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Review Article

Flatfoot Deformity; Exercise to Therapeutic Interventions: A Systematic Review

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Abstract

Background: Deviation of the foot from the normal posture affects the function of the foot and lower limb and causes lower limb injuries in normal people and athletes. Flat feet or flatfoot deformity are usually associated with pain in the foot area and a decrease in the normal function of the foot, which can negatively affect the sports ability of athletes. Therefore, we aimed to investigate the abnormality of flat feet from training, exercise to therapeutic interventions.

Methods: Articles were identified by searching five databases: PubMed, Scopus, Google Scholar, Science Direct, and Gate & Pasteur from 2000 to 2022. The keywords were selected specifically and correctly and all the researches and articles related to the title of the article were searched and found. This research was also searched in Persian databases that this database, included: Irandoc, Mag Iran and Noormagz.

Results: Finally, 30 studies met the criteria for entering this study, selected and used to conduct this study.

Conclusion: By using the results obtained in the research, which include corrective exercises and therapeutic interventions, especially the use of orthoses and various medical insoles, it is possible to help in the treatment and improvement of this anomaly.

Keywords: Flatfoot deformity; Exercise; Therapeutic interventions

Introduction

Deviation of the foot from the normal posture affects the function of the foot and lower limb and causes lower limb injuries in normal people and athletes. Flat soles are usually associated with pain in the foot area and a decrease in the normal function of the foot, which can negatively affect the sports ability of athletes (1). Among the most common deformities of the foot area, we can mention the deformity of flat feet, so that its prevalence in the adult population is reported between 2% and 23% (2). One of the most important and variable structural features of the foot is the height of the medial longitudinal arch (MLA) (3). A decrease in the height of this arch is called a flat foot. The flatness of the sole of the foot is expressed as a reduction of the inner longitudinal arch of the foot, valgus deformities of the heel and the inner protrusion of the talus. Many factors lead to this deformity, the most important of added to ligament laxity, the presence of navicular bone. (Accessory navicular), rotational malformation of the tibia, congenital verticality of the talus and the presence of interosseous bridges (4, 5).

People with flat feet have different movement biomechanics than normal people, for example, when walking; these people have more emergence and pronation in the back of their feet, more plantar flexion in the ankle joint, and more flexion in the knee joint (6). There are two types of flat foot deformity: structural and functional (flexible). Its flexible type is said to be a way in which the arch of the sole of the foot is straightened during weight bearing, and when a person stands on his toes, this arch is formed again, which is a response to ligament laxity (7). People with flat feet experience fatigue and pain in their lower limbs earlier when walking compared to healthy people (8). Flat soles impose high stress on the foot and lower limbs and cause pain and dysfunction in sports activities (9). Moreover, people with flat feet suffer from lower limb damage, pain, and disruption in daily functions because of increased pressure on the soles of the feet (10).

Correcting flat feet by using exercise methods and the use of medical orthotics has always been discussed, for this reason, in most cases; an exercise program with the use of medical insoles is more recommended (11). Nevertheless, variables such as age, type and severity of the condition and exercise programs are very important factors in improving the said condition (12). A variety of therapeutic and clinical interventions is available to treat flat feet, such as the use of orthotics, orthopedic surgery, and the use of special exercises (13). In a study, the result was controlling the movement of the subtalar, ankle and knee joints, as well as correcting foot pronation. It was while walking (14).

There are other treatment methods to correct the structural deformities of the foot in order to improve the movement function of the lower limb. Using medical insoles is one of the common non-surgical methods. Usually, medical insoles are able to prevent complications caused by flat feet and improve foot function by limiting extra foot movements. By reviewing the previous research on the effect of medical insoles in the fields of kinematics, kinetics and electromyography, the insoles lead to a reduction of extra leg movements in different sub phases of walking and running stance (15). Flexible flatfoot is a condition characterized by the deformations of the foot where the calcaneus is pronated by weight support (16). Flat feet can affect balance and the entire chain of motion, causing indirect problems in adjacent joints (17). A variety of clinical interventions is available for the treatment of flat feet, such as orthopedic surgery, orthotics, and taping (18). In particular, short foot exercise (SFE) is commonly used as a therapeutic exercise to strengthen intrinsic foot muscles (19). SFE is a training used to create an MLA by pulling the first metatarsal bone head to the heel without bending or excessively extending the toes (20). SFE may be helpful in improving the balance in functional movement of both, normal and flat feet subjects, preventing navicular drop (ND) through intrinsic muscle activation (21). Moreover, SFE can be used to activate further abductor hallucis (AbdH) supporting navicular stability, increasing the stability of foot (22). Sensorimotor training (SMT) is a type of proprioceptive exercise or balance exercise. It is an integrated approach of the sensory and motor systems to treat chronic musculoskeletal pain, restore normal muscle balance and reflexive stabilization, and promote coordinated exercise patterns (23). Posture is the most crucial consideration when performing SMT, and the maintenance of upright posture depends on sensory inputs from the foot, the sacroiliac joint, and the cervical spine. SMT combined with barefoot training enhances the amount of appropriate feedback information in the somatosensory nervous system (24).

Several studies have recently investigated the effect of combined SMT and SFE among different target groups. Functional balance training with SFE increased postural stability in participants with functional ankle instability, and a four-week rehabilitation of intrinsic foot muscle strength during balance exercises resulted in an improved self-reported function in individuals with chronic ankle instability (24). In studies related to electromyography, the use of medical insoles reduces excess muscle activity in people

with flat feet deformity compared to normal people (16).

Another therapeutic intervention and optimization of foot structural problems in people with flat feet is the use of medical shoes, which can play a very important role in optimal walking of these people (25). The outer sole of the shoe is the first area that is in contact with the ground and is directly exposed to the reaction force of the ground, optimal design for the sole of the shoe and knowing the pressure and load on the sole of the shoe can be used in the discussion of therapeutic interventions and prevention of Injuries play an important role.

The importance of identifying various abnormalities and paying attention to their treatment and adjustment solutions has been one of the most important challenges for sports and medical science experts. Finding solutions based on exercise and training is of particular importance in this field. We aimed to conduct a comprehensive review of various methods of dealing with flat feet deformity in a wide range of sports exercises and other interventions.

Methods

Articles were identified by searching five databases: PubMed, Scopus, Google Scholar, Science Direct, and Gate & Pasteur. The period and time of searching for articles was from 2000 to 2022. The keywords were selected specifically and correctly and all the researches and articles related to the title of the article were searched and found. Moreover, articles were searched through their sources. Searching in databases through keywords such as: Flat feet, medical insole, Training, Therapeutic interventions, Exercise and treatment interventions, Impact of insole on flat foot, Flat foot deformity, Treatment of flat feet with insoles, Influence of Kinetic and kinematic variables on flat feet, the effect of exercise and treatment on flat feet was done. This research was also searched in Persian databases, which included Irandoc, Mag Iran and Noormagz.

After collecting all the results, the title and abstract of the articles were studied. The articles whose inclusion and exclusion criteria were appropriate were enrolled. According to the title, results, main criteria and goals of the article, 30 articles that were completely aligned with the research were selected as full text. Finally, the researcher evaluated and reviewed all the selected articles that were in line with our research. Finally, the summary of all the information available in the researches and their results was also used in a table with the aim of investigating the effect of exercises and therapeutic interventions in people with flat feet. Moreover, the scoring method was used to evaluate the grade of the articles used, and the articles and studies that got more points indicated their level and good grade, and more of them than other articles that had lower points in this research used (Fig. 1).

Results

The process of selecting articles is shown in Fig. 1. Overall, 250 articles were found by searching electronic sources. By manual search and by checking the sources of articles and studies, we found 4 articles. After removing duplicate titles, the number of 150 articles and researches was identified for reviewing the studies. After checking the titles and abstracts of the studies, 100 articles were removed and 50 articles were selected in general. Then, after reviewing the general text and 40 original articles, 10 articles that investigated the change in shape of flat feet from exercise to therapeutic interventions, their results were enrolled (Table 1).

The reviewed cases about the deformity of flat feet mostly deal with issues such as various exercises and therapeutic interventions such as orthoses and medical or surgical insoles, which indicate that these interventions can have an effect on Improvement and treatment of this abnormality, are effective.

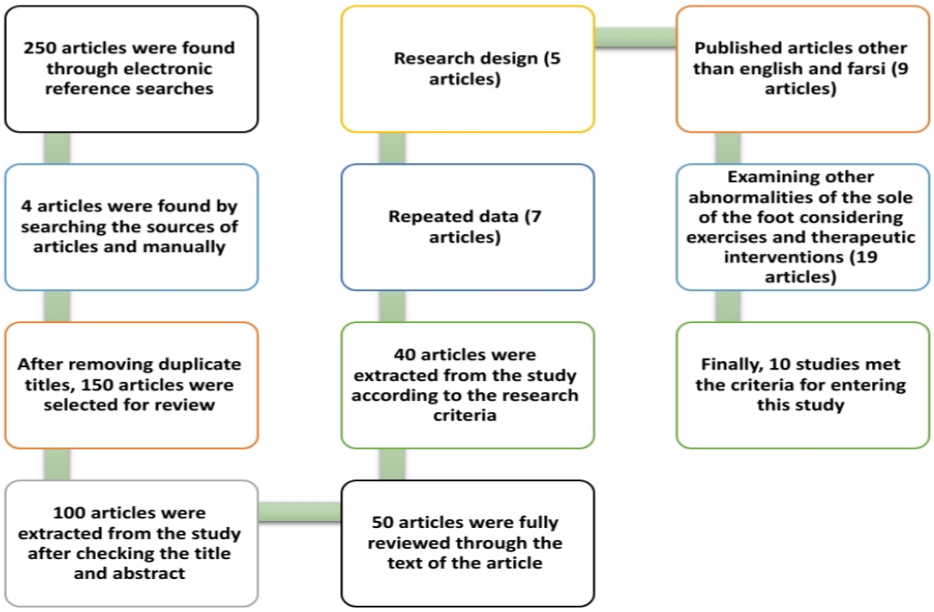

Fig. 1: Screening articles

Table 1: The results of the researches that have investigated the deformity of flat feet from exercise to therapeutic interventions

Author(Ref)	*Type of research*	*Type of intervention*	*Results*	*PED*
Samper et al (16)	Review	Treatment	Arthrodesis has been effective in other stages, but is associated with loss of range of motion in the hindfoot and increased pressure on adjacent joints	4/11
Kim et al (26)	Intermittent	Exercise on balance	This study investigated the effect of SFE using visual feedback on balance and accuracy of knee joint movements in people with flat feet and showed that this exercise improves balance and accuracy of knee movement using visual feedback	10/11
Evans et al (25)	Review	Treatment	Evaluation of pediatric flat feet should be considered with reference to epidemiological findings, where there is consensus that pediatric flat feet decrease with age and most children are asymptomatic. Globally, there is a need for a standard to classify and manage pediatric flat feet. Until then, evaluation should use the existing evidence-based management model.	5/11
Jafarnezhad et al (27)	Intermittent and random	Treatment	Intervention: long-term use of arch support orthoses in boys with flexible flat feet to improve lower limb alignment during walking was practical and effective	9/11
Jafarnezhad et al (28)	Intermittent	Treatment	We conclude that foot orthoses reduce the asymmetry of the hip joint moment on the frontal level, but it has little effect on the ankle and knee joint asymmetry	6/11

Table 1: Continued…

Yart et al (29)	Intermittent	Therapeutic intervention	Therapeutic intervention of CAD-CAM insoles and conventional design are both more effective than artificial insoles in reducing pain in PFFF	10/11
Nazari et al (30)	Research and observation	Use of insoles	Data analysis showed that the use of textured insoles can be effective in improving balance in people with flexible flat soles. This can be the result of improved inner sense and proprioception. On the other hand, we found that conventional insoles can disturb the balance in this group of patients	9/11
Aminian et al (31)	Observational	Treatment	The construction of orthoses can effect the distribution of plantar pressure in flat feet	10/11
Huang et al (32)	Review	Therapeutic and training	Both exercise and foot orthoses can reduce pain, but they do not realign the position of the foot. Exercise alone or together with foot orthoses showed a better effect on the flatness of the soles of adults than the use of foot orthoses.	8/11
Paydar et al (33)	Intermittent	Training and treatment	The UCBL foot orthosis was able to reduce overall sway and improve balance in people with flexible flat feet	9/11

Discussion

The aim of the present study was to investigate the deformity of flat feet from exercise to therapeutic interventions. The results of studies have reported different information about this issue. In these studies, the causes of flat feet abnormality were different factors, and the cases related to different exercises and therapeutic interventions were different, which we will also examine in this section.

In line with the results of these studies, several studies have also reported that different exercises can have different effects on people with flat feet (27-29, 31). There were many therapeutic interventions for flat feet deformity, but one study showed that the best and most effective way to treat this deformity is to use medical insoles to fix flat feet (34). A study on the effect of SFE exercises on the balance of people with flat feet also showed that the results of these exercises in these people showed that the use of these types of exercises also improves the balance and strength of knee movement in these people (13, 21). SMT exercises were performed on people with flat feet, which showed a significant difference and effect on these people, but the effect of SFE exercises on the balance of these people was more than SMT exercises. To some extent, these exercises were contradictory and inconsistent, but both cases were also effective on these people with flat feet deformity (26).

The performance of children with flat feet was also aligned and related with the current research (30, 35, 36). Many other studies have also focused on therapeutic interventions, for example, some examples of these studies include the effect of orthotic insoles on adults, the effect of new elastic foot orthoses on adults with mild flat foot deformity, the effect of hydrodynamic insoles on kinematics. The feet in people with flat soles were flexible (flexible) or the effect of three-dimensional medical soles in people with this abnormality (36, 37). In addition, regarding the effect of using medical insoles on the balance of people with flat feet, medical insoles are also effective in reducing internal-external deviation by improving neuromuscular control in the ankle (38). In addition to these cases, the unfavorable alignment of the joints of the lower limbs in patients with flat feet causes an increase in PCI in this group compared to healthy people, and the use of medical insoles improves the alignment of the feet and as a result reduces energy consumption in these people is (39). Among the other results obtained in connection with medical insoles for people with flat feet, the insole causes the pressure to be transferred from other nearby areas, including the heel and forefoot, to the middle area of the foot, which is consistent with

the results of other studies (40). The significant reduction of pressure in the heel region of the foot confirms the use of the orthosis, which may indicate the function of the foot in compensating the lost function of the longitudinal arch in this deformity (41).

In relation to the injuries of people with flat feet, on the condition of using orthosis, the amount of knee flexion was more than the movement in the sagittal plane of the ankle joint, and the insole used in this case has had positive effects in reducing the injury rate. The orthosis used in the present study in male children with flat feet caused the greatest changes in the inter-articular coupling angles of the lower limb during the loading response phase. Nevertheless, the proof of this requires more research and it has some inconsistency with the current research (42).

Moreover, in relation to flat foot exercises, 1) Foot muscle strength and foot function in people with flexible flat feet could improve significantly after receiving foot muscle exercises, 2) UCBL foot orthosis is able to reduce general fluctuations and balance improvement were observed in people with flexible flat feet and in the group with flexible flat feet, 3) More absorption in the abductor hallucis and more fatigue in the tibialis anterior were observed and 4) People with flexible flat feet after From 6 min of brisk walking, they changed the muscle activation pattern (43, 44).

These findings can provide an evidence-based explanation of associated syndromes in flatfoot populations and lead to potential future intervention strategies (41, 45, 46). Moreover, in relation to therapeutic interventions, we can also state these results that 1) Foot orthoses reduce the asymmetry of the hip joint moment at the frontal level, but it has little effect on the asymmetry of the ankle and knee joints, 2) The use of orthotic insoles is recommended for flexible treatment and 3) Textured insoles can be effective in improving balance in people with flat flexible soles (21, 42).

Therefore, by obtaining all these results, performing each of the mentioned factors, both corrective exercises and therapeutic interventions, can help to improve the flatness of the soles of people with this deformity (47).

Conclusion

The cause of flat feet is different in different people, for this reason, by using the results obtained in the research, which include corrective exercises and therapeutic interventions, especially the use of orthoses and different medical insoles, it is possible to treat and improvement of this anomaly. Among all these cases, some good and special cases can be considered, studied, and investigated more in relation to them.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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