org/10.24843/mifi.2020.v08 .i03.p05

11. Nayarti, H., Sampul, H., Fisioterapi, P. S., Keperawatan, F., & Hasanuddin, U. (2021). *Hubungan postur terhadap keseimbangan statis dan dinamis pada lansia di unit pelaksana teknis daerah pusat pelayanan sosial lanjut usia mappakasunggu kota parepare*.

12. Nisa, F., & Aktifah, N. (2020). 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. *Kajen: Jurnal Penelitian Dan Pengembangan Pembangunan*, *4*(01), 73–84. https://doi.org/10.54687/jurnalkajenv0 4i01.6

13. Nugroho, A., & Nurulita, F. (2013). *HUBUNGAN ANTARA PES PLANUS DENGAN KESEIMBANGAN DINAMIS PADA MURID MI NURUL KARIM COLOMADU Agus Setyo Nugroho, Fadhila Firma Nurulita*. 6–14.

https://doi.org/https://doi.org/10.3734 1/jkf.v4i1.120

14. Nurohman, M. A. (2017). Hubungan Tinggi Lompatan Dan Bentuk Arcus Pedis Dengan Kejadian Sprain Pergelangan Kaki Pada Atlet Bulutangkis Yang Melakukan Jumping Smash. *Digilibadmin.Unismuh.Ac.Id*. https://digilibadmin.unismuh.ac.id/uplo ad/7996-Full_Text.pdf

15. Radwan, N. L., Ibrahim, M. M., Eid, M. A., & Aly, S. M. (2020). *The long-term effect of foot insoles on kinetic gait parameters in female children with flexible flat foot*. 25(02), 13412051.