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Series of exercise therapy in order to make the medial longitudinal arch in changing flat foot conditions, systematic literature review

Seria terapii ruchowej w celu zmiany przyśrodkowego łuku podłużnego w schorzeniach płaskostopia, przegląd literatury systematycznej

Ridwan Abdul Rachman[A,B,C,D,E,F], Wawan Sundawan Suherman[A,B,C,D,E,F], Budi Calamita Sandra[A,B,C,D,E,F], Ahmad Nasrulloh[A,B,C,D,E,F]

[1]Faculty of Sport and Health Science, Universitas Negeri Yogyakarta, Indonesia

Abstract

Flat foot is a condition in which the foot has no or less arch in the arches longitudinal medial that cause the footprints become flatter than usual or seem to appears have no arch. Arches longitudinal medial is one of the pedis arches which plays an important role in the support and balance of the foot when walking. If this part becomes flat and being ignored, it will cause the limitation of walking activities, muscle imbalance, the changes of body alignment, and it can cause a risk of injury to someone as well. The aim of this paper is to identify whether the series of exercise therapy in order to make the Medial Longitudinal Arch in changing Flat Foot Conditions is an appropriate exercise method that can be carried out. This research is using the systematic literature review method with preferred reporting items for systematic reviews and meta-analytic. The data that is used in the article's findings in Sinta accredited journals is Google Scholar & Pubmed. The articles searched were based on the keywords, in which flat foot exercise therapy and changes in arches longitudinal medial, then being filtered based on the inclusion and exclusion criteria. It was 6 out of 20 articles were used as the main source in this study. The first finding of this research shows that a series of strengthening exercises such as tower curl exercise, heel raises exercise, short foot exercise, strengthening Ball Roll Exercise, calf stretch, and towel stretch can provide a curving effect or additional of the arches longitudinal medial on the flat foot. The second finding of this research is that providing training with the addition of kinesio taping can improve postural control, increase proprioception, and increase static stability in the intrinsic muscles of the foot.

Keywords

exercise therapy, flat foot, arches longitudinal medial, systematic literature review

Streszczenie

Płaskostopie to stan, w którym stopa nie ma żadnego łuku lub ma go mniej w łuku podłużnym przyśrodkowym, co powoduje, że ślady stają się bardziej płaskie niż zwykle lub wydają się nie mieć łuku. Łuk podłużny przyśrodkowy to jeden z łuków stopy, który odgrywa ważną rolę w podparciu i równowadze stopy podczas chodzenia. Jeśli ta część stanie się płaska i ignorowana, spowoduje to ograniczenie aktywności chodu, brak równowagi mięśniowej, zmiany w ułożeniu ciała, a także może spowodować ryzyko kontuzji. Celem pracy jest ustalenie, czy seria ćwiczeń ruchowych mających na celu wywołanie zmian przyśrodkowego łuku podłużnego w warunkach płaskostopia jest odpowiednią metodą ćwiczeń, którą można przeprowadzić. W badaniu tym zastosowano metodę systematycznego przeglądu literatury z preferowanymi pozycjami raportowania dla przeglądów systematycznych i metaanalitycznych. Dane wykorzystane w wynikach artykułu w czasopismach akredytowanych przez Sinta pochodzą z Google Scholar i Pubmed. Wyszukiwane artykuły opierały się na słowach kluczowych, w których terapia płaskostopia oraz zmiany w łuku podłużnym przyśrodkowym, a następnie filtrowano je w oparciu o kryteria włączenia i wyłączenia. Jako główne źródło w tym badaniu wykorzystano 6 z 20 artykułów. Pierwsze wyniki tych badań pokazują, że seria ćwiczeń wzmacniających, takich jak ćwiczenia z uginaniem wieży, ćwiczenia unoszenia pięty, ćwiczenia krótkich stóp, wzmacniające ćwiczenia z piłką, rozciąganie łydek i rozciąganie ręcznikiem, mogą zapewnić efekt zakrzywienia lub dodatkowego podłużnego przyśrodkowego łuku na płaskiej stopie. Drugim wnioskiem płynącym z tych badań jest to, że zapewnienie treningu z dodatkiem kinesiotappingu może poprawić kontrolę postawy, zwiększyć propriocepcję i zwiększyć stabilność statyczną wewnętrznych mięśni stopy.

Słowa kluczowe

terapia ruchowa, płaskostopie, podłużne łuki śródstopia, systematyczny przegląd literatury

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Introduction

The foot is a part of the body that has a function to support the body weight and maintain the body balance when standing. The foot has two primary functions, namely the body foundation (base of support) and the lever to move forward the body while walking or running [1]. If the support is not firm, it is not impossible that the body will often fall and end up damaging the body structure as a whole.

One of the important parts of the foot is arches. Houglum & Bertoti said that arches are divided into three parts, namely arches longitudinal medial, arches longitudinal lateral, and arches transversal [2]. Arches serve several functions. First, they can help the foot adapt to various land surfaces. Next, they can be the power absorption that is given to the foot and base of support as well. Then, they give strength and balance when walking and disseminate the mass of the body equally on the foot. Lastly, arches keep the energy while running [3].

Arches longitudinal medial is an arch that has the highest arch composed of calcaneus, talus, navicular, cuneiform, first metatarsal, second metatarsal, and third metatarsal [4]. This arch is powered and stabilized by ligaments and intrinsic muscles. The ligaments that play a role in powering and stabilizing are the calcaneonavicular and deltoid ligaments, and the intrinsic muscles of the foot used to power and stabilize are the abductor hallucis, flexor digitorum brevis, and quadratus plantae [5]. As the arches longitudinal medial lowers or even has no arch, it may cause flat foot or it is known as pes planus. Arches longitudinal medial is one of the pedis arches which plays an important role in the support and balance of the foot when walking [6]. In the condition of flat foot, the ability of push off while walking becomes less effective due to the weakening of the plantar flexor muscle [7].

Flat foot can occur in one or both feet. This disorder has a special characteristic, namely hyperpronation of the feet [8]. Flat foot can be caused by genetic factors (congenital), the ligament weakness of the foot, or the tension in the extrinsic muscle of the ankle joint [2]. Arinaa said that the impacts that can occur due to flat foot are lessening the speed and agility while walking, getting tired easily, and changing the biomechanics of the body that can cause imbalancing [9].

The research of Nakhostin-Roohi et al. in 2013 shows that 50 teenage girls aged 14-17 with flat foot have bad static and dynamic balance [10]. Balance is needed when doing some activities such as walking, running, and standing. If someone has low balance, it will make it easy to fall and cause disruption while walking [11]. Arches that grow abnormally evoke balancing disorders, sustainability deformity, muscle weakness that make people with flat foot easy to get injured and painful [12].

Flat foot is divided into two types: flexible flat foot and rigid flat foot. Flexible flat foot is mostly due to physiological reasons, so it does not need surgery [13].

However, rigid flat foot is caused by bone abnormality [14]. Flat foot deformity first appears at the age of 10 years or more. At the age of 9 or 10 years, the arches are supposed to be firmed. It can also be given some treatments to prevent the deformity when they are adults; the prevalence of flat foot among children worldwide is around 20%-30%. In the year 2020, the child prevalence in Indonesia had not been discovered yet [15]. However, one of the research held in Surakarta showed that 27.55% of kids aged 6-12 have flat foot [9]. The case number of flat foot in Indonesia is still low. Yet, there is one research that showed 40% of teenagers aged 9-16 have flat foot [16]. The condition of flat foot can still develop during the growth period up to the age of 8 years. Nevertheless, the condition in some kids still needs some treatments so that it can prevent them from having growth problems [17].

The intervention that can be done in handling flat foot or flexible flat foot is exercise therapy. There are many exercises to improve the balance and strength [18]. One of them is strengthening exercise, the use of kinesiotaping, and medial arch support, and any other exercises. This form of strengthening exercise can improve muscle performance by increasing strength in connective tissue such as tendons, ligaments, and intramuscular connective tissue, increasing the body balance, making positive changes in body composition, and improving physical performance in daily activities [19]. The purpose of this literature review is to evaluate the treatments that can be done for the flat foot condition and explain the types of exercises that can be applied to help arch in the foot, specifically the medial longitudinal arch, by collecting and reviewing related articles over the past eight years. It is because the literature that discussed the way to handle or cure flat foot specifically reviewed from exercise therapy is still limited.

Methods research design

This research is a systematic literature review that is done by reviewing the results of previous research which discussed the series of exercise therapy to make the medial longitudinal arch in changing flat foot conditions. A systematic literature review study is a research design that uses related secondary data to a specific topic [20]. The aim of this literature review is to summarize previous research findings.

Discussion regarding the series of exercise therapy to change the medial longitudinal arch in flat foot is deemed very necessary since it considers that whether this case is a small matter but it may have fatal consequences if it was not being noticed or treated further. So the type of exercise therapy used is one of the components as well as the supporting factors to the success of physiological changes in the medial longitudinal arch in children or adults who experienced flat foot.

The data used in the article's findings are Google Scholar & Pubmed. The inclusion criteria in the study were selecting articles related to exercise therapy for flat foot. The published articles are Bali Medical Journal, Respati Jogjakarta University, Journal of nr 2/2023 [23], Physical Education, Health and Sport, FisioMU, and Kemenkes Surakarta which are accredited by Sinta. Meanwhile, the exclusion criteria in the study were articles that are not accredited by Sinta and some articles that cannot be downloaded in full text.

Result

The data collection resulted in information from research articles, including articles published in Indonesian or English Language, full text articles, articles that discuss exercise therapy in order to make the medial longitudinal arch in changing flat fo-

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ot conditions, and the impact included or results from the application of exercise therapy to the condition of flat foot. The collection of the data taken from articles in the last five years, which is from 2018-2023. The first findings show the flow of data collection articles which is presented in Figure 1. Then in Table 1, it explains the analysis review of related articles about the course of exercise therapy in order to make the medial longitudinal arch in changing flat foot conditions.
Figure 1. Flow of Data Collection Explanation of the analysis results improve proprioception [29]. Using kinesio taping can also increase stimulation of mechanoreceptors that help strengthen the posterior tibial muscle, activate sensory receptors and neuromuscular function, so that it can improve static and dynamic balance [30]. In flat foot conditions, applying kinesio taping can correct hyperpronation, so that it can improve the medial longitudinal arch [27].
One regularly with varying sets or repetitions aimed at forming the curve in the arches of the foot and strengthen the foot. By increasing muscle strength and flexibility, there will be some additional arches or an increase in the degree of arch. Therefore, it will provide good results in improving and changing the medial longitudinal arch in children who have flat foot.

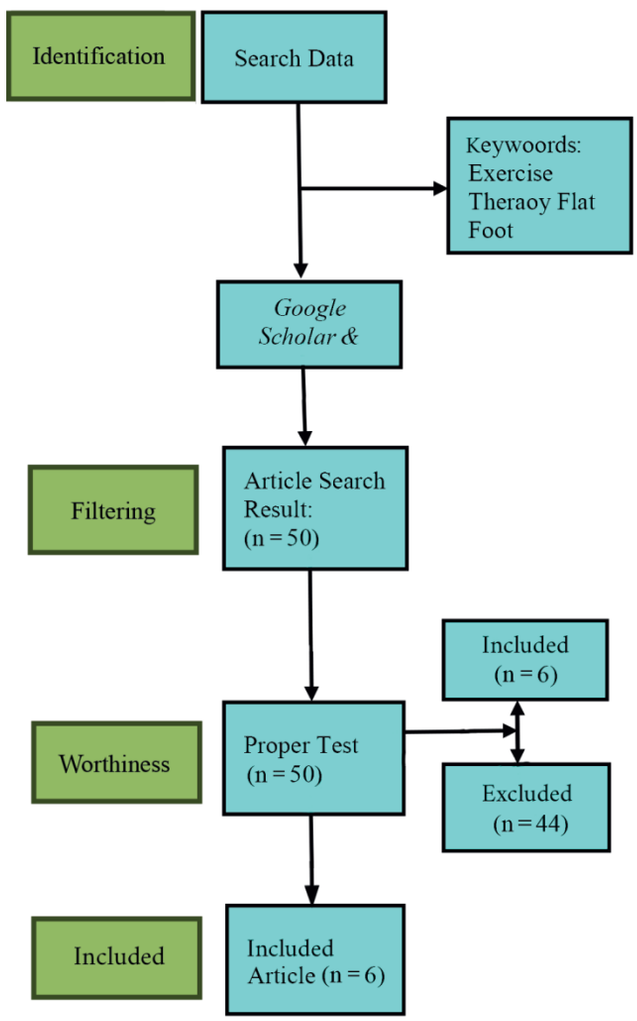

Figure 1. Flow of data Collection Explanation of the analysis results

Discussion

Based on Table 1, from 6 articles that have been reviewed and analyzed, it obtained 4 discussions about exercise therapy in order to make the medial longitudinal arch in changing flat foot conditions and it will be discussed as follows:

Strengthening Exercise

Strengthening exercises, including Tower Curl Exercise, Short Foot Exercise, Heel Raises Exercises, Calf Stretch, Towel Stretch, and Strengthening Ball Roll Exercise can help in making the medial longitudinal arch in flat foot conditions become curved [21]. This is because these exercises aim to activate the muscles, which focuses on movements involving the core muscles, especially the intrinsic parts of the foot or metatarsals [22].
Short Foot Exercise, Towel Curl Exercise, Towel Stretch are sensorimotor training that can improve the functionality of the ankle by strengthening the activation of the intrinsic muscles of the foot such as the ankle, abductor digiti minimi, abductor

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hallucis, and flexor digitorum [23]. When the intrinsic muscles of the foot are activated, it will cause changes that the medial longitudinal arch becomes curved [24].
In other forms of strengthening exercises, such as Heel Raises Exercises, Calf Stretch and Strengthening Ball Roll Exercise are forms of exercise that aim to stretch the plantar fascia and increase the arch of the foot [25]. Additionally, this exercise refers to the ability of muscle contractile tissue to produce tension and resultant force in the muscle which will have an impact on changes in the medial longitudinal arch. When biomechanical changes occur, this situation can increase the tension of the intrinsic muscles in the foot so that it can help in forming the medial longitudinal arch in a flat foot condition [26].

Using Kinesio Taping

Kinesiotaping is a material similar to duct tape that was created using high technology, first developed by a chiropractor from Japan named Dr. Kenzo Kase in the 1970s [27]. This tape is made from special, highly elastic materials like cotton with an acrylic adhesive backing. Kinesio taping has a different mechanism than ordinary foot bandages [28]. Apart from supporting muscle performance, kinesio taping also functions as a natural therapeutic tool. The function of kinesio taping is; [1] Corrects muscle function by strengthening weakened muscles. [2] Improve blood and lymph circulation by eliminating bleeding under the skin by moving the muscles. [3] Relieve pain through nerve compression. [4] Reposition subluxated joints by eliminating abnormal muscle tension, helps to restore fascia and muscle function [7]. An important function of most kinesio taping is to provide support during movement. Some kinesio taping aims to reduce injury and improve proprioception [29]. Using kinesio taping can also increase stimulation of mechanoreceptors that help strengthening the posterior tibial muscle, activates sensory receptors and neuromuscular function, so that it can improve static and dynamic balance [30]. In flat foot conditions, applying kinesio taping can correct hyperpronation, so that it can improve the medial longitudinal arch [27].

Table 1. Explanation of the analysis results

Researcher	Objective	Methods	Discussion
Putri Hapsari Srirahayuningsih & Fitri Yani 2020	To find out whether there is an effect of increasing dynamic balance in flat foot condition by giving towel curl exercise and short foot exercise	Narrative Review	Providing intervention strengthening exercise, namely with towel curl exercise and short foot execise regulary can form curves in the middle longitudinal arch in flat foot conditions
Herta Meisatama et al., 2022	To determine intervention the effectiveness of heel raises exercises and towel curl exercises on stork stand test scores in the cases of flat foot	Experiment and quantitative analysis	This research shows that strengthening exercises such as heel raises exercises and towel curl exercises. both of them can provide strengthening of the intrinsic muscles of the foot which refers to muscle contractile tissue to produce tension and resultant muscles which will have an impact in the medial longitudinal arch of the flat foot and can help children to improve static balance of the body
Nanang Indardi, 2018	To determine the effect of strengthening exercises with kinesio taping on balance in flat foot condition	Pre and Post-test group	Providing strengthening exercise intervention with three types of exercises, namely: calf stretch, towel stretch, and towel curl which combined with using kinesiotaping can provide the effect to make change the Medial Longitudinal Arch in Flat Foot Conditions
Imam Haryoko, 2023	To determine the effect of Strengthening Ball Roll Exercise, Kinesio Taping and Towel Curl Exercise on movement disorders and ankle joint function due to flat foot	Case Study	The interventions provided by strengthening exercise are Strengthening Ball Roll Exercise and Towel Curl Exercise combined with kinesio taping. The results obtained are increased arches caused by strengthening exercise modalities which can increase the arch of the foot and The plantar fascia muscle becomes stretched and can improve the functional activities of the human body
Amirah Zahidah et al., 2020	To determine the effect of short foot exercise with using kinesio taping. in order to make the Medial Longitudinal Arch in changing flat foot Conditions	Eksperimen with randomized control trial design	Providing short foot exercises with the use of kinesio taping can influence in the medial longitudinal arch to a flat foot condition changes, increase proprioception, increase static stability in the intrinsic muscles of the foot
Rayhan Dhafa Ali & Melya Rossa., 2022	To find out the management of Exercise Therapy for Flat Foot conditions	Assessment, diagnosis, anamnesis, and intervention	Providing exercise therapy such as strengthening exercise with Heel Raises Exercises & Toe Curl Exercises involving stabilizer muscles as the shape of the arches

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Medial Longitudinal Arch Change in Flat Foot Conditions

Problems in the medial longitudinal arch will cause foot abnormalities, namely flat foot. Firstly, flat foot is a condition where the sole of the foot does not have an inner arch [31]. Flat feet are caused by the bones' curve becoming flatter than usual, This case can happen because there are usually injuries in the leg or the presence of balance disorders caused by trauma or the changing of the body's spine [32]. Secondly, flat foot is considered as pes planus, which means a condition where the arch of the foot is flat, the entire sole of the foot is attached to the ground when walking or standing in a static position [33]. Lastly, factors that influence the formation of arches are genetic, complication, gender, hormones, metabolic disorders, and mechanical stress [34].

Strengthening training modalities like exercises can be applied daily with a regular training program and the body will have a physiological response and the muscles become flexible so that the medial longitudinal arch in flat foot become high [23].

Improved Muscle Strength and Balance

Doing stretching exercises will increase muscle strength and capillary blood circulation which triggers additional recruitment of motor units in the muscles so that the muscles activate the Golgi tendon organ, then the muscles will work more optimally and generate good stability [5]. In this case, the balance of flexible flat foot patients will have an increase in strength that can improve static, dynamic and postural control [23].

Strengthening exercises can also help in increasing the strength of the intrinsic muscles of the legs and around the pelvis, thighs and knees because the impacts of biomechanical changes result in muscle imbalance and cause effects on the nerves and skeleton from proprioceptive stimulation to maintain a balanced position [5, 35].

Strengthening exercises can make significant improvements in the muscles trained as well as static and dynamic balance and postural control. By having an increase in balance that has been facilitated by the twitch speed of the motor unit, the muscle contractions stimulate gamma efferent activity in the muscle spindle. The results of strengthening exercise show an increase in strength and improvement in static and dynamic balance as well as postural control.

Conclusion

Based on the results of the explanation, it can be concluded that providing a series of exercise therapy interventions with strengthening exercises therapy such as doing towel curl exercises, heel raises exercises, short foot exercises, strengthening ball roll exercises, calf stretches, and towel stretches can give an impact toward the changes of the medial longitudinal arch in flat foot conditions. This is based on the fact that these exercises can provide stimulation to the foot and can help in making the curve in the medial longitudinal arch of the foot for flat foot condition. Basically, these movements directly provide functional strengthening and muscle flexibility in the legs as a whole. Apart from providing muscle strengthening, this exercise can also improve the arch of the foot and stretch the plantar fascia muscle. Apart from doing exercise therapy intervention, the use of kinesio taping on the foot combined with exercise therapy can improve postural control, increase proprioception, increase static stability in the intrinsic muscles of the foot. In flat foot conditions, applying kinesio taping can correct hyperpronation, so that it can repair a flat medial longitudinal arch [37]. These exercises can be done regularly with varying sets or repetitions aimed at forming the curve in the arches of the foot and strengthen the foot. By increasing muscle strength and flexibility, there will be some additional arches or an increase in the degree of arch. Therefore, it will provide good results in improving and changing the medial longitudinal arch in children who have flat foot.

Adres do korespondencji / Corresponding author

Ridwan Abdul Rachman

E-mail: ridwan.abdrchmn@gmail.com

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