

Effectiveness of Specialized Small Motor Games for the Improvement of Dynamic Balance in Flexible Flat Foot

*Mutasem Khatatbeh, *¹ Ibrahim Dabayebh ¹*

Abstract

Objective: This study examined the effectiveness of specialized small motor games for improvement of dynamic balance in Flexible Flat Feet (FFF).

Method and Materials: Ten healthy female school children (10 - 12 yrs), who have FFF, participated in the study. A specialized small motor games exercise program was designed using the main elements of the tradition rehabilitative methods to improve dynamic balance. The duration of the exercise program was 12 weeks using a diverse set of games each week. Children performed 3 exercise sessions per week which consisted of 45 minutes and included warm up exercises, small motor games and a cool down period.

Results: The T test analysis of pre and post exercise participation for the Star Excursion Balance Test (SEBT) showed a significant improvement in FFF dynamic balance ($P < 0.05$). Improvement has been shown in the dynamic balance for both feet ($P < 0.05$) in different foot sides. The improved dynamic balance for the right foot sides were the lateral and posterior lateral and for the left foot were anterior, later posterior, medial posterior and medial sides ($P < 0.05$).

Conclusions: The results of this study indicate the effectiveness of specialized small motor games for the improvement of dynamic balance in the FFF condition.

Keywords: Exercise Program, Small Motor Games, Flexible Flat Foot, Dynamic Balance.

(J Med J 2012; Vol. 46 (4):320-330)

Received

Accepted

December 26, 2010

February 14, 2012

Introduction

The foot is the farthest part in the lower body and has a small base of support for the whole body. This base maintains balance especially when one uses one foot during movement, exercise and/or certain skills in the participation of a sport. Any kind of foot deformity, even the smallest one, may have a tremendous effect on the movement and balance of the whole body.¹

The roles of a healthy foot include keeping balance, maintaining stability and adapting to the

ground surface and shocks.² In addition, the foot must be able to go through a transition of rigidity leverage to introduce a push to the body after a typical absorption state.³ However, such foot functions are undermined as a result of flat foot conditions.

The definition of flat foot (Pes Planus) is the lack of a medial longitudinal arch of the foot. There is a difference between flexible flat foot and congenital, rigid flat foot that is caused by osseous deformity (abnormality of the fiber or the bony structure). The precise definition of Pes

1. Exercise Rehabilitation Department, Faculty of Sport Sciences, Mu'tah University, Jordan.

* Correspondence should be addressed to:

Mutasem Khatatbeh

Planus is not universal, and thus the estimation of its prevalence is not accurate.⁴

Flat foot is one of the most common conditions seen in pediatric orthopedic practices. All children are born with flat feet, and more than 30% of newborn children have deformities in both feet.¹ Such a condition rarely causes real difficulty in the child's life. However, it is usually a major concern for parents. One of the major concerns for parents is the possibility of helping their child with a rapid and effective treatment for such a condition.⁵ In addition, flat foot is often associated with sports injuries; even the type of arch structure is associated with a specific injury pattern in sports.^{6,7}

Previous studies showed that 28% to 35% of school children have some kind of foot deformity⁷ and 80% of these children are considered to have a mild flat foot. Flexible Flat Foot (FFF) is a specific condition caused by the laxity of all the ligaments and joints, and this usually is the result of heredity and stress of weight. The suggested percentage of children suffering from FFF is 17.2%³ and 16 - 20%.⁸

The medial longitudinal arch could be affected by the nature of the anatomical shape of the arch. The posterior tibial muscle plays an important role in the foot position and flexibility. The muscle's tendon passes into the medial/posterior behind the medial malleolus and inserts into the navicular, cuneiforms, and metatarsal bases.⁹ As one walks, the foot takes a flexible state as the heel hits the ground, and then it takes a suitable position similar to the surface. However, as the foot pushes up the body, the arch and the foot must take a rigid construct. The bony structure of the medial longitudinal arch is an important element of foot stability.⁶ FFF is caused mainly by heredity and often can be traced to the parents and close family. Wearing shoes may contribute to the failure of the arch development or affect the age of arch development.¹

One of the first FFF symptoms noticed in adolescences is the contraction of the Achilles tendon which limits full ankle dorsiflexion.

Such a condition may with time cause the tarsal joints to break. The motion of the subtalar and transverse tarsal is decreased by 50%.¹⁰ Some studies suggested that flat foot may cause a walking disorder later in age.⁷ It has also been suggested by Lin et al¹¹ that children with FFF performed physical tasks poorly as well as walked slowly and indicated that FFF should not be considered as a static alignment problem. Lin et al¹¹ indicated that an FFF condition should be considered as a dynamic problem resulting from changes in the lower extremity. Therefore, the prevention of such a possibility at a later age was a concern of certain researchers.⁷ Management programs have been suggested by some physical therapists and other exercise professionals. There is no general agreement on the importance of arch support for correcting flat foot.¹² This showed the importance of finding other more appropriate methods to have a long term improvement and treatment.

Stability seems to be an important element of the flat foot condition since some suggested that the flat foot condition may cause repetitive ankle sprains.¹ Lin et al¹¹ found that flexible flat foot may cause a poor, slow physical performance. Certain exercises that increase muscle strength, muscular coordination and stimulate proprioceptors may improve this condition.¹ It is also suggested that some barefoot activities may develop stronger muscle which would in turn decrease the effect of the FFF condition.⁷ Immediate intervention to help in the normal development of the longitudinal arch should be undertaken to prevent pelvic and spinal postural deformities. Previous studies suggested that the initial treatment of FFF may include activities such as stretching and strengthening exercises prior to all surgical interventions.¹³

Specialized exercise for FFF may concentrate on the strengthening of lower leg muscles especially the tibialis posterior. This may be achieved by developing exercises and movements which use internal/external rotation. For example, previous investigations suggested that the towel gathering exercise (scrunching a towel) may be helpful in the treatment of FFF. It has been indicated that

the physiological treatment of flat foot is very costly for parents and often ineffective.³ Budurova¹⁴ suggested that physical exercise improved the FFF condition in 70% of the studied sample.

Dynamic balance is defined as the ability to perform a task while maintaining a stable position.¹⁵ Dynamic balance is affected by the sensory information obtained from the somatosensory, visual, and vestibular systems and motor responses that affect coordination, joint range of motion and strength.¹⁶ Dynamic balance is considered one of the important fitness components in most sports and exercise participation. Spencer¹⁷ suggested that dynamic balance is related directly to the foot function and structure. Their study on dynamic balance was designed using the foot ink imprints method. In addition, Karen¹⁸ found that the foot structure is related to dynamic balance. They used the Brody method to determine the foot type and relate that to the dynamic balance ability. The dynamic balance was tested using the one foot method (Star Excursion Balance). The concerned age group in this study tends to lose interest in traditional exercise programs. The specialized small motor games method may be designed to encourage children to do the exercise program in a regular and interesting fashion. Therefore, the purpose of this study is to examine the effectiveness of small motor games for the improvement of dynamic balance in FFF.

Method

1) Subjects

In this experiment, one group of subjects participated (table 1) which consisted of 10 female children (10 - 12 years). The children volunteered to participate in this study with the approval of their parents. The possible benefits and risks of exercise participation in this study were explained to the parents. A consent form of participation was signed by their parents. The inclusion criteria for the subjects included: the age from 10 to 12 years, a documented FFF condition using an Emed-AT-2 platform system

and Jack Test to determine the type of flat foot (chronic or FFF), no other medical conditions or surgery that interferes with normal sport participation nor any medication which may effect the result of the study. Subjects also did not have a recent participation in a balance training program. Subjects were not included in the study if they suffered from a lower extremity injuries, or had a vestibular problem (e.g. vertigo), visual problem, (e.g. blind in one eye) or a concussion in the 12 weeks prior to the participation in the study. Subjects were asked not to participate in physical exercise 2 hours prior to the testing period.

Table (1): Characteristics of the subjects (N: 10).

<i>Variables</i>	<i>Mean</i>	<i>St. Dev.</i>
<i>Weight (KG)</i>	7.46	37.50
<i>Height (CM)</i>	9.39	141.00
<i>Age (yr)</i>	0.70	10.60

2) Testing Protocol

a) Pilot Study

Prior to the experiment application and data collection, a pilot study was performed. Subjects who participated in the pilot experiment were excluded from the actual experiment.

b) Evaluation Prior to and After the Application of the Exercise Program

Evaluations prior to the application of the specialized small motor games included:

a. Flat Foot Evaluation

The Emed-AT-2 platform system (Novelgmbh, Munich, WinEmed software) which was attached to a personal computer was used in this study. The midgait method is an accepted protocol in studies evaluating foot function.¹⁹ The Emed-AT-2 platform system is typically used to measure the plantar pressure distribution under both feet (figure 1).



Figure (1): The Emed-AT-2 platform system plantar pressure image¹⁹

However, in this study, we were concerned about the foot imprints to evaluate the type of foot of the subject (figure 2). Each subject performed 3 barefoot walks. The walks usually involved three to five minutes of practice. Subjects were also instructed to walk at a normal pace. Average plantar pressure measurements at a complete foot contact were recorded for three discrete equal areas (masks): the rearfoot (A), midfoot (B), and forefoot (C) ignoring the toe area. Each one of these areas was divided into two masks by a vertical line (J-K line in figure 3) starting from the second toe. Then, the forefoot and toe regions were divided into three equal masks (areas) (figure 2).

The foot imprint index calculation²⁰ (figure2) was calculated as the percentage of the surface area in B divided by the total of the areas A+ B + C. To determine the type foot, we used the following:

- Equal or less than 0.21...rched foot
- More than 0.21 and less 0.26 ...normal foot
- Equal to or more than 0.26...flat foot

To determine the kind of flat foot, the Jack evaluation was used. If the foot was flat in a standing position and then the arch appeared during standing on the tip of the toes or during the elevation of the big toe, this kind of flat foot is considered flexible.

b. Star Excursion Balance Test (SEBT)

Dynamic balance was assessed using the internationally recognized SEBT described and validated by several studies. Researchers have reported high intertester and intratester reliability and validity.^{16,21-24} The testing grid consisted of 8 lines; each line is 120 cm in length, extended from the same central point at a 45 degree separation between the lines (figure 3). The lines were drawn using standard white tape placed on a hard tile surface. The center point was a small dot where the child was asked to center the stance foot during testing procedures. The lines were marked with one cm increment starting from the central point to facilitate recording of the results.

Testing methods were described by Bressel,²³ and Gribble.²⁵

- The subject stands on one foot only (the other foot cannot touch the floor).
- Hands are placed on the waist.
- The subject jumps forward. The foot should touch the line and the subject should keep balance and keep hands on the waist. Otherwise, this will be considered as a failed trial.
- The subject performs three trials with a 10-second rest between trials. The average of the three trials is recorded.
- The trials are done for the eight directions.

The motor games used in this study were designed in a similar manner to the skills employed in traditional rehabilitative programs.¹⁴ Foot small games were done with exercise specificity to increase the accuracy of the foot movement and improve muscle and ligament strength. For example, the main activity in some of the games included using the toes in cup movements, making certain robe ties and tiptoe walking.

The leg tested (dominant and non-dominant) and the order of direction was randomly selected before the start of the testing. During the resting period both legs stance was required. Before trials, 180-second familiarization trial periods were given for each subject, and then a 120-second resting period prior to recorded trials.

All possible visual clues were removed from the floor to avoid visual or auditory influence. Reached distance was marked immediately with chalk on the tape at the touchdown site. Then the distance from the center to the marked touchdown point is recorded to the nearest centimeter and the chalk marks were removed after each trial. The evaluations prior to the experimental trials were performed during two separate days.

After the application of the suggested exercise program, post experimental testing was carried out under similar conditions (similar to pre-experimental).

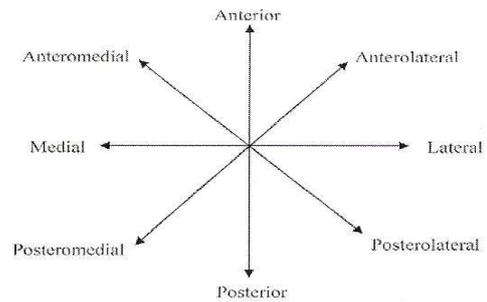


Figure (3): Star Excursion Balance Test (SEBT) grid. All directional terms are indicated on the grid.^{23,25}

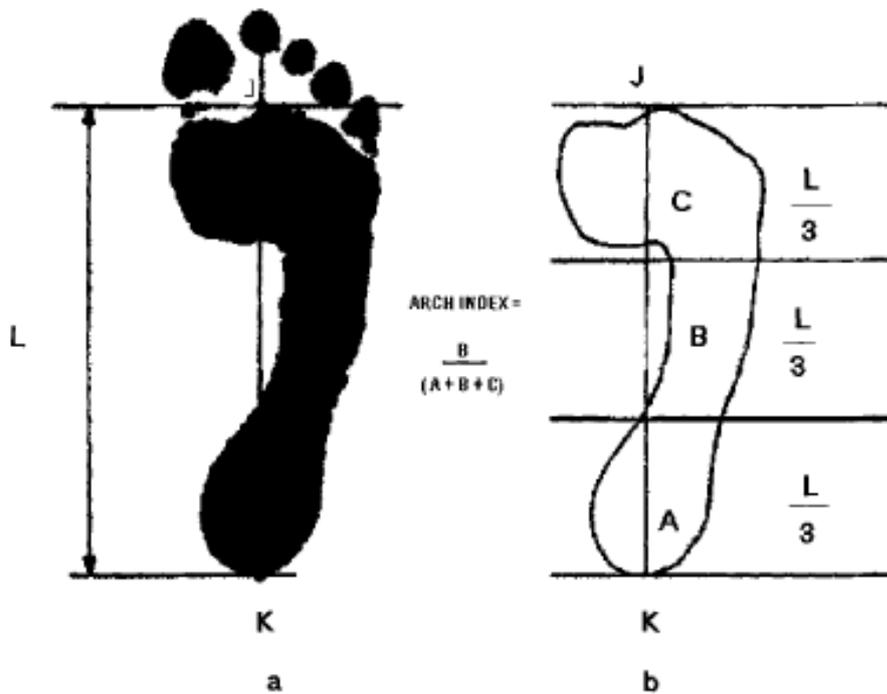


Figure (2): The foot imprint index²⁰

3) Exercise Sessions Application (Specialized Small Games)

After the subject's selection, the experimental trials started with the application of the exercise program. The used small motor games were designed based on the scientific findings concerning the treatment of FFF. In addition, traditional exercise therapy programs also were studied and considered in the suggested groups of games.

The frequency of the application of the exercise program (games) was three times a week. The duration of each exercise session was 45 minutes. The total number of sessions was 36 sessions expanded over 12 weeks in which twelve different sets of games were presented (one set/week).

A typical exercise session consisted of:

- a. The performance of general and specific warm up activities for approximately 8 minutes.
- b. The performance of the specialized small motor games which are similar in their effect on the traditional flat foot rehabilitative exercise program ^{26,27} and are suitable for children. ^{28,29}

- c. The main part of the exercise program consisted of explaining the game and then applying the game. The games were designed also based on the rehabilitative goals and the excitement of the games for the study sample. The games were simple and the activities started from easy skills to more advanced skills.
- d. The final part consisted of cool down activities at low intensity and some stretching exercise (approximately 5 minutes).

Results

The purpose of the study was to examine the effectiveness of specialized small motor games for the improvement of dynamic balance in FFF. Central tendency measures and the spread of SEBT data are noted in table (2) for the right foot and in table (3) for the left foot.

These results suggest that there is a significant improvement in dynamic foot balance for the right foot at the lateral side and the posterior lateral side ($p < 0.05$). However, the other six sides of the dynamic foot balance were not affected. In addition, a significant improvement in dynamic foot balance was noted for the left foot at the anterior, posterior medial, posterior lateral and medial sides ($p < 0.05$).

Table (2): The results of the t-test analysis pre and post games program participation for the SEBT direction for the right foot.

<i>SEBT Direction</i>	<i>Test Pre/Post</i>	<i>Mean</i>	<i>St. Dev.</i>	<i>T. Value</i>	<i>P</i>
<i>Anterior</i>	<i>Pre</i>	85.30	13.66	1.56	0.153
	<i>Post</i>	88.20	12.82		
<i>Anterior Lateral</i>	<i>Pre</i>	76.22	8.42	0.16	0.877
	<i>Post</i>	76.60	12.39		
<i>Lateral*</i>	<i>Pre</i>	61.30	8.68	3.04	0.014
	<i>Post</i>	68.60	12.71		
<i>Posterior Lateral*</i>	<i>Pre</i>	51.70	7.41	3.08	0.013
	<i>Post</i>	55.30	8.45		
<i>Posterior Medial</i>	<i>Pre</i>	38.30	8.21	0.53	0.604
	<i>Post</i>	39.50	8.91		
<i>Posterior</i>	<i>Pre</i>	53.30	11.10	1.76	0.111
	<i>Post</i>	57.30	8.01		
<i>Medial</i>	<i>Pre</i>	62.70	16.59	0.40	0.697
	<i>Post</i>	64.00	8.62		
<i>Anterior Medial</i>	<i>Pre</i>	67.10	14.18	1.13	0.286
	<i>Post</i>	69.90	9.00		

* Significant ($P < 0.05$)

Table (3): The results of the t-test analysis pre and post games program participation for the SEBT direction for the left foot.

SEBT Direction	Test Pre/Post	Mean	St. Dev.	T. Value	P
Anterior *	Pre	79.69	9.04	4.75	0.001
	Post	97.20	9.57		
Anterior Lateral	Pre	74.30	10.17	1.46	0.178
	Post	79.30	4.50		
Lateral	Pre	63.50	10.49	0.28	0.780
	Post	62.50	7.62		
Posterior Lateral *	Pre	46.36	7.19	2.81	0.020
	Post	50.60	6.77		
Posterior	Pre	37.80	6.80	2.19	0.056
	Post	40.70	6.80		
Posterior Medial *	Pre	58.26	11.30	2.29	0.048
	Post	66.00	4.03		
Medial *	Pre	64.70	10.00	2.76	0.022
	Post	73.90	7.71		
Anterior Medial	Pre	80.70	13.27	1.53	0.159
	Post	87.00	5.75		

*** Significant (P< 0.05)**

Discussion

We hypothesized that dynamic balance scores would be different after participating in the specialized small motor games for children with FFF. The important finding of this study is the effectiveness of the small motor games exercise program in the improvement of dynamic balance in FFF. Although it was not generalized for all directions, this result has been indicated for both feet dynamic balance ability. Most individuals participate usually in dynamic activities more than static activities.² It is expected that children participate in dynamic activities more than adults. In addition, dynamic balance is essential in most activities, daily living and sport activities. Dynamic balance ability during sport participation may affect and relate to neuromuscular demand, performance, sport injuries and demands placed on joints.

A previous investigation has suggested that improved balance is essential in preventing injuries.³⁰ Dynamic balance was determined in relation to joint abnormalities, especially ankle instability. To further the notion of dynamic stability in relation to FFF, this study investigated the effect of a new and innovative method of exercise programs (i.e. small motor

games). For children, the suggested method may be more interesting and exciting and may lead to a better and a longer participation in the exercise program. In addition, small motor games program participation may have further beneficial effects on health, fitness and wellbeing beyond the rehabilitative value of a typical exercise program in a clinical sitting. The improved dynamic balance in this study may be related to either an improved structural stability or changes in the proprioception. It is believed that the improvement of the dynamic balance in this study may be related more to an improved proprioception function due to the participation in the small motor games program. Proprioceptive information during movement depends upon the sensory information coming from ligaments, capsules, skin, and muscle mechanoreceptors.⁶ In this study, the improved balance in a certain foot side (but not other sides) may be related to an improvement in some previously mentioned aspects of proprioception (e.g. muscle mechanoreceptors). It is also important to mention that the test used in this study may be affected by the foot, ankle and even hips which could indicate that the improvements were a result of a combination of changes at different levels.

In this study, dynamic balance improvement due to the participation in the specialized small games is the major concern. The mechanism of a possible rehabilitative value of the present exercise program may be considered separately in future investigations. Some possible explanation of the result may be related to the results of Mortazavi¹ who indicated that certain exercises that increase muscle strength, muscular coordination and stimulate proprioceptors may improve FFF condition. It is also suggested by other investigators that some barefoot activities may develop stronger muscles which would in turns decrease the effect of FFF condition.¹⁴

It is not clear whether longer duration of the exercise program would have a greater influence on the dynamic balance or not particularly on the directions that were not affected on this study. The reason for the ineffectiveness of the program on the other sides of each foot balance is not clear either. It could be related to the duration of the program (12 weeks). It is possible that a longer duration of exercise participation could change the results for these sides. In addition, the foot used (right or left foot) for balance and take off during the small games participation (i.e. application of the program) was not controlled (not monitored) by the researchers in this study which may indicate that some subjects may have preferred to use one foot more than the other while all the statistical analysis was done on one foot at a time. This may have introduced a possibility of error concerning the sides which were not affected. The subjects were not classified as right footed or left footed subjects. The result for the left foot indicates that the suggested exercise program was effective on the frontal side of the foot and both the lateral posterior and medial sides. Some previous studies concerning dynamic balance did not find a relation between ankle injury and directional balance.³¹ Others found such a relation between the type of foot and directional balance.^{28,32} In this study, the difference in the effectiveness of the suggested exercise program may be related to directional dynamic balance improvements.

One explanation of dynamic balance improvements was mentioned by Olmsted and Hertel.³³ They found direction specific balance improvements and suggested that such improvements are related to an increased mechanical support of the medial aspect of the foot, enhanced sensory receptor activity and neuromuscular function.

The results of this study are in accordance with previous results by Olmsted and Hertel.³³ The motor games used in this study were designed by using similar skills to the ones employed in traditional rehabilitative programs.¹⁴ This study used foot small games with exercise specificity to increase the accuracy of the foot movement, muscle strength and ligament strength. Some games included using the toes in cup movements, making certain robe ties and tiptoe walking. The main purpose of these games was to improve the arch function. Such improvements are important in dynamic and static balance.

It is concluded that employing small motor games may be used for the improvement of dynamic balance in FFF condition. The use of this exercise program may be generalized on female subjects without a specific knowledge of the source of improvement. Further investigations should determine the source of improvement as it relates to structural balance changes and proprioception changes. Further study should be conducted on males using a longer duration period than 12 weeks to examine the effectiveness of the program on the other sides of foot. In addition, future investigation may use small games on all eight sides of the foot in a more controlled and balance manner for the foot used (i.e. right or foot) to remove a possible confounding factor.

References

1. Mortazavi S, Espandar. Flat foot in children: How to approach? *Iran J. Ped.* , 2007; Vol 17: 163-70.
2. Cote KP, Brunet ME, Gansneder BM, Shultz SJ. Effects of Pronated and Supinated Foot Postures on Static and Dynamic Postural Stability. *J Athl Train*, 2005; Mar: 40(1): 41-46.

Effectiveness of Specialized Small Motor Games for the Improvement of Dynamic Balance in Flexible Flat Foot... Mutasem Khataatbeh and Ibrahim Dabayebeh

3. Akcali O, El O, Kosay C, Kaner B, Arslan Y, Sagol E, Soylev S, Iyidogan D, Cinar N, Peker O. Flexible flatfoot and related factors in primary school children: a report of a screening study *Rheumatology International*, 2006; 26(11): 1050-1053.
4. Pfeiffer M, Kotz R. Prevalence of flat foot in preschool-aged children. *Pediatrics*, 2006; 118: 634-39.
5. Mital M. Children's feet: common worries of parents. *Prof Care Mother Child*, 2000; 10 (2): 33-4.
6. Williams DS, McClay Davis I, Scholz JP, Hamill J, Buchanan T. High-arched runners' exhibit increased leg stiffness compared to low-arched runners. *Gait and Posture* 19, 2004; 263-269.
7. Hale SA, Hertel J, Olmsted-Kramer LC. The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability. *J Orthop Sports Phys Ther*. 2007; Jun: 37(6): 303-11.
8. Leung AKL, Cheng JCY, Mak AFT. A cross-sectional study on the development of foot arch function of 2715 Chinese children. *Taylor & Francis*, 2005; 29(3): 241- 253.
9. Franco AH, Pes cavus and pes planus. Analyses and treatment. *Phys Ther*, 1997; 67(5): 688-694.
10. Brodelon RL. Flatfoot in children and young adults. In: Mann TA, *Surgery of the foot ankle*, 16th ed. St Louis: Mosby, 1993; 77.
11. Lin CJ, Lai KA, et al. Correlating factors and clinical significance of flexible flatfoot in preschool children. *J. Pediatr Orthop*, 2002; 22: 134.
12. Menz HB, Munteanu SE. Validity of three clinical techniques for the measurement of static foot posture in older people. *J Orthop Sports Phys Ther*, 2005; 35(8): 479-86.
13. Harris EJ, Vanore JV, Thomas JL, et al. Diagnosis and treatment of pediatric flatfoot. *J Foot Ankle Surg*, 2004; 43: 341-73.
14. Bađurová J, Samsonová H. Impact of exercising on school children with valgus heel and flatfeet, emed scientific meeting. Leeds, UK, 2004; Jul.29-Aug.1, 2004.
15. Winter DA, Patla AE, Frank JS. Assessment of balance control in humans; *Med Prog Technol*, 1990; 16: 4: 31-51.
16. Palmeiri T, Sesma AR, Mattacola CG, Uhl TL, Nitz AJ, McKeon PO. Effect of foot orthotics on single- and double-limb dynamic balance tasks in patients with chronic ankle instability. *Foot Ankle Spec*, 2008; Dec: 1(6): 330-7.
17. Spencer Karen Meyers-Rice B, Sugars L, McPoil T, Cornwall MW. Comparison of three different methods for obtaining plantar pressures in nonpathologic subjects. *Journal of the American Podiatric Medical Association*, 1994; 84: 499-504.
18. Igbigbi PS, Msamati BC. The Footprint Ratio as a Predictor of Pes Planus: A Study of Indigenous Malawians. *The Journal of Foot & Ankle Surgery*, 2002; 41(6): 394-397.
19. Hertel J, Miller JS, Denegar CR. Intratester and intertester reliability during the Star Excursion Balance Tests. *J Sport Rehabil*, 2000; 9: 104-116.
20. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther*, 2006; Dec: 36(12): 911-9.
21. Bressel E, Yonker J, et al. Comparison of Static and Dynamic Balance in Female Collegiate Soccer, Basketball, and Gymnastic Athletes. *Journal of Athletic Trainers Association, Inc*, 2007; 42(1): 42-46.
22. Bouillon LE, Sklenka DK, Driver AC. Comparison of training between 2 cycle ergometers on dynamic balance for middle-aged women. *J Sport Rehabil*, 2009; May: 18(2): 316-26.
23. Gribble PA, Robinson RH, Hertel J, Denegar CR. The effects of gender and fatigue on dynamic postural control. *J Sport Rehabil*, 2009; May: 18(2): 240-57.
24. Moller Nasm Jefferson. American Council on Exercise. Dorsey SW, Iren SM. Arch structure and injury patterns in runners. *Clinical Biomechanics*, 2001; 16: 341-7.
25. Warren BL, Jones CJ. Predicting plantar fasciitis in runners. *Med Sci Sports Exerc*, 1987; 20: 547-51.
26. Wen DY, Puffer TC, Schmalzried TP. Injuries in runners: a prospective study of alignment. *Clin J Sports Med*, 1998; 8: 187-94.
27. Olmstedl and Hertel Derner Richard, FACFAS, Keith Goss, Hiedi Noel Postowski, and Nancy Parsley, A Plantarflexory-Shortening Osteotomy for Hallux Rigidus: A Retrospective Analysis ,*The Journal of Foot & Ankle Surgery* : (2005) 44(5),377-389.
28. Jam, Bahram, Evaluation and Retraining of the Intrinsic Foot Muscles for Pain Syndromes Related to Abnormal Control of Pronation. 2005 Stand-alone document,
29. Leung A. K. L. , Cheng J. C. Y. , and Mak A. F. T, calculation of contact area ratio using dynamic footprint, *orthopadie techink quarterly*, English edition 1/2001,7-11.

Effectiveness of Specialized Small Motor Games for the Improvement of Dynamic Balance in Flexible Flat Foot... Mutasem Khatatbeh and Ibrahim Dabayeb

30. Lin CJ, Lai KA. Correlating factors and clinical significance of flexible pes planus. *J Manip Physio Ther*, (1999) 22(4):221
31. Machado, Deyse Borger, , Evaluation of A female Volleyball team regarding anthropometrical foot print Image Planter Pressure Distribution and treadmill Walking Vertical force Parameters, VIII emed scientific meeting – Kananskis, Alberta. (2002) July 31st – August 3rd .
32. Machado, Deyse Borges, and Ewald M. Hennig. "The Influence of Daily Activity Movement Patterns on the in-Shoe Plantar Pressure Distribution of Children." Fourth Symposium on Footwear Biomechanics. Eds. Ewald M. Hennig and Darren J. Stefanyshin. Canmore: University of Calgary, (1999). 28-29.
33. Nelson, Scott C, Darryl M. Haycock, FACFAS, and Eugene R. Little, FACFAS, Flexible Flatfoot Treatment with Arthroereisis: Radiographic Improvement and Child Health Survey Analysis, *The Journal of Foot & Ankle Surgery* (2004) 43(3):144-155.
34. M, Ingersoll CD. The effect of a simulated knee joint effusion on postural control in healthy subjects. *Arch Phys Med*, (2003) 84: 1076-79.

فعالية استخدام الألعاب الصغيرة المتخصصة لتحسين التوازن المتحرك لدى المصابين بتبسط القدم المرن

معتصم أحمد الخطاطبة، إبراهيم مفلح الدبائية

كلية علوم الرياضة، جامعة مؤتة، الأردن

الملخص

الهدف: هدفت هذه الدراسة إلى التعرف على أثر استخدام الألعاب الصغيرة المتخصصة على التوازن المتحرك للمصابين بتبسط القدم المرن للفئة العمرية من (10-12).

المنهج: تكونت عينة الدراسة من (10) طالبات، ممن لديهن تبسط مرن للقدمين. باستخدام العينة التجريبية الواحدة بحيث تطبق العينة البرنامج التأهيلي المقترح لمدة 12 أسبوعاً، وواقع 3 مرات أسبوعياً. وتكونت الوحدة التدريبية من 45 دقيقة (10 دقائق للإحماء العام والخاص، 30 دقيقة للجزء الرئيسي - الألعاب الحركية الصغيرة المتخصصة -، 5 دقائق للجزء الختامي). تضمنت الإجراءات القبلية قياسات خاصة بالكشف عن تبسط القدم من خلال حساب معيار القدم المقاس بالاعتماد على اختبار طبعة القدم الكترونياً وكذلك تم إجراء اختبار جاك لتحديد تبسط القدم المرن. ولقياس التأثير التدريبي لبرنامج الألعاب الصغيرة المتخصصة تم إجراء القياسات القبلية والبعيدة على التوازن المتحرك بواسطة اختبار رحلة النجم لاتجاهات التوازن المتحرك الثمانية (أمامي، خارجي، خارجي خلفي، خلفي، داخلي خلفي، داخلي، أمامي داخلي).

النتائج: أظهرت نتائج اختبار (ت) للمجموعة واحدة تحسناً دالاً إحصائياً على التوازن المتحرك لكل من القدم اليمنى للاتجاهات التالية: الخارجية، الخارجية الخلفية، وللقدم اليسرى للاتجاهات التالية: الأمامية، خلفية جانبية، خلفية داخلية، وداخلية (مستوى الدلالة $(P < .05)$).

الاستنتاجات: خلصت الدراسة إلى فعالية استخدام الألعاب الحركية الصغيرة المتخصصة لتحسين التوازن المتحرك لدى المصابين بتبسط القدم المرن.