# EFFECTS OF EXERCISE PROGRAMS ON PES PLANUS IN CHILDREN UNDER 18 YEARS OF AGE: A SYSTEMATIC REVIEW

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*Review paper*

***Abstract***
*The significance of this paper consists in seeking to understand the effects of physical exercise on the improvement of functional abilities of the feet in children under 18 years of age who have flat feet. The objective of this paper is to identify the effects of exercise programs on children under 18 years of age who have flat feet. Persons with detected pes planus, also known as the deformity of flat feet, have muscular, ligament and bone systems that are jointly unable to sustain a normal foot appearance due to the influence of external forces. Guided and correctly administered physical activity makes possible both improvement of this condition and total recovery from it, accompanied by doing away with the everyday challenges this deformity brings to those afflicted. A survey of electronic databases returned studies which satisfied the criteria set. The applied programs, lasting between 8 weeks and four years, with a weekly frequency of two to five times per week and session duration of 30 to 80 minutes, had effects indicating a possibility of alleviating or recovering from the deformity, depending on the duration of the treatment. The scarcity of studies available presents researchers with possibilities for further work in this area. The pedagogic significance of this paper lies in identifying the need for professionals who would guide the activities of parents and children to help improve their quality of life.*

***Key words****: children, deformity, corrective exercises, pes planus*

## Introduction

The development of correct posture depends on a balanced relationship between all of the body's segments, a requirement for their proper functioning. As part of the apparatus for active movement, the muscular system plays the most important role in developing and maintaining correct body posture. Weakness of certain muscle groups, as well as excessive or uneven strain placed on them, may lead to the emergence of various disorders. In case of a disproportion between the foot's active strength and the force of the strain, there can occur a change in the normal appearance of the foot as well as its statics (Amico 2001; Mickle, Steele & Munro, 2008; Rose, Welton & Marshall, 1985). The first to diminish is muscle strength, next the ligaments lose some of their elasticity and become lax, and finally changes occur in the shape of the bone structure of the foot. Such deformities can manifest as a lowering of the foot arch and the emergence of flat feet (pedes plani) (Pfeiffer, Kotz & Ledl, 2006). The first stage of the collapse of the longitudinal arch (pes valgus) is the calcaneus assuming the valgus position. Unless this phase is stopped, what ensues is the descending of the accessory navicular (os naviculare) and cuboid bone (os cuboideum), and a descending of the longitudinal and transverse arches, or the second phase of the collapse (pes plano-valgus). Simultaneously with the changes in the longitudinal and transverse arches occurs an increase in the distance between the heads of the metatarsals as well as their collapse, which constitutes the third phase of the flat feet deformity (pes transverso-planus) (Lee, 2005; Otman, Kose & Yakut, 2005; Rome, Ashford & Evans, 2008). Numerous researchers studying this area have emphasized the alarming incidence of this postural deformity in children of preschool and school age. Živković and Milenković (1994/95) studied the incidence of postural deformity in children in all kindergartens in Niš Municipality, Niš, Serbia. Their results indicate that initial stages of this deformity were present in 61% of the children. Ulić (1997) conducted a measurement of postural status in all school-starters in the elementary school "Miroslav Antić" in Futog, Novi Sad, Serbia.

In that sample, 59.03% of the children had fallen arches. The study by Radisavljević, Ulić and Arunović (1997) found flatfoot (both in lighter and in more severe forms) in 75-79% of the subjects of both sexes. Due to the plasticity and sensitivity of children's bodies, correct postural status development is of critical importance in the preschool and school age. The means toward accomplishing this goal is guided and correctly administered physical activity. The objective of this paper is to identify the effects of exercise programs on correcting flatfoot, based on a systematic review of electronic databases.

## Methodology

In order to collect the studies conducted to date on flatfoot deformity and the effects of appropriate corrective exercise programs in children under 18 years of age, the following electronic databases were searched: PubMed /Medline, PEDro, SCIndeks, DOAJ. Papers spanning the period between 2005 and 2014 were searched.

The following keywords were used while searching the databases: foot, children, deformity, flat feet, corrective exercises, pes planus. The retrieved paper titles, abstracts or full texts of the studies were then analyzed. In order for a study to be included in the final analysis, the following two criteria had to be met: the study had to include an experimental group, and the subjects needed to be under 18. Those studies which satisfied the two criteria were then analyzed and represented according to the following parameters: reference (first author's surname and the year when the study was published), the subject sample (their age, total number and any subject subgroups), the physical exercise program, the duration of the program, and the study results.

**Results**

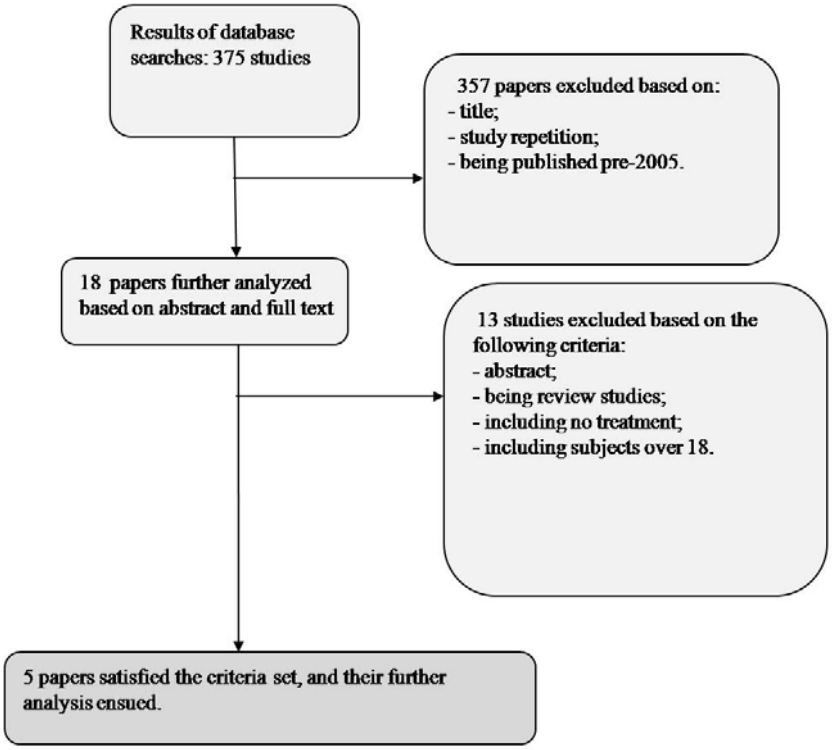


Figure 1. A statistical representation of the retrieved studies

The process of collection, analysis and elimination of the retrieved studies is presented in Figure 1. Based on the keywords, 375 papers were identified. Based on the title alone, paper repetitions, or studies excluded based on the period when they were published (i.e., before 2005), 357 studies were excluded, and 18 papers were retained for further analysis. This analysis then excluded a further 13 papers based on several criteria: the abstract revealing these were also systematic review studies, there was no control group, or the subjects' age did not correspond to this study (i.e., included subjects older than 18 years). The remaining 5 papers satisfied the criteria set, including: studies published between 2005 and 2014, and including subjects under 18 years of age who were assessed for flat foot deformity and who underwent a corrective exercise program.

**Discussion**

Table 1 is a representation of studies dealing with the effects of corrective exercise programs on flatfoot persons under 18 years of age. A survey of the table demonstrates that the papers were presented and analyzed across seven parameter groups: reference, subject age, pathology, subject numbers and subject groups, treatment characteristics, measurement methods (condition assessment and treatment effects), and the results achieved after the treatment. Diagnosing pes planus was done by means of a plantogram (Stanišić, 2014) or pedoscope (Otman, 2005; Riccio, 2009), interpreted using Thompson's (Stanišić, 2014) or Viladot's method (Riccio *et al.*, 2009). The subjects were aged between 3 (Riccio, 2009) and 16 years (Kolooli, 2014). The total number of subjects of both sexes included in the presented papers was 620, with the fewest subjects (30) participating in the paper by Kolooli *et al.* (2014), whereas the study by Riccio *et al.* (2009) had the highest number of subjects (a total of 300). In the treatment characteristics column, the application of a specific corrective exercise program, with the aim of strengthening muscles, enhancing balance and foot flexibility, was presented. The program took place in intervals between 30 minutes (Ahmad, 2014) and 120 minutes long (Riccio, 2009), with a weekly frequency of three (Riccio, 2009; Ahmad, 2014; Stanišić, 2014; Kolooli, 2014) to five times per week (Otman, 2005), and total study duration ranging from eight weeks (Kolooli, 2014) to four years (Riccio, 2009).

Table 1. An outline of studies to date

| Reference | Age | Pathology | Number of subjects | Treatment characteristics | Measuring method | Study results |
|---|---|---|---|---|---|---|
| Otman *et al.* (2005) | 13-15 y. | Postural status | 50 (12 boys and 38 girls) | 5 times per week for 6 weeks, after that prolonged to 6 months and one year with decreased intensity. | Measurement done by pedoscope | No statistically significant improvement in terms of foot deformity. |
| Riccio *et al.* (2009) | 3-8 y. | Flat feet | 300 (61% male) | 3 times a week with a total duration of 2 hours during an average time period of 2.66 years (1.9-4.1). Exercise for strength, flexibility and balance used. | Pedoscope for measurement, results assessment by means of Viladot's method | 600 feet – 38 feet remained at the same level or went down by one degree of deformity; all other feet were normal after treatment. III-degree: 386 feet. After treatment: 22 ft. same degree as before, 12 ft. II second degree, and 86.6% normal. II-degree: 214 feet, of which 4 showed no change and 98.1% became normal. |
| Ahmad *et al.* (2014) | 6-10 y. | Flat feet | 180, in 3 groups of 60 group I – experimental, 60 subjects; II – experimental, 60 subjects; III- control, 60 | Group I exercised for 30mins 3 times per week over 36 weeks. Group II used orthoses during the same time frame. Group III had normal everyday activities only. | Gait Velocity, Cadence and Step-length | Improvement in both experimental groups, greater in first group where there is statistically significant difference in some parameters (Gait Velocity p=0.003) and difference, though not statistically significant, in others (Cadence (0.373) and Step-length (0.304). |
| Stanisic *et al.* (2014) | 6 y. | Flat feet | 60 (39 girls and 21 boy) | 3 sessions per week, 6omins each, over 2 months | Plantogram for measurement, Thompson's method for interpreting | Prior to treatment, 63.3% of children without deformity, after treatment increased to 66.7%. Improvement achieved I-degree 30%-26% II-degree 6.7%-6.7%. There is a difference, but it is not statistically significant. |
| Kolooli *et al.* (2014) | 12-16 y. | Flat feet | 30 (control and experimental with 15 subjects in each) | 8 weeks with a total of 18 treatments lasting 60-80mins each. | Navicular drop test | Difference between measurements before and after treatment indicates statistical significance relating to the experimental group (left navicular height p=0.004 and right p=0.008). No statistically significant changes in control group. |

The treatments consisted of up to ten exercises, with between 10 and 18 repetitions in each set. The instruments used to diagnose the condition after treatment included the plantogram, pedoscope, navicular drop test, Gait Velocity, Cadence and Step-length. Each study used different measure instruments. The results of final measurements demonstrated that: there was no statistically significant difference in terms of foot deformity improvement in the study by Otman (2005).

in the study by Riccio *et al.* (2009), out of 600 feet only 38 remained at the same level or were one degree lower in terms of deformity, whereas all others were normal after the treatment. There were 386 III-degree feet. Following treatment, 22 feet remained at the same deformity degree, 12 feet became 2$^{nd}$ degree and 86.6% became normal.

In addition, there were 214 II-degree feet, of which 4 showed no improvement whatsoever , whereas 98.1% became normal. In the study by Ahmad (2014), both experimental groups showed improvement, but the first group had better results and there was statistically significant difference in the parameter Gait Velocity (p=0.003) while in the parameters Cadence (0.373) and Step-length (0.304) there was a difference but without statistical significance; Stanišić (2014) identified the following improvements as a result in their study: I-degree 30%-26%, II-degree 6.7%-6.7%, that is, there was no statistical significance; in the final research reviewed, (Kolooli 2014), there was statistically significant difference between the measurements obtained before and after the treatment for the experimental group, with significance after treatment for left navicular height

p=0.004 and right p=0.008, whereas no statistically significant result was found for the control group. It follows from the findings outlined above that different programs, intensities and exercise duration produced different results in persons with a diagnosis of flat feet.

It can be concluded that the studies reviewed demonstrated that changes had occurred which were not statistically significant yet constituted improvements between the initial and final measurements, measurable in percents in studies lasting up to 8 weeks (Stanišić 2014; Otman, 2005).

Studies where treatment lasted over 8 weeks, and included longer sessions and greater weekly frequency and number of exercises (Riccio *et al.* 2009; Ahmad, 2014; Kolooli 2014) showed a statistically significant improvement, that is, indicated statistically high results in terms of successful correction and complete recovery from the deformity.

**Conclusion**

The range of studies reviewed indicates a scarcity of information emerging from scientific research aimed at the effects of corrective physical exercise in flatfoot children aged under 18, in turn indicating a need for more research in this area in the future. There is an increase in persons affected by foot deformity, especially of elementary-school age. Consequently, there is rising need for timely prevention and treatment of such occurrences. Being professionally in contact with children, educators in physical education and health culture play a very important role in prevention, as do parents who need to care about their children's health. Identifying the deformity as early on as possible, choosing the right corrective exercises, adequate shoes, and reducing obesity in children are just some of the tasks placed before parents and teachers with the aim of reducing the deformity presented and described in this paper. A strong and healthy foot in childhood leads to a healthier and happier life later on; consequently, this all-too-often neglected part of the body should be given greater attention.

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## UČINCI PROGRAMA VJEŽBANJA NA RAVNO STOPALO KOD DJECE ISPOD 18 GODINA: SISTEMATSKI PREGLED

**Sažetak**

*Značaj ovog rada sastoji se u potrazi za razumijevanjem učinaka tjelesnog vježbanja na poboljšanje funkcionalnih sposobnosti noge u djece ispod 18 godina koja imaju ravna stopala. Cilj je utvrditi definirane učinke programa vježbanja na djecu mlađu od 18 godina, koja imaju ravna stopala. Osobe s otkrivenim PES planus, također poznat kao deformitet ravnih stopala, imaju snažne, ligamente i kosti sustave koji su zajednički u mogućnosti održavati normalnu pojavu stopala zbog utjecaja vanjskih sila. Vođena i pravilno primjenjena tjelesna aktivnost čini moguće, kako poboljšanje tog stanja tako i ukupni oporava, uz rad dalekosežno sa svakodnevnim izazovima koje ova deformacija donosi. Istraživanje elektroničkih baza podataka pokazujui da studija zadovoljava kriterije. Primijena programa, u trajanju od 8 tjedana i četiri godine, s tjednom frekvencijom od dva do pet puta tjedno i trajanje sesije od 30 do 80 minuta, ima učinak koji ukazuje na mogućnost ublažavanja ili oporavlja od deformiteta, ovisno o trajanju tretmana. Rijetkost studija dostupnih predstavlja istraživačima mogućnosti za daljnji rad na tom području. Pedagoški značaj ovog rada leži u prepoznavanju potreba za profesionalcima koji će voditi aktivnosti roditelja i djece kako bi poboljšali svoju kvalitetu života.*

***Ključne riječi**: djeca, deformitet, korektivne vježbe, pes planus*

*Received: November 06, 2015*
*Accepted: December 05, 2015*
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