

COMPENSATORY EXERCISES AS FLATFOOT PREVENTION IN TEAMGYM

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Abstract

The topic of this article is the issue of flat feet and the effect of compensatory exercises in TeamGym gymnasts. The aim of our study was to investigate and document the effect of specific compensatory exercises on the flatfoot condition in five selected gymnasts competing in TeamGym. The research questions were based on our practical observations and practice sessions with TeamGym gymnasts. Foot arch examination methods were used for the research part. Each athlete underwent initial testing, which included a standing examination, and each proband had her foot imprinted using Footdisc and Podoscope devices, all documented by taking photographs which were compared and evaluated before and after the intervention exercise. The results of the initial examination confirmed a flat foot and uneven foot loading in all gymnasts. Subsequently, interventional compensatory exercise was performed and lasted for three months. Output examination showed that after regular compensatory exercise, most probands showed some improvement in flat foot loading.

This work suggests that compensatory exercise should be incorporated into routine training to have a preventive effect on the undesirable development of flatfoot.

Keywords: posture, compensation, plantar arch, flatfoot, degrees of flatfoot, TeamGym

1. INTRODUCTION

TeamGym is a team sport that uses elements of gymnastics and acrobatics. It competes in three disciplines – a set for movement composition, acrobatics and jumping from a small trampoline. The large number of jumps and hard impacts that gymnasts perform barefoot is one of the reasons why, in our experience, flat-footedness problems are more prevalent in this sport. With the constant jumping, skipping and landing, the feet are subjected to excessive forces and the disparity between the load and the strength of the muscles and ligaments is one of the causes of flat feet in gymnasts. Changes caused by poor pressure distribution of the flat foot can create dysfunction of the foot and other upper body segments, but can also increase the risk of other serious lower extremity injuries. Targeted compensatory exercises to affect the flatfoot should be an important part of the training process in these types of

gymnastic sports. TeamGym is a team sport that uses elements of gymnastics and acrobatics. It is competed in three events - tumbling routines, acrobatics and jumping from a small trampoline. The large number of jumps and hard impacts that gymnasts perform barefoot is one of the reasons why, in our experience, flat-footedness problems are more prevalent in this sport. With the constant jumping, skipping and landing, the feet are subjected to excessive forces and the disparity between the load and the strength of the muscles and ligaments is one of the causes of flat feet in gymnasts. Changes caused by poor pressure distribution of the flat foot can create dysfunction of the foot and other upper body segments, but can also increase the risk of other serious lower extremity injuries. Targeted compensatory exercises to affect the flatfoot should be an important part of the training process in these types of gymnastic sports.

2. AIM AND RESEARCH QUESTIONS

The aim of our study was to verify and document the effect of a specific compensatory exercise on plantarflexion in five female athletes competing in Teamgym. The research questions were based on our practical observations and practice sessions with the team gymnasts. We were interested in whether a flatfoot disorder would be found in all the gymnasts examined and whether there would be an improvement in the overall weight distribution on the gymnasts' feet after the three-month exercise program.

3. METHODOLOGY

Five young female gymnasts aged between 10 and 12 years old who have been involved in TeamGym for at least 6 years and train 4 times a week were selected for the study. The girls' parents agreed to participate in the research. Initial testing included standing and gait aspect testing, and each proband's feet were imprinted using Footdisc and Podoscope devices. The standing examination and foot impression on both devices were documented by taking photographs, which were compared and evaluated after three months. Based on the input examination, a compensatory

exercise program was developed to improve plantar foot position. The exercise program was carried out over a period of three months. The probands exercised 4 to 5 times a week, for 15 minutes. In addition to continuous quality control of exercise execution during the training, the gymnasts had a recorded video with individual exercises and detailed descriptions and could also consult their possible problems regarding the exercises with the supervising coach - co-author of the paper.

The output examination again included a standing examination, and a foot examination on the Podoscope and Footdisc devices, along with photo documentation for final comparison of results. Compensatory exercises included five exercises to activate the longitudinal and transverse arches along with stimulation of the small muscles of the foot. All exercises were performed barefoot, on a hard mat, and, when possible, in front of a mirror. The selected exercises are shown in Figures 1-5 (stimulation of the plantar surface of the foot using a rehabilitation hedgehog, training of the four-point foot support, activation of the transverse arch of the foot, training of the 'small foot' and toe abduction).



Fig. 1: Stimulation of the foot muscles



Fig. 2: Training the four-point foot support



Fig. 3: Activation of the transverse arch of the foot



Fig 4: Abduction training of the big toe



Fig. 5: Small foot training

4 RESULTS AND DISCUSSION

The results of the examination of individual probands were processed in the form of case reports. Here we present the photo documentation of the examination of the foot loading of each proband before and after the exercise program and our overall evaluation of each proband separately.

Proband no. 1.

The initial examination of proband No. 1 is

shown in Figures 6-8. It can be noted that there is no loading of the pinkie on the right foot and a slight reduction of the longitudinal arch on the left is visible. According to the Footdisk scale, the proband is in category C and according to our visual scaling, she is a first-degree flatfoot. This is the principle of the visual scaling method (Kapanji, 1987), which consists of comparing the shape of the plantogram of the healthy foot with the examined one (Riegerová, Přidalová, Ulbrichová, 2006).

Proband no. 1 before intervention



Fig. 6: foot position
(source: authors)



Obr. 7: load on Podoscope
(source: autors)



Fig. 8: load on Footdisc
(source: authors)

After the exercise, the proband's pinkies loading improved, the foot arches flattened and there was a change in the Footdisc rating scale to grade B, and

according to visual scaling, we determined that this was a normal foot (Figures 9-11).

Proband no. 1 – after three month of intervention



Fig. 9: foot position
(source: authors)

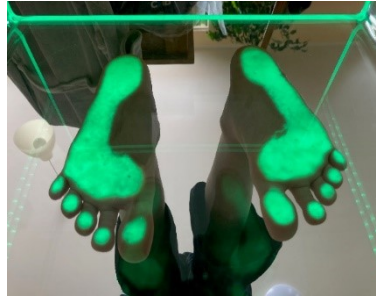


Fig. 10: load on Podoscope
(source: authors)



Fig. 11: load on Footdisc
(source: authors)

Proband no. 2 The initial examination of proband No. 2 is shown in Figures 12-14. We can note that there is a visible bilaterally reduced internal longitudinal arch of the foot more visible on the right

and the right little toe is unloaded. According to the Footdisc rating scale, the proband is in category D and according to our visual scaling, this is a grade two flatfoot.

Proband no. 2 before intervention



Fig. 12: foot position
(source: authors)



Fig. 13: load on Podoscope
(source: authors)



Fig. 14: load on Footdisc
(source: authors)

Proband no. 2 – after three months of intervention



Fig. 15: foot position
(source: authors)



Fig. 16: load on Podoscope
(source: authors)



Fig. 17: load on Footdisc
(source: authors)

After the exercise, the proband reported improvement on the left foot but had difficulty with the exercise on the right foot. This was evident on the exit examination, particularly on the footprint on the device, where the left foot improved by one degree of flatfoot according to visual scaling. We rate the visual scaling as grade I on the left and grade II on the right for flatfoot. Bilaterally, there is a small heel load and decreased internal longitudinal arch of the foot on the right, the left big toe along with the 1st metatarsal is almost unloaded along with a small load of the 2nd -5th toe on the right. The Footdisc flatfoot rating improved to a C rating on

the right and a B rating on the left (Figures 15-17).

Proband no. 3.

The initial examination of proband no. 3 is shown in Figures 18-20. On the Podoscope, more load is visible on the inner edges of both feet. Examination on Footdisc shows decreased loading of the left toes, also bilaterally decreased inner longitudinal arch of the foot more to the right. Thus, according to our assessment, this is a Footdisc C flatfoot and we rate it a grade I flatfoot according to visual scaling.

Proband no. 3 – before intervention

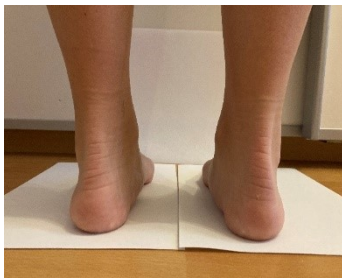


Fig. 18: foot position
(source: authors)



Fig. 19: load on Podoscope
(source: authors)



Fig. 20: load on Footdisc
(source: authors)

Proband no. 3 – after three months of intervention



Fig. 21: foot position
(source: author)



Fig. 22: load on Podoscope
(source: authors)



Fig. 23: load on Footdisc
(source: authors)

After the three-month intervention, the proband reports that she subjectively perceives an overall improvement in the position of her feet and ankle joints. Exit examination using Footdisc assesses a slight reduction of the internal longitudinal arch bilaterally, the weight of the body is reflected more on the right foot and bilateral loading of all toes is visible. We assess the Footdisc grades by visual scaling, assessing as a normal foot. On examination with the Podoscope, we observe V. metatarsal unloading bilaterally with decreased left toe loading (Figures 21 - 23).

Proband no. 4.

The initial examination of proband no. 4 is shown in Figures 24 - 26. On examination of the posterior aspects, there is a visible loading of the feet on the medial edges with slight internal impingement of the hindfoot, a reduced internal longitudinal arch of the foot with a valgus position of the heels is visible, and the Achilles tendons are asymmetrical. Podoscope examination shows bilateral loading of the inner edges of the feet, more on the left. Thus, we rate the visual scaling as grade II flatfoot. Footdisc examination shows the 2nd and 3rd toes of the right foot unloaded with bilateral reduction of the left inner longitudinal arch of the foot. The Footdisc flatfoot rating is C.

Proband no. 4 – before intervention



Fig. 24: foot position
(source: author)



Fig. 25: load on Podoscope
(source: authors)



Fig. 26: load on Footdisc
(source: authors)

Proband no. 4 – after three months of intervention



Fig. 27: foot position
(source: authors)



Fig. 28: load on Podoscope
(source: authors)



Fig. 29: load on Footdisc
(source: authors)

After the interventional exercise, the valgus position of the ankle joints and bilaterally reduced internal longitudinal arch of the foot are still evident. A slight valgus position of the calcaneus is still evident with the reduced internal longitudinal arch of the foot bilaterally, with Achilles tendons pointing obliquely medially bilaterally. The load on the whole body is more on the heels. The Podoscope exit examination shows a small load on the second toe of the right foot. Visual scaling assessment is left I. grade flatfoot and right grade II flatfoot. Output examination by Footdisc assesses a slightly reduced internal longitudinal foot arch bilaterally but more so on the right. The Footdisc flatfoot rating is a left rating of B and the right rating of C. The proband evaluates the entire therapy positively, mostly for the foot pain she experienced frequently prior to therapy after any major

exertion. These pains have completely resolved (Figures 27-29).

Proband no. 5

The initial examination of proband no. 5 is shown in Figures 30 - 33. Examination of the feet by inspection reveals a valgus position of the calcaneal bones bilaterally, asymmetry of the Achilles tendons, which point obliquely medially, more to the left, as well as a narrow base width and longitudinal reduction of both feet. From the Podoscope examination, we evaluate less loading of the left little toe compared to the right one and a slight lightening of both V. metatarsals. The visual scaling assessment corresponds to a I. grade flatfoot. The Footdisc examination shows a greater load on the right LL with a more pronounced loading of the inner edge of the foot on the left. Footdisc flatfoot rating C.

Proband no. 5 –before intervention



Fig. 30: foot position
(source: authors)



Fig. 31: load on Podoscope
(source: authors)



Fig. 32: load on Footdisc
(source: authors)

Proband no. 5 – after three months of intervention



Fig. 33: foot position
(source: author)

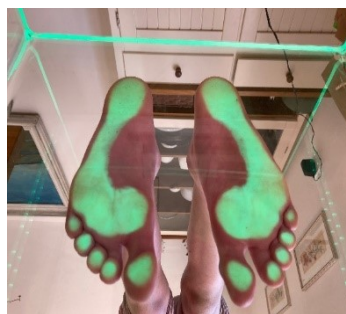


Fig. 34: load on Podoscope
(source: authors)



Fig. 35: load on Footdisc
(source: authors)

After a three-month intervention, the proband felt progress on her left foot, which was also better exercised. There was no visible progress in terms of the instrumented examination compared to the initial examination. There is still bilateral unloaded body weight distribution to the foot and 4th and 5th toes of the left foot, and bilateral reduction of the internal longitudinal plantar arch persists. Exit examination using Podoscope assesses the left little toe still in reduced load and bilateral minor V metatarsal loading. We diagnose the assessment by visual scaling as I. grade flatfoot. According to Footdisc, we grade the flatfoot as grade C (Figures 33-35).

4 DISCUSSION

Pes planovalgus meaning pediatric flatfoot, is one of the most common orthopaedic defects in children, occurring as they grow. López (2014) reports that up to 30% of all children suffer from foot arch disorders. Dungal (2005) describes typical signs indicative of flatfoot problems as the tibia dropping medially and walking with the toes turned inward. In contrast, a study by Vergillos, et al. (2023) mentions that flatfoot is a common finding in children under 10 years of age and is somewhat normal during development. Therefore, pediatric flatfoot should not be considered pathological unless stiffness or functional limitation is present.

Our initial examination revealed a problem with flatfoot in all the gymnasts tested, to varying degrees. All girls were also found to have valgus of the calcaneus, Achilles tendon pointing medially bilaterally, and drop of the tibia medially. Toe-in gait was not seen in any of the girls. On the contrary, one of the gymnasts showed the opposite feature manifested by standing and walking with the toes outwards, which, in our opinion, may lead to additional unwanted loading in running or in jumping

from challenging elements, which may subsequently negatively affect the upper body segments.

The postural function of the foot is also a source of proprioceptive and exteroceptive information for the central nervous system (Vařeka, 2009). It follows that pathological foot position or impaired foot function is associated with impaired motor stereotype. This in turn can affect the posture and function of the entire lower limbs and the whole body's axial system (Toppischová and Šnoplová, 2008). Using various physiotherapeutic techniques and targeted compensatory exercises for the plantar foot, it is then possible to influence the associated problems associated with faulty posture. (Buchtelová and Vaníková, 2010).

Since we had the opportunity to observe the gymnasts during the training program, we can state that even there, the consequences of incorrect loading of the plantar foot are evident in individual elements (e.g., one-legged stand on the balance beam or precision push-ups).

It is clear that after three months of regular compensatory exercises, there was some improvement in the loading of the footplate in most of the probands, so it is certainly appropriate to recommend adding compensatory exercises focusing on the correct function of the footplate to the training plan of gymnasts.

One of the basic compensatory exercises that has been applied to gymnasts is the "four-point foot support" exercise, which is the essence of full body support. Dylevský (2009), describes that the foot has three points for proper and even loading, Kapandji (1987) advocates four-point support. As demonstrated in our study, targeted exercise and stimulation of the plantar surface of the foot can lead to improved use of this four-point support; most gymnasts were able to distribute their body weight evenly over the entire foot,

and one gymnast achieved conscious loading of her little toes to the ground, something she was unable to do prior to therapy.

This included a final interview to subjectively assess the effect of the three-month therapy. Three of the tested gymnasts reported that the compensatory exercises helped to relieve their leg pain, while others became more aware of the alignment of their entire lower limb. All probands were aware of the possible consequences of poor loading of the plantar surface of the foot after the programme. A study by Knappová, Charvátová and Stackeová (2022) showed that the effects of a movement intervention and regimen can be corrected without the need for orthotic insoles or other special footwear modifications. If exercise is not regularly performed and regimen measures are not followed, the effect of the intervention diminishes. Other influences, such as inappropriate sporting activity or inappropriate footwear, may also negate the positive effect of the intervention.

5 CONCLUSIONS

The issue of flat feet in gymnasts competing in TeamGym is often a neglected topic. However, due to the demanding nature of the sport and the heavy load placed on the lower limbs, it is a topic of utmost importance, especially in the prevention of injury and the development of any chronic pain conditions occurring in the sport. Compensatory exercises targeting the plantar region of the foot, according to our observation, appear to be a suitable tool for maintaining the functionality not only of the lower limbs but of the entire musculoskeletal system.

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