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Comparing the effect of wearing insoles on some motor-physical factors, lower extremity performance and stability in male adolescents with structural flat foot

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Abstract

Background: flatfoot is a common deformity characterized by the midfoot arch collapses during walking. As the midfoot is responsible for shock absorption, persons with flatfoot experience increased risk of injuries

Aim: to the purpose of this study was to compare some motor-physical factors, lower extremity performance and stability index in male adolescents 10-12 having structural flat foot with and without insole.

Materials and Methods: Subjects who utilized medical insoles for four to six months were selected in access from technical orthopedic in Karaj. After parents got aware of the purpose and conditions participating in research, their height and weight were measured. In the first day, they were assessed by motor-physical factors test (agility, speed, endurance), lower extremity performance (one-leg jump, cross jump, maximum distance access, walking six meters) and stability index wearing insole and on the next day without wearing insole. To analyze data, paired t-test was utilized. Wilcoxson was used respectively for parametric and non-parametric data.

Results: According to the paired t-test a significant difference was observed in the 6-meter timed test. Mean difference was slower in wearing insole compared to not wearing insole. Moreover, stability index results showed more stability when not wearing insole which eyes were closed to significant.

Conclusion: According to the results, wearing insole in individuals with flat foot, could slow down the walking speed. However, wearing insole may improve stability index when visual input is not in access.

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1. Introduction

The arch of the foot is the result of the continuous evolution of basic human movements such as walking [1, 2]. Only human species have the arch of the foot among vertebrates [3]. However, foot problems are common in 30% of children among them flat foot is most prevalence problem [4, 5]. Since sole arches have a shock absorbing role in balance and moderating forces on the body [6, 7], flat foot deformity leads to a change in natural pattern of weight transfer in the lower extremities and increases the likelihood of injury and the application of abnormal compressive and tensile forces in the external and internal areas of the knee and ankle joints, respectively [8, 9, 10]. Increased pressure in some areas of the foot due to flat foot can be a major cause of exacerbated injuries due to repeated activities in the lower extremities. Studies show that increased sole contact surface in this deformity could lead to an increase in pain in lower back, metatarsal, and knee, restriction in mobility, fatigue, gait disturbance, and injuries such as ankle dislocation or knee patellofemoral pain syndrome, thumb valgus, tendinitis, plantar fasciitis [10, 11, 12, 13]. According to research, between 3-13% of children have flat feet with higher probability in youth which has harmful effects on physical fitness [14].

Some researchers recommend the use of medical insoles to control risk factors such as shock to the lower extremities causing because of flat foot [15, 16]. Although evidence behind the effects of insoles on flatfoot is somehow limited sine, there is variety of the disorder and low methodological quality [17, 18].

Foot insoles has been shown to have positive effect on the ankle joint in patients with flat feet [19]. The insoles reduce the maximum pressure in the sole of the foot by improving the longitudinal arch of the foot [20]. Customized arch support insoles showed improved pain/comfort, physical health, upper extremity and physical function, and transfer and basic mobility [17]. According to Kido et al. (2014), therapeutic insoles can affect significantly the structure of the sole bones [18]. Arch support insoles can assist with shock absorbing mechanism by distributing contact areas across midfoot [21]. In runners with flat foot, insole usage has shown to realign lower extremity joints and prevent fatigue [16]. Balakrishnan, Jacob and Nair (2015) reported that the effect of corrective exercise and insoles on sole arches are more than each of them alone [22]. Nakano et al. (2020) examined the long-term effect of insoles with toe-grip bar on walking, running and balance in preschool children and reported improvements in running of pre-school children [23]. However, in addition to biomechanical effects of insoles, they could have a physiological effect by increasing the proprioception in the sole of the foot [19].

In the literature, the question is whether some factors of physical fitness change in people with flat feet, with or without medical insoles in the function of the lower limbs. And does having an open or closed eyes affect their stability indicators? Therefore, the present study aimed to discover the effect of wearing therapeutic insoles on motor physical factors, lower limb performance and stability index with open and closed eyes.

2. Materials and Methods

Twelve boys, 10-12 years old, were recruited from orthopedic technicians and

physiotherapists in Karaj, Alborz [24, 25]. They had structurally flat feet and had a history of wearing medical insoles for 4 to 6 months. We explained to the parents about the stages and conditions of the research and they signed consent forms for children to participate in this research.

Inclusion criteria: Boys who were between 10-12 years old; they have structurally flat foot and a history of using personal medical insoles for a minimum of 4 and a maximum of 6 months; lack of participation in regular physical activity or special sports history; lack of history of cardiovascular, lung, specific diseases and disorders of the inner ear.

Exclusion criteria: Not use drugs that affect balance; having abnormalities such as braced knee and crossed knee. (Distance between the inner condyle of the knee and the inner ankle of the ankle is more than 3 cm).

2.1. Measurement

Forms related to health, stopwatch model CR 2032 Q&Q (made in China), bar meter, ruler, gymnastic mats, static balance device called stabile meter made in Iran (Danesh Salar Iranian Company), two pieces of wood 5 by 10 cm, bars with 15 cm wide and 6 m long.

The participants were measured with height and weight and with the permission of their physician. They were tested with insoles and one week later without insoles. In the first day, subjects stood on stabilimeter, and were assessed for their physical-motor fitness, including agility (4 in 9 running) speed (20 m running), and endurance (Cooper modified test); the next day, lower limb function tests including one-leg jump, cross jump, maximum access distance, walking for 6 m in time. All tests were performed both with and without medical insoles from 3 to 8 p.m.

Descriptive and inferential statistical methods were used to analyze the collected information. To determine the normality of the data, Kolmogorov-Smirnov test was used. To compare test scores with and without medical insoles we used paired t-test for physical fitness (agility, speed, cardiovascular endurance), lower limb performance (one-leg jump, cross jump, maximum access distance and walking six meters in time), and Wilcoxon Ranking Test for and stability (stability index) at a significance level of 95% and $\alpha \leq 0.05$.

3. Results

Table 1 shows the results of paired t-test on physical fitness factors. According to the results on agility (t= 1.024, sig= 0.328), speed (t= 1.024, sig= 0.104) and endurance (t= -0.410, sig= 0.689). There was no significant difference between the means in these two conditions of wearing insoles and not-wearing insoles. Therefore, medical insoles did not affect physical fitness factors (agility, speed, cardiovascular endurance) in boys 10-12 years of age (P<0.05),

Table 1 depicts the results of paired t-test on lower limb performance. According to the results, one-leg jump (t= -7.718, sig= 0.114), cross jump (t= 1.122, sig= 0.248), maximum access distance (t= -0.691, sig= 0.504). There was no difference between conditions of wearing insole and without insole. However, in walking 6 m (t= 380.3, sig= 0.006), there was a significant difference between insole and non-insole conditions. And these differences showed slower speed of walking 6 m when wearing insole compared to non-insole condition. Therefore, medical insole showed a positive effect on lower limb function in children 10-12 years old with flat feet only in 6 m walking time (P<0.05).

Table 1. Results of paired t-test on physical fitness (agility, Speed, Endurance) and lower limb performance (one-leg jump, cross jump, maximum distance access, walking six meters in time)

Variable	Mean	SD	SE	T statistics	P value
Agility	12.83	0.81	0.198	1.024	0.328
Speed	4.98	0.53	0.176	1.774	0.104
Endurance	762.08	145.73	30.468	-0.410	0.689
One-leg jump with insole and without insole	95.44	15.92	3.777	-1.718	0.114
Cross jump with insole and without insole	2.97	0.43	0.122	1.221	0.248
Maximum access distance with insole and without insole	39.87	20.56	4.881	-0.691	0.504
Walking 6 m in time with insole and without insole	3.08	0.24	0.663	3.380	0.006

Table 2 shows the results of Wilcoxone Ranking Test on stability index with open and closed eyes when with insole or without insole. There was not a significant difference (z= -0.118, sig= 0.906) between with insole and without insole condition. In closed eyes condition, there was not a significant difference between with insole and without insole condition(z= -1/687, sig= 0.092). However, this difference was close to significant. The rankings showed that wearing insole with closed eyes, there was less stability compared to without insole (P<0.05; Figure 1).

Table 2. Results of Wilcoxon Ranking test on stability Index with and without insoles with open and closed eyes

Variable	Z statistics	P value
Stability index with and without insoles with open eyes	-0.118	0.906
Stability index with and without insoles with closed eyes	-1.687	0.092

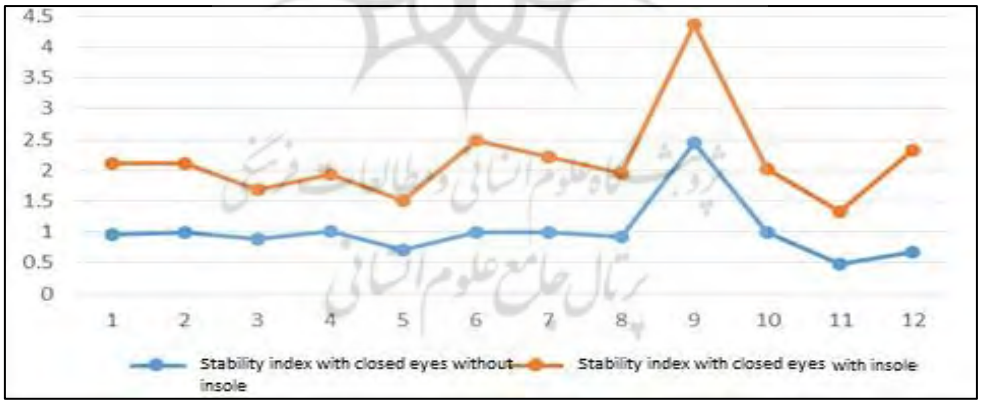

Figure 1. Stability index with closed eyes with insole and without insole

4. Discussion

The results of the present study indicated that wearing therapeutic insole did not have a significant effect on selected factors of physical fitness (agility, speed and cardiovascular endurance) and lower limb performance tests (one-leg jump, cross jump, maximum access distance). However, wearing insole could have a significant effect on decreasing the walking speed. Moreover, comparing the effect of wearing insole in open and closed eyes, wearing insoles may create more stability when eyes are closed.

Regarding insole use, Karimi et al.

(2012) reported that insole usage could affect energy consumption during walking and improve gait performance in individuals with flat feet [26]. In this regard, Farmani et al. (2011) shows wearing insole was mentioned as a barrier to muscle fatigue in long-distance running, and when medical insole was used for patients, their energy consumption while running decreased [16]. Nakano et al. (2020) reported that wearing insoles could improve running speed in pre-school children [23]. The use of medical insoles restores normal walking postures and consumes less energy in people with flat feet [16]. Yu-chitsen et al. (2009) studied the effect of orthoses on gait pattern and observed the effect of insoles on increasing torque and knee varus. Although the effects were not significant, the effectiveness of wearing insole on the knee joint was mentioned [27]. Geller Kolko et al. (2009) also reported the effect of insoles on the forces acting on the foot and the entire lower limb [28]. Karimi et al. (2012) reported the effect of using insoles on improving the performance of people with flat feet while walking [26].

These results are not consistent with present study. The duration of walking 30 m with insole was more than the duration of walking this distance without insole. It seems that indicating wearing insole has a negative effect of wearing insoles on activities that require speed. Hsieh et al. (2018) findings are in line with the present study as they did not report any improvement in speed in performance of walking speed in children as a result of wearing customized arch support insoles [17]. It seems that different materials, designs, hardness levels, textures, contact areas, and even practitioners can influence the effects of insoles.

Regarding the variable of stability index with closed eyes, there was not a significant difference between the two modes with insole and without insole, but it was close to significant. Stability index with closed eyes when wearing insoles was higher with insole compared to without insole.

Habibian et al. (2016) compared the effect of medical insoles on dynamic balance of people with flat feet and reported using medical insoles in people with plantar fasciitis caused a significant increase in the achievement of the star balance test. Immediately after the use of medical insoles, the dynamic balance of these people improved [29]. Shin et al. (2016) investigated the effect of the amount of contact area between the insole and the sole of the foot on static balance. All subjects wore three types of insoles (no orthopedic insole, partial and full contact). They suggested that the use of insoles increased the contact area of the sole of the foot, which improved the ability of static balance [30].

While Samimi, Anbarian and Abdolmaleki (2011) reported that the immediate effect of toe supportive foot arch on the displacement of the foot center of pressure in the barefoot position is less than the position of shoes and shoes with insoles [31]. Aboutorabi et al. (2014) compared two types of orthotic interventions common in Iran including functional insole and medical shoes and showed that in the group with flat feet, functional insoles along with ordinary shoes and medical shoes compared to the barefoot position significantly reduced the displacement of the pressure center and there was no significant difference between the two groups of medical shoes and functional insoles with ordinary shoes [32]. Insole usage increases the level of cutaneous receptor activity and

improves postural control by stimulating the subcutaneous plantar surface sensation and stimulating the plantar surface sensation [29]. Habibian et al. (2016) stated that people with flat feet, by wearing insoles, not only enjoy mechanical advantages but also its neurophysiological benefits [29]. It seems that in the present study, with closed eyes while wearing the insole by removing the visual information, the role of deep receptors of the sole and other receptors of the deep and articular senses increases positively to maintain balance.

Having a small sample size was a limitation of this study that makes generalization of findings impossible. Although some other studies have used the same sample size [24, 25]. Another limitation of the present study was that we did not valid confirmation that the consistency of wearing insoles for all the participants.

5. Conclusion

According to the results of the study, the effect of wearing insoles could increase the speed of walking. Also, when visual data is not available, wearing insole may be effective in improving stability index. It seems that in balance activities, wearing insoles can be an effective factor in improving the role of deep receptors and reducing postural fluctuations.

Plain Language Summary

Since the deficiency of flat foot is one the most prevalent issues in children, and influence negatively motor performance and balance, increase the probability of other injuries, and causes pain in them, investigating strategies that could ameliorate this problem is significantly important. Utilizing insoles is one the solutions for this issue that has not been well documented and needs more research. This study provides insight into how wearing therapeutic insoles can affect motor functionality in children who suffer from structural flat foot. For this, we assessed children's motor-physical factors such as agility, speed, endurance; lower limb performance (one-leg jump, cross jump, maximum access distance and walking six meters in a specified time and stability in two conditions of wearing insoles and without insoles. The findings showed that the lower extremity performance i.e. walking speed increased when wearing insoles compared to without insole condition. In addition, improving in stability index was noted when the participants did not wear insoles and they had closed eyes compared to the condition with wearing insoles with open eyes.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design. Shahriar Rafiei Milajerdi performed all the process form managing the whole project, collecting data, analyzing data, draft preparation and editing the manuscript. Afsaneh Sheiki did literature search, editing the manuscript, preparing the tables and figure, references. Mahboubeh Ghayour Najaf Abadi supervised all the process and checked the manuscript before submission.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication

and/or redundancy, submission, etc.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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