

PART II. PHYSICAL ACTIVITY OF SOCIAL AND PROFESSIONAL GROUPS
DZIAŁ II. AKTYWNOŚĆ FIZYCZNA GRUP SPOŁECZNYCH I ZAWODOWYCH

FLAT FEET IN CHILDREN: THE STATE OF THE PROBLEM AND PEDAGOGICAL
TECHNOLOGY OF CORRECTION

PŁASKOSTOPIE U DZIECI: STAN PROBLEMU I PEDAGOGICZNA
TECHNOLOGIA KOREKCYJNA

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Authors' contribution
Wkład autorów:
A. Study design/planning
zaplanowanie badań
B. Data collection/entry
zebranie danych
C. Data analysis/statistics
dane – analiza i statystyki
D. Data interpretation
interpretacja danych
E. Preparation of manuscript
przygotowanie artykułu
F. Literature analysis/search
wyszukiwanie i analiza literatury
G. Funds collection
zebranie funduszy

Summary

Background. According to the data from the World Health Organization, the condition of children's feet is unsatisfactory. An effective solution to this problem requires the development of pedagogic and health correction technologies, the basis of which should consist of the joint effort of orthopedists, coaches and the family, founded on the advice of orthopedists, therapeutic swimming and corrective gymnastics. The aim of this research is to study the effectiveness of the technology of orthopedist-coach-parent joint activity in correcting foot problems in children between the ages of 11 and 12.

Material and methods. The condition of the locomotor system in children was assessed using the plantographic method. In order to correct foot disorders, a program was developed whose effectiveness was studied in a scientific pedagogical experiment.

Results. As a result of the pedagogical experiment, the indicators of the first degree of flat feet of all 5 children in the experimental group were significantly reduced, and no significant improvement was recorded in the control group.

Conclusions. The results of the research showed that the correction of deviations in the locomotor system is more effective if it is carried out as a result of collaboration between the orthopedist, a coach and parents, using therapeutic swimming and corrective gymnastics, as well as maintaining the orthopedic regime.

Keywords: pedagogical experiment, foot deformity, orthopedist, coach, parent

Streszczenie

Wprowadzenie. Zgodnie z danymi Światowej Organizacji Zdrowia stan stóp dzieci jest niezadowalający. Skuteczne rozwiązanie tego problemu wymaga opracowania technologii pedagogicznych i korekcyjnych, których podstawą powinien być wspólny wysiłek ortopedów, trenerów i rodziny, oparty na radach ortopedów, pływaniu w celach zdrowotnych i gimnastyce korekcyjnej. Celem tego badania jest analiza skuteczności technologii wspólnych działań ortopeda-trener-rodzic w korygowaniu wad stóp u dzieci w wieku od 11 do 12 lat.

Material i metody. Stan narządu ruchu u dzieci oceniano metodą plantograficzną. Do celów korygowania wad stóp opracowano program, którego skuteczność badano w naukowym eksperymencie pedagogicznym.

Wyniki. Rezultatem eksperymentu pedagogicznego było to, że wskaźniki płaskostopia pierwszego stopnia u wszystkich 5 dzieci z grupy eksperymentalnej uległy istotnemu obniżeniu, przy czym w grupie kontrolnej nie odnotowano istotnej poprawy.

Wnioski. Przeprowadzone badania wykazały, że korekcja wad narządu ruchu jest bardziej skuteczna, jeśli jest prowadzona w formie współpracy ortopedy, trenera i rodziców, z wykorzystaniem pływania w celach zdrowotnych i gimnastyki korekcyjnej, a także z utrzymaniem kontroli ortopedycznej.

Słowa kluczowe: eksperyment pedagogiczny, deformacja stopy, ortopeda, trener, rodzic

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Introduction

Maintaining, strengthening and restoring children's health is an important aspect of the educational and health systems, as well as of the family, as the locomotor system of the growing generation is currently in a woeful condition.

According to data from the World Health Organization, among a number of diseases of the locomotor system the most common are foot deformities (FD), the percentage of which, according to some literary sources, is 69% [1]. One of the most common locomotor disorders is flat feet, which has been identified in between 20% and 30% of children worldwide [2,3].

Locomotor system disorders, in particular foot disorders, may impair children's health and the quality of their lives [4,5]; they may cause detrimental consequences with secondary pathologies of the ankle, knee, hip and even lumbar vertebrae [6], and lead to deterioration of functions and disability of the lower extremities [7].

In the Republic of Armenia this problem is widespread and between 39% and 44% of children have functional deviations, most common among which is the locomotor system [8].

Improving children's health is the responsibility of health, sports and educational institutions, together with parents. The use of physical education in the family is of great importance, and may be quite effective in solving this problem [6]. The importance of the correction process comes from parents' and teenagers' tendency to lean towards conservative approaches, e.g. the use of physical exercises, when engaged in correcting LS problems [9]. It should be emphasized here that this approach is certainly effective in combination with other methods of correction, in particular with therapeutic swimming. Methods of correction of the LS with physiotherapy at home may be an important approach.

The co-operation of this trio of orthopedist, coach and parents should form the basis for and even guarantee a resolution of the LS problems, an improvement in health and an increase in the children's quality of life. Teamwork is also one of the most important elements of the Scientific Exercises Approach to Scoliosis (SEAS) method [10]. Effectively solving the problem by such co-operation requires a new approach in pedagogical and health technologies.

In the collaboration of the trio physical education, particularly the use of physical exercise, plays an important role. Therapeutic swimming [11] and corrective gymnastics (therapeutic physical culture) have a special place in this respect as an effective means of improving health. According to some authors, the correction of FD [12] through therapeutic swimming and corrective gymnastics training have the potential to be effective, especially when performed in combination. It should be noted that corrective gymnastics training may be performed at home and may in such conditions be more effective given parents' concern and the possibility of their constant supervision. The combination of corrective gymnastics classes at home and the therapeutic swimming classes in the pool should be implemented. This process may, however, only be effective in cases when the coach and parents have the necessary knowledge and appropriate skills.

The correction of the LS in the orthopedist-trainer-parent format is touched upon in the literature available. It may be therefore noted that the co-operation of this trio is yet to be practically formed, developing the technology of such an approach and revealing its effectiveness.

The aim of this research is to study the effectiveness of the orthopedist-coach-parent collaboration in correcting foot problems in children aged between 11 and 12.

Material and methods

The research comprised four methods: the study and analysis of scientific and methodological literature, a sociological survey among swimming coaches and parents, developed according to the recommendations proposed in special literature [13], plantography [14] and mathematical statistics [15].

Plantography, as recommended by Chizhin [14] was used to determine the condition of children's feet. The study was carried out as follows: the subject sits on a chair and cosmetic ointment, glycerin or vegetable oil is applied to the sole of the feet. The subject then stands up on both feet at the same time on a piece of paper placed on the floor [16]. Since the oil spreads quickly across the paper, we immediately trace around the footprints on the paper with a pencil. Corresponding lines are then drawn on the resulting footprint and marked with specific letters (Figure 1).

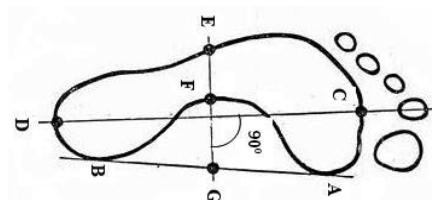


Figure 1. Assessment of the condition of the foot

The line AB on the inside of the foot is drawn. The line CD is then drawn from the center of the heel to the base of the second toe and its center is determined. From the center of the line CD, a perpendicular line EG is drawn crossing the line AB and the outer edge of the foot. The segments EF and FG are then measured. In order to determine the shape of the foot, the Chizhin index is calculated using the following formula: $I=(EF/FG)$. The results are evaluated as follows:

- $I=0.0-1.0$ the foot is not flattened,
- $I=1.1-2.0$ - flattened or flat feet (1st degree),
- $I=2.1$ and more - the foot is flat (2nd degree).

The pedagogical experiment (PE), during which the technology developed by us was tested was considered of especial importance. It aims at co-operation between a doctor, a coach and a parent, and aims at correcting deformities in LS with the objective of revealing its effectiveness. The recommended technology required the theoretical knowledge regarding the correction of deformities of LS, orthopedic foot care and therapeutic swimming lessons in the pool and corrective gymnastics at home.

Providing adolescents with theoretical knowledge is important, since they, in particular, care for their backs at a low level [17]. We suppose that this refers also to foot care. Providing theoretical knowledge to parents was especially important [18] because we consider it insufficient, which is confirmed by the results of our sociological research. The selection of the proposed physical exercises was based on recommendations in the literature [11,12,18-22].

The results of the study were processed by calculating the relevant indicators determined by the aims of the study, and the reliability of the difference between the average values of the data for the variant of interdependent and independent groups was determined. Statistical significance was set at $p<0.05$ [15]. The widely used statistics program SPSS (version 16) was used for numerical data processing. Mathematical analysis required the numerical values be determined on the basis of the Kolmogorov-Smirnov test, designed to characterize the features of the distribution of the analyzed sample (Table 1).

The table also contains the data of only the 5 children in the experimental and control groups, who suffered 1st degree flat feet. Research of the locomotor system, the sociological survey and the PEs were carried out in 2022 in Yerevan, Armenia.

Table 1. The normal distribution of indicators of plantograms of 1st degree flat feet (right and left feet) in the experimental and control groups (One-Sample Kolmogorov-Smirnov Test)

Parameters	Indicators	Plantogramm of right foot, experimental group	Plantogramm of right foot, control group	Plantogramm of left foot, experimental group	Plantogramm of left foot, control group
n		5	5	5	5
Normal parameters	Mean	3.00	3.00	2.40	3.00
	Standard deviation	1.581	1.581	1.140	1.581
Most extreme differences	Absolute	0.136	0.136	0.237	0.136
	Positive	0.136	0.136	0.237	0.136
	Negative	-0.136	-0.136	-0.163	-0.136
Test statistic		0.136	0.136	0.237	0.136
Asymptotic significance	(2-tailed)	0.200	0.200	0.200	0.200

Prior to the research and the implementation of the PE, written consent was obtained from all the participants, parents and coaches for the sociological survey, diagnosis, implementation of the PE. The processing of the digital data and the publication of the data was thereby obtained as well. This was discussed and approved by the Scientific Research Ethics Committee of the Armenian State Institute of Physical Culture and Sport (Decision No. 2023-H-1).

The sociological survey, consisting of open and closed questions, was carried out among 50 parents of children attending swimming classes, in order to improve the level of relevant knowledge and increase practical techniques regarding FD. The survey revealed that most parents are unable to assess even approximately the condition of their children's feet and ways of correcting existing deformities by dint of physical exercise.

A corresponding survey was also conducted among 18 swimming coaches with at least 6 years' coaching experience. The research showed that the majority of coaches do not fully understand the approaches used to correct FD. It should be noted that the sociological survey conducted among the coaches and parents is one of the important stages of the research and the results also formed the basis for developing the content of the experimental program.

In order to improve the knowledge of parents and coaches on the treatment of FD, we developed a program on FD including the necessary theoretical knowledge, series of physical exercises and methodical instructions aimed at correcting existing deformities. The program was developed in accordance with the recommendations found in literature [11,12,18-22].

Before the PE the program's methodological instructions were given to the parents of children and to the coaches included in the PE, so that they could acquaint themselves with them. Seminars were also held on the issues and consultations if necessary.

The effectiveness of the theoretical and practical sections of the corrective program developed was assessed in the PE with children enrolled in experimental groups. The preliminary research examined 35 cases of FD from 56 examined children. With the consent of the parents, 8 children with FD (in the experimental group)

participated in the experiment. An equal number of children were included with parental consent in the control group. In the subsequent 19 cases of FD the parents did not wish to include their children in the research.

The pedagogical scientific experiment was carried out on the correction of FD in order to assess the effectiveness of the program. It was conducted under the supervision of a coach in the pool and with the participation of parents of children with FD at home. Children between the ages of 11 and 12 years from the experimental and control groups were enrolled in the experiment. Three children with 2nd degree longitudinal flat feet and 5 children with 1st degree longitudinal flat feet (taps) were enrolled in the experimental group. The control group also included 3 children with 2nd degree flat feet and 5 children with 1st degree flat feet.

Classes with children with FD in the experimental group were carried out according to the program. Classes took place three times a week for six months and lasted 45 minutes. A total of 72 training sessions were held. All children had mastered the swimming strokes used in the experiment. The content of the program included not only different swimming styles, but also special corrective exercises. The sequence of exercises was as follows: in the preparatory part of the training session, breathing and preparatory exercises were carried out for between 8 and 10 minutes. In the main part of the training sessions (25-30 minutes), as well as general swimming exercises, some exercises designed to strengthen the locomotor system of the lower limbs were performed, for example, from a standing position on the bottom of the pool making so-called caterpillar movements with the toes, moving forward. The next exercise involved cycling movements with the feet touching the back and holding the pool wall or the swimming lane. The children also did this with a small weight attached to their feet (a rubber ring), jumping out of the water by pushing off from the bottom of the pool. They also swam with fins among other exercises. The set of exercises consisted of 10 drills. In the final part of the training sessions (3-5 minutes), free swimming, muscle relaxants, breathing exercises and entertainment were prescribed. During the training sessions the children swam about 600 m.

In authors' opinion, the 6-month program of scientific experiments is not so tedious, since 45-minute swimming classes formed only part of the main section, correctional swimming came out of the entertaining, main and final parts of the training.

Children from the experimental group also did special corrective exercises recommended by us under parental supervision at home three times a week on days when they did not attend the pool. The parents of the children were also given relevant theoretical knowledge on FD. In the 6 months of the scientific experiment at home parents conducted 72 sessions. Each lesson lasted 45 minutes and consisted of an introductory section (8-10 min.), a main section (25-30 min.) and a final section (3-5 min.). Children did the exercises in different positions, such as lying on their backs, sitting and standing, 10 exercises each, including short foot exercises. Ten exercises were done walking and toe exercises were done using different objects. Exercises such as walking on the toes, the heels, with the feet placed parallel on the outer edge were widely used. Classes were held barefoot or in soft cloth gym shoes.

The exercises were aimed at strengthening the muscles of the anterior and posterior tibia, the muscles of the foot, the long flexor of the big toe that moves the big toe, together with the muscles of the inner, interosseous plantar, involved in maintaining the medial longitudinal arch. The children also performed exercises to stretch the flounder, calf, short fibular and other muscles of the lower extremities. These exercises were performed in accordance with the relevant guidelines [18,20-22]. For six months the experimental and control groups had the same number (72) of swimming sessions.

The children of the experimental group also followed the advice given by the orthopedist regarding the daily orthopedic treatment, for example, choosing the right shoes, pouring cold water on their feet, walking barefoot on sand and grass, correctly planting the feet when doing exercises, when walking, and relieving foot tension by relaxing them.

Results

Analyzing the data from the sociological survey of the parents of the children attending swimming sessions, it could be concluded that not all parents could correctly assess the condition of their children's feet.

Only 32% of the parents interviewed assessed the condition of their children's feet as bad, but half of them came to this conclusion after the orthopedist's diagnosis. As a result of the plantographic examination, which was carried out, it was discovered that 27 of the 65 children (42%) had 1st degree flat feet, and 8 (12%) had 2nd degree flat feet. This was confirmed by an orthopedist. 22% of parents said they could correct foot problems, but only 29% correctly described the list and content of the necessary exercises.

In the light of the survey, it became clear that the coaches' knowledge was also rather scant. 89% of them stated that they considered swimming itself adequate treatment for FD. While swimming in such cases has a therapeutic effect, the full effect requires the performance of the special exercises.

Analysis of the data from the foot, in particular the plantogram, before the experiment (Table 2) revealed that the children examined did not differ in terms of the indicators of 1st and 2nd degree of flatfoot.

Table 2. The comparative indicators of the plantographic examination of the foot of the experimental and control groups prior the experiment

Indicator		Arch index of the foot (score)					
		Right foot (X±σ)	t	p	Left foot (X±σ)	t	p
1*	Experimental group	1.37±0.02	0.68	>0.05	1.31±0.03	1.03	>0.05
	Control group	1.35±0.03			1.34±0.06		
2**	Experimental group	2.12	-	-	2.14	-	-
	Control group	2.13			2.11		

Notes: * 1st degree flat feet, ** 2nd degree flat feet

The analysis of the data from the PE revealed that the program used in the experimental group had a significant impact on the correction of FD (Table 3). First-degree flatfoot indicators decreased significantly and statistically in the experimental group. There was, however, no significant change in the control group. The indicators of 2nd degree flat feet remained unchanged in the experimental and control groups.

Table 3. Plantographic indicators of the foot before the experiment and after the experiment in the experimental and control groups (X±σ)

Indicator		Arch index of the foot (score)									
		Right foot					Left foot				
Condition of the foot		BE ¹ (X ¹)	AE ² (X ²)	X ¹ -X ² ±σ	t	p	BE ¹ (X ¹)	AE ² (X ²)	X ¹ -X ² ±σ	t	p
1*	E ³	1.37	1.19	0.18 ±0.05	7.53	<0.01	1.31	1.20	0.11 ±0.05	5.12	<0.01
	C ⁴	1.35	1.29	0.06 ±0.07	2.14	>0.05	1.34	1.27	0.07 ±0.08	2.12	>0.05
2**	E ³	2.12	2.12	-	-	-	2.14	2.15	-	-	-
	C ⁴	2.13	2.12	-	-	-	2.11	2.13	-	-	-

Notes: * 1st degree flat feet, ** 2nd degree flat feet, BE¹ – before the experiment, AE² – after the experiment, E³ – experimental group, C⁴ – control group.

Discussion

One of the problems related to the deterioration of children's health are the disorders of the locomotor system, particularly those affecting the feet. FD in turn may lead to unwanted consequences of the lower extremities, and in many cases do [6]. It is therefore necessary to take measures to correct the defects in the locomotor system effectively and prevent other health problems [23,24].

Some authors mention the importance of corrective exercises in the correction of flat feet [24-27]. As a result of their research, Lazuta et al. [28] concluded that special corrective gymnastics exercises, taken twice a week for 20 minutes over 4 months are effective in correcting 1st degree flat feet. They are also convinced that in more complex cases of flat feet corrective exercises are needed over a longer period of time and more frequently per week [28]. We also feel confident therefore that regularly taken corrective physical exercises, including strengthening exercises, are vital in improving the condition of the foot. This also accords with other authors, as was substantiated in the research Golchini et al. [18]. An interesting approach was used in one of the studies. The results of this indicate the beneficial effect of plyometric exercises on improving foot condition [29]. Kazantseva [30] obtained similar results from experiments on children using jumping exercises on an elastic support, exercises on a trampoline, on an acrobatic track and on a double minitramp. In study Kamalakannan et al. jumping exercises with a skipping rope were used to correct flat feet [31]. The results our study achieved are also consistent with the data of Kazantseva [30], and Kamalakannan et al. [31].

The harmonious co-operation between doctors, teachers, parents and children also plays its part. Our studies confirmed the effectiveness of this approach, but, unlike other studies, we include a swimming coach. The importance of co-operation between parents and children with professionals working on deformity correction is noted by a number of researchers [32].

It is necessary to note that conversations with children and parents revealed that children participate in these sessions with great pleasure and do not get too tired. Their desire to resolve problems in the locomotor system motivated children and their parents and they showed a keenness to exercises at home, addressing a number of problems.

In order for the parents' effort to be effective in correcting locomotor system disorders, parents must have appropriate knowledge, which, as the results of our study have shown, currently stands at a low level. Some authors point out the importance of providing parents who are addressing their children's problems with all the necessary information [33]. This was one of the reasons we conducted our seminars and training sessions with parents on these issues. Parents were also given relevant practical advice for performing corrective exercises at home.

The environment in which parents help their children is the family home because it is full of warmth and care; it may have "unlimited" duration and be materially beneficial. The role of the family in resolving such problems in children is especially important in the Republic of Armenia, due to the financial limitations of the state (polyclinics), specialized public organizations and foundations, and the briefness of the services available. This situation cannot help the issue. All this means that family members need to be equipped with the necessary knowledge and practical abilities and skills to increase the role of parents in solving spinal and FD.

It should also be noted that the professional qualifications of those conducting the correctional treatment is important, as is emphasized by Banjevic [34]. We also emphasized the activities aimed at improving coaches' theoretical knowledge and practical abilities. In the process of correcting LS violations we also noted the importance that children follow the recommendations of an orthopedist in maintaining hygienic daily treatment. These tips concerned the issues on which they should receive relevant information, such as pouring cold water on the feet, walking barefoot on sand and grass; the correct setting of the feet when training, when walking; the correct selection of shoes. Since there are no specific recommendations in the literature regarding the way

patients with flat feet acquire this knowledge, we consider it appropriate to draw an analogy with the experience of teaching patients with posture problems, as mentioned in their works by a number of authors [35,36]. This approach formed the basis of the results of the correction of foot disorders recorded in the PE.

Conclusions

1. The study and analysis of literary sources revealed that FD loom large in the problems of locomotor system common today.
2. The sociological survey carried out among children's parents and swimming coaches revealed that their knowledge and practical skills in identifying disorders in the locomotor system and their correction are insufficient in carrying out this task effectively.
3. Studies of the locomotor system, particularly the feet, among school-aged children in Yerevan, Armenia, revealed that 62.5% of 56 children examined had various degrees of FD.
4. Based on the results of scientific and methodical literature and sociological survey, a pedagogical technology for correcting FD in children's locomotor system was developed and applied in a 6-month scientific experiment.
5. As a result of the orthopedist-coach-parent collaboration based on the implementation of a developed program for the diagnosis of disorders, therapeutic swimming, therapeutic gymnastics and orthopedic treatment, it was possible to achieve a statistically significant improvement in deformities, such as 1st degree flat feet. In children with 2nd degree flat foot, no improvement in the condition of the foot was in evidence at the end of the PE.
6. In order to correct locomotor system disorders, it is recommended that appropriate knowledge and practical skills be improved in parents and coaches. These are diverse including special TV programs, materials posted on the Internet in Armenian, special information corners organized in polyclinics, consultations, published methodological guidelines.
7. For coaches, the swimming federation could organize training seminars and relevant lectures. Practical training sessions may be conducted in higher and secondary specialized educational institutions for training coaches and teachers of swimming.

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