Universitat de Barcelona

Bibliographic Comparison of the Treatments in Children with Flatfoot

Subject Code:

360416

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Date: 8TH of June 2015

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1 ABSTRACT

Background: The flat foot is a common syndrome seen in the practice of pediatric health and there is no universally accepted definition and precise to define flat feet therefore the main aim of this study is better understand and manage paediatric flatfoot to make the best diagnosis, to find evidence supporting use of custom made orthotics by using the latest research available and to clarify if there is any difference in development between children with flat feet who receive a treatment for pes planus in scholar and pre-schooler and the ones that do not.

Methods: The studies included in this bibliographic review examine the association between pes planus in children and the ideal treatment for those cases. Studies included were from 2006 to 2015 to ensure up-to-date results. Patient case studies between 3-14 years and adolescents up to 17 years old were used.

Results: 45 studies were found with the selected keywords, 25 were excluded because they didn't meet the selection criteria. Of the 20 remaining studies, 12 were of conservative treatments for Pes planus, 2 of surgical treatments and 6 were articles related to factors that would potentially be useful as a part of a treatment. We classified the treatments listed in the studies as surgical or conservative.

Conclusion: Flatfoot has a good established clinical term and a common diagnosis but there is a lack of consensus on the methods of evaluation. Flexible asymptomatic flatfoot in children under the age of seven, does not need use orthotic insoles, but periodically observation. Symptomatic flexible flatfoot should be treated with activity modification, stretching exercises and orthoses. If the response is not satisfactory, surgical intervention should be considered. Conservative management for rigid flatfoot indicated if it’s asymptomatic, but when nonsurgical options failed, operative interventions are warranted for painful flatfeet. Age is the primary predictor for flatfoot and the weight it’s a factor of prevalence. Patient’s control that didn’t follow any treatment (younger and older than 6 and older) reported improvement as well.

Keywords: Flatfoot, Children, Diagnosis, Treatment, Orthotics.

1.1 RESUMEN

El pie plano es un síndrome común que se observa en la práctica de la salud pediátrica y no existe una definición universalmente aceptada y precisa para definir los pies planos, por esa razón el objetivo principal de este estudio es comprender y evaluar el pie plano pediátrico para hacer un mejor diagnóstico y tratamiento, encontrar pruebas que apoyen el uso de soportes plantares mediante las últimas investigaciones disponibles y aclarar si existe alguna diferencia en el desarrollo entre los niños con pies planos que recibieron un tratamiento en edad pre escolar y escolar y los que no recibieron tratamiento.

Métodos: Los estudios incluidos en esta revisión bibliográfica examinan la asociación entre los diferentes tipos de pie plano en niños y el tratamiento ideal para estos casos. Los artículos incluidos fueron del año 2006 al 2015 para garantizar estudios recientes. Se utilizaron estudios de casos con pacientes niños entre 3-14 años y adolescentes de hasta 17 años de edad.

Resultados: 45 estudios se encontraron con las palabras clave seleccionadas, 25 fueron excluidos al no cumplir los criterios de selección. De los 20 estudios restantes, 12 eran de tratamientos conservadores para el pie plano infantil, 2 tratamientos quirúrgicos y 6 eran artículos relacionados con factores potencialmente útiles como parte de un tratamiento. Clasificamos los tratamientos indicados en los estudios como quirúrgico o conservador.

Conclusión: El diagnóstico del pie plano tiene un buen sistema clínico establecido y un diagnóstico común, pero hay una falta de consenso sobre los métodos de evaluación. El Pie plano flexible asintomático en niños menores de siete años, no necesita usar soportes plantares (SP), pero si hace falta observación periódica. El niño con pie plano flexible sintomático debe tratarse con modificación de la actividad física, ejercicios de estiramiento y SP. Si el resultado no es satisfactorio, la intervención quirúrgica debe ser considerada. El Tratamiento conservador para el pie plano rígido está indicado si es asintomático, si las opciones no quirúrgicas fracasan, intervenciones quirúrgicas están garantizados para pie plano doloroso.

La edad es el principal predictor para el pie plano y el peso es un factor de prevalencia de este. Pacientes que no recibieron ningún tratamiento también reportaron mejoría.

2 AIMS

The main aim of this study is better understand and manage paediatric flatfoot to make the best possible diagnosis.

A secondary aim is to find evidence supporting use of custom made orthotics for paediatric flatfoot treatment by using the latest research available.

A third aim is to clarify if there is any difference in development between children with flat feet who receive a treatment for pes planus in scholar and pre-schooler age and the children that don't get any treatment during childhood but still grow out of flat feet.

3 PERSONAL MOTIVATION

Popular media is quick to publish controversial studies that may not reflect established medical practices. After learning about flat-feet last semester in the Pediatric Podology module, I wanted to do a bibliographic study about pediatric flat-feet to further understand the subject and the various treatments available. From my practical experience in the clinic, I knew that, if assessed in childhood, and either prevented or controlled with the right methods, we can avoid consequences and complications for patients later in adulthood. I wanted to discover when to treat and when to control pediatric flat-feet, which treatments are appropriate, when to use surgery, and a fuller understanding of the subject in general. So during the process of this study, with more than 50 articles read, I found many treatments and was especially interested in the conservative approaches like orthotics, which I'll be able to do as a podiatrist.

4 INTRODUCTION

The flat foot is a common syndrome seen in the practice of pediatric health. There is no universally accepted definition and precise to define flat feet, but in general it has been recognized on clinical examination, to present some of these features: internal collapse of the longitudinal arch (ALI), hindfoot valgus superior to 6 degrees

Flat track, abduction regarding hindfoot and forefoot internal rotation of the tibia. Other authors base the diagnosis primarily in the collapse of the inner longitudinal arch. Arandes and Viladot (8) consider the plantar arch as a structure for the maintenance of body weight. Foot and ankle specialists acknowledge that flatfoot de-Frequently Encountered formity is a pathology in the pediatric population. Flattening of the medial arch is a universal finding in flatfoot and it is common in both pediatric and Populations adult. Pediatric flatfoot comprises a group of conditions occurring in infants, children, and adolescents (1) that are distinguished by anatomy and etiologic factors.

Flatfoot May exist as an isolated pathology or as part of a larger clinical entity (4). These entities include generalized ligamentous laxity, muscular and neurologic abnormalities, genetic conditions and syndromes, and collagen disorders.

Pediatric flatfoot can be divided into flexible and rigid categories. Flexible flatfoot is characterized by normal during non-weight bearing arch and a flattening of the arch on stance. Flexible flatfoot May be asymptomatic or symptomatic. Characterized by rigid flatfoot is a stiff, Flat-File count it on and off weight bearing. Most are rigid flatfeet Associated With underlying pathology that requires special consideration.

The foot print technique was used to evaluate the shape of the plantar surface in 882 asymptomatic feet in normal people aged 1 to 80 years and this demonstrated that most infants are flatfooted, that the arch develops spontaneously during the first decade of life in most children, and that flatfeet are within the normal confidence limits for arch height in adults as well as children. Most current authors conclude that excessive ligamentous laxity is the

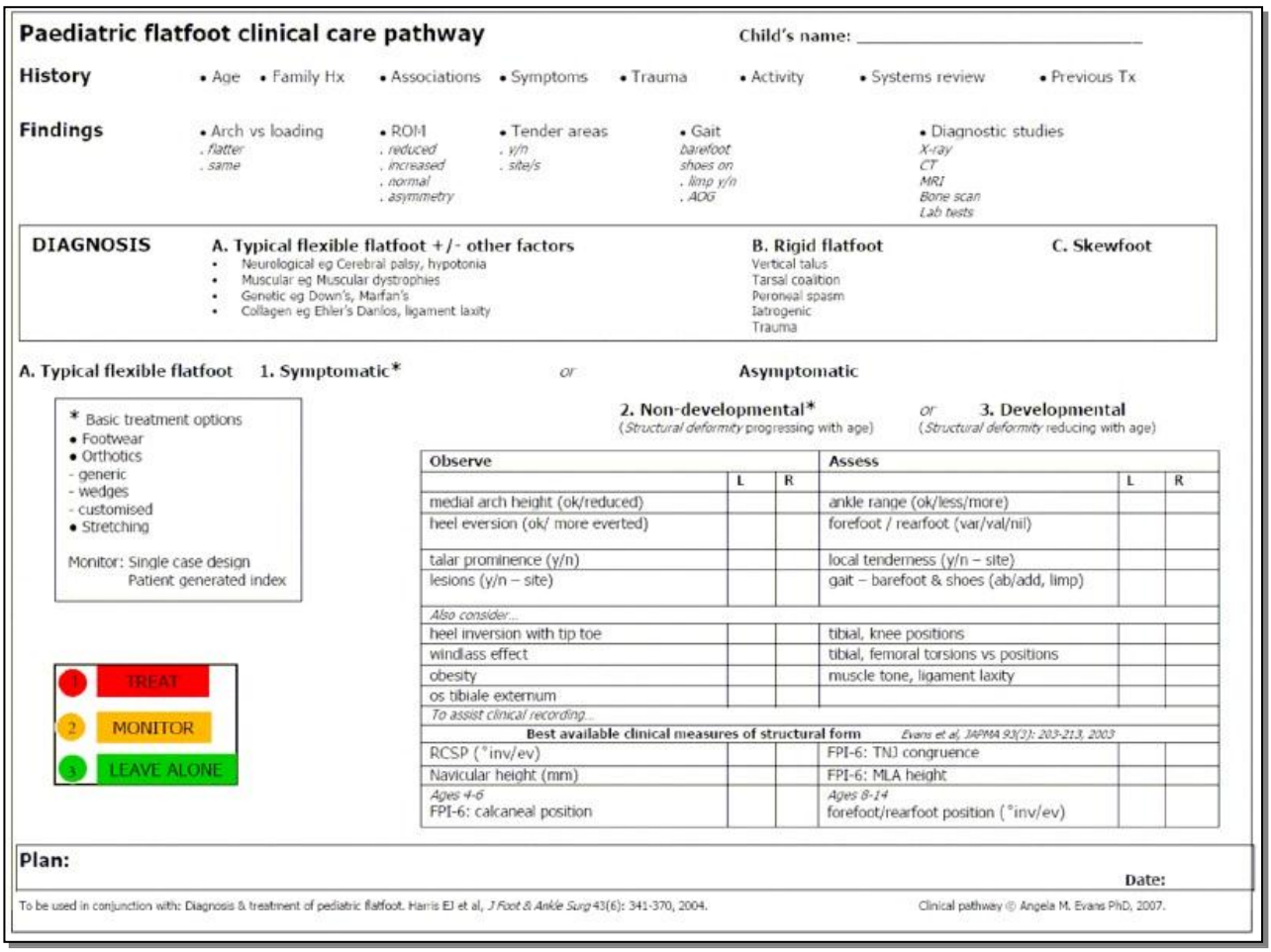
primary abnormality in Flexible Flatfoot and bone deformities are secondary reflection of a long- standing flatfoot. It's confirmed that muscle activity is not required to support the arch in static weight bearing.

Children in the age infancy and childhood usually come because of their parents concern about the cosmetic appearance of the feet. A good assessment of the clinic in an individual with a flatfoot consist in the examination of the musculoskeletal system, foot and ankle. The aim is to find out torsional and angular variations of the lower extremities and the walking pattern. We should always look for evidence of generalized ligamentous laxity, like make them touch the thumb to the volar forearm, hyperextension of the metacarpo-phalangeal joints of the fingers to 90 degrees and touching the palms to the ground with knees extended. Will be useful if we ask about family with flatfeet and check the child's shoe as well. It's important to be aware that flatfoot is not a single deformity, it is a combination of deformities that includes valgus deformity of the hindfoot and supination deformity of the forefoot. These are rotationally opposite direction deformities (4).

Figure 4.1 Flatfoot on a lateral view radiography, in a relaxed, bipedal, weight-bearing, stance position. Low calcaneal inclination angle (a) with increased value of calcaneal-first metatarsal angle (b)

Modified from Harris et al 2004 which have been adopted by Evans *et al.* (2009) in the paediatric flatfoot clinical care pathway (paediatric flat foot proforma, p-FFP).and accepted by the American College of Foot and Ankle Surgery, an algorithm emphasizes the diagnosis of pediatric flatfoot.

Designated subtypes of flat feet are the mainstay of treatment and therefore the realization of the "pediatric flat foot proforma p- FFP" which makes a division of child flatfoot for a better diagnosis and treatment:



Paediatric flatfoot clinical care pathway Child's name: _____

History • Age • Family Hx • Associations • Symptoms • Trauma • Activity • Systems review • Previous Tx

Findings
- • Arch vs loading: *. flatter . same*
- • ROM: *. reduced . increased . normal . asymmetry*
- • Tender areas: *. y/n . site/s*
- • Gait: *barefoot shoes on . limp y/n . ADG*
- • Diagnostic studies: *X-ray CT MRI Bone scan Lab tests*

DIAGNOSIS

A. Typical flexible flatfoot +/- other factors
- Neurological eg Cerebral palsy, hypotonia
- Muscular eg Muscular dystrophies
- Genetic eg Down's, Marfan's
- Collagen eg Ehler's Danlos, ligament laxity

B. Rigid flatfoot
Vertical talus
Tarsal coalition
Peronwal spasm
Iatrogenic
Trauma

C. Skewfoot

A. Typical flexible flatfoot **1. Symptomatic*** *or* **Asymptomatic**

2. Non-developmental* (*Structural deformity* progressing with age) *or* **3. Developmental** (*Structural deformity* reducing with age)

* Basic treatment options
- • Footwear
- • Orthotics
  - generic
  - wedges
  - customised
- • Stretching

Monitor: Single case design
Patient generated index

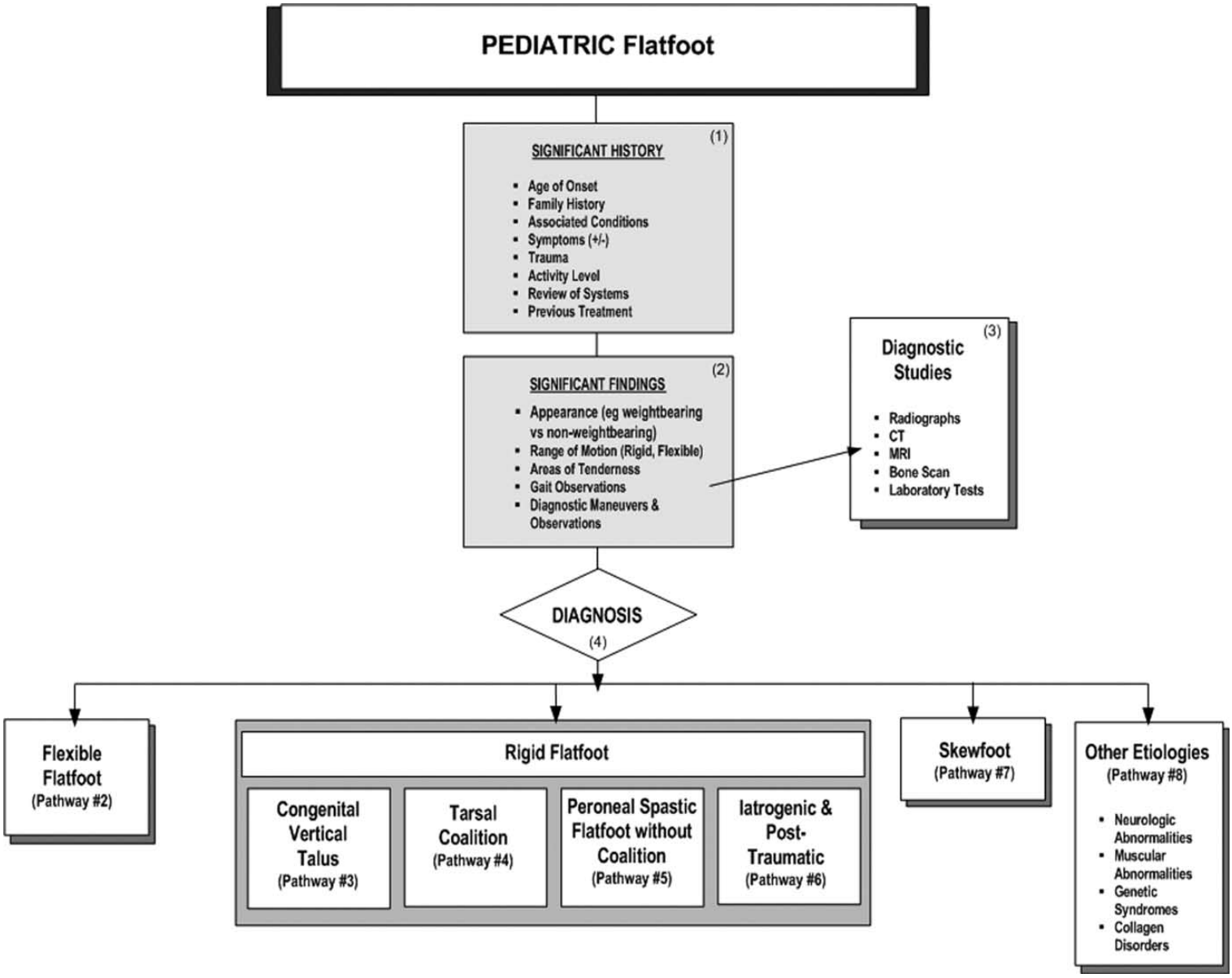
1 TREAT
2 MONITOR
3 LEAVE ALONE

Observe	L	R	Assess	L	R
medial arch height (ok/reduced)			ankle range (ok/less/more)		
heel eversion (ok/ more everted)			forefoot / rearfoot (var/val/nil)		
talar prominence (y/n)			local tenderness (y/n – site)		
lesions (y/n – site)			gait – barefoot & shoes (ab/add, limp)		
Also consider...					
heel inversion with tip toe			tibial, knee positions		
windlass effect			tibial, femoral torsions vs positions		
obesity			muscle tone, ligament laxity		
os tibiale externum					
To assist clinical recording...					
Best available clinical measures of structural form *Evans et al, JAPMA 93(3): 203-213, 2003*					
RCSP (°inv/ev)			FPI-6: TNJ congruence		
Navicular height (mm)			FPI-6: MLA height		
Ages 4-6 FPI-6: calcaneal position			*Ages 8-14* forefoot/rearfoot position (°inv/ev)		

Plan: **Date:**

To be used in conjunction with: Diagnosis & treatment of pediatric flatfoot. Harris EJ et al, *J Foot & Ankle Surg* 43(6): 341-370, 2004. Clinical pathway © Angela M. Evans PhD, 2007.

Scheme 4.1 The paediatric flatfoot clinical-care pathway (FFP)



Scheme 4.2. Diagnosis and Treatment of Pediatric Flatfoot. Adapted from: Clinical Practice Guideline Pediatric Flatfoot Panel: Edwin J. Harris. The journal of foot and Ankle surgery. 2004

This algorithm emphasizes the diagnosis of pediatric flatfoot in a broader context of significant history and findings. The designated subtypes of flatfoot refine diagnosis and are the foundation of the model directing treatment as developed herein (1).

Classification of Flatfeet:

- Flexible Flatfoot
  - Symptomatic
    - Asymptomatic
      - Developmental (decreases with the years)
        - Non-development (progress with the years)

- Rigidus flatfoot
  - Vertical talus
  - Tarsal coalition
  - Peroneal spasticity
  - Iatrogenic
  - Traumatic Flafoot

- Skewfoot: Metatarsus adductus

- Other Etiologies

1. Flexible Flatfoot

There is not an universal definition for this kind of foot, but Flexible Flatfoot is the term to describe a weight-bearing foot shape where the hindfoot is in valgus alignment, the midfoot sags in a plantar direction with reversal of the longitudinal arch and the forefoot is supinated in relation to the hindfoot and that moreover has the mobility of the subtalar joint and the longitudinal arch, this means that there is possible to reverse those alignments. Despite descriptions, the flexible flatfoot is poorly understood but common, rarely painful and even more rarely disabling. We need to be careful and not automatically consider someone whose stature is bellow the fifth percentile as pathologic without more

information. We need to considerate the etiology of the flatfoot and relationship between the bones and expectation of future pain or disability.

The tipic flexible flat foot is the most common presentation for clinical pediatric flatfoot. Once we diagnose this kind of foot in children, to treat accurately it is important to make subdivisions based on symptoms and morphological development. This approach three subtypes of flexible flatfoot and consistent treatment arise.

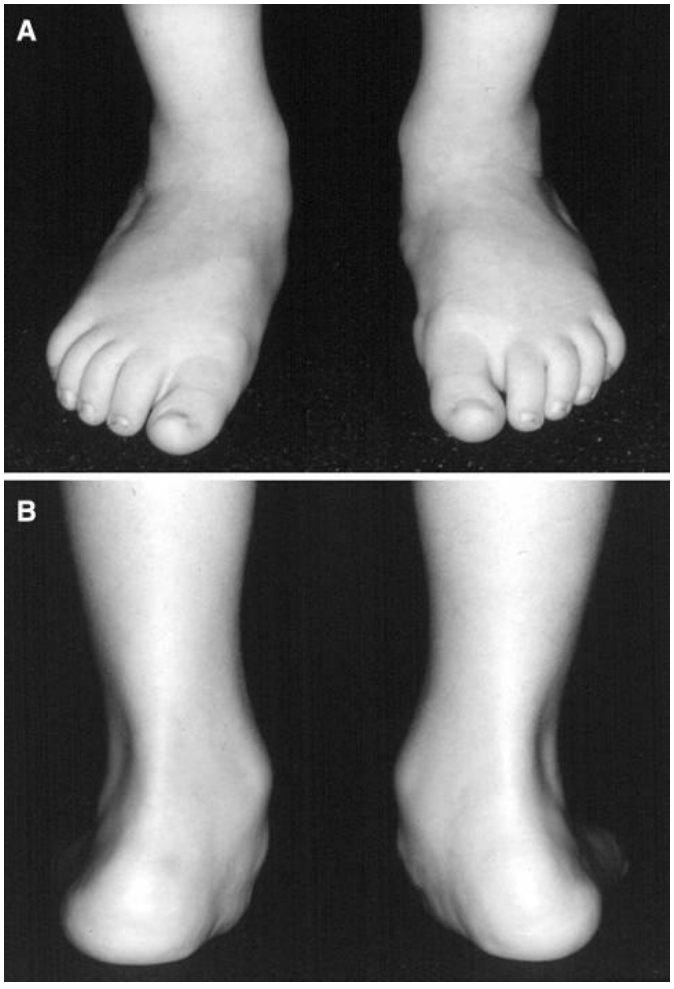


Figure 4.2 Flexible flatfeet, a) Convex medial border with midfoot sag. b) Valgus hindfoot (source: http://www-ncbi-nlm-nih-gov.sire.ub.edu/pmc/articles/PMC2839866/)

1.1 Symptomatic flat foot: the patient with painful flexible flat foot that needs to be treated to relieve symptoms, with footwear, stretching, or orthotics. The efficacy of this treatment can be measured using an individual index for patient. In a symptomatic flatfoot, there is also a contracture of the gastrocnemius or the Achilles tendon. The clinical features that we can observe are a straight or even convex medial border of the foot. The midfoot sags and touches the ground the

ground in weight bearing. The foot appears externally rotated in relation with the leg and the hindfoot is in valgus alignment. The flexibility of the flatfoot refers to the motion of the subtalar joint complex. The subtalar joint will invert to neutral and a longitudinal arch can also be demonstrated by toe-standing and by dorsiflexion of the great toe (toe raising test)

1.2 Asymptomatic Non-developmental flat foot: not corrected with the development of the child is monitored over time to determine if the morphological characteristics deteriorate. This type may be (shoes, stretching, or brace) and must use an index generated by the patient to justify any intervention.

1.3 Asymptomatic Developmental flat foot: This flat foot will decrease with the years. Has not further problems and its recommended to give general advice about foot health.

2. Rigid Flatfoot

It's very rare, used to be recognized as spasmodic flatfoot. The cause of the peroneal spasm is attributed to an irritative lesion of the subtalar joint, such as an intra-articular calcaneal fracture, rheumatoid or infective arthropathy or tumor. It is clear that many of these feet become rigid and painful because a tarsal coalition is present.

2.1 Flatfoot associated to Congenital Vertical Talus

To differentiating features of this deformity we should check the rigidity and the fact that the hindfoot is held in equinus, producing a "vertical" talus. The forefoot is dorsiflexed and the talonavicular joint is dislocated, with the navicular lying dorsal to the head of the talus. The severity of the deformity can be gauged by both the lateral, "Eyre-Brook" radiograph and the degree of calcaneocuboid separation. The more this midfoot breaks, the more fixed will be the talar head. The medial arch appears convex because of the prominence of the head of the talus and the ankle and subtalar joints are rigid because of calf muscle contracture.

2.2 Flatfoot due to Tarsal Coalition Tarsal coalition is a congenital anomaly, with variable levels of union between two of the tarsal bones. This results in rigidity of motion in the foot in the Plano valgus position. The clinical syndrome has been referred to as the “peroneal spastic flatfoot.” True spasticity of the peroneal musculature is not a causative factor, nor is it probably even a result of the coalition. Rather, lateral joint pain from restricted joint articulation is seen on examination with attempts to move the subtalar joint through its range of normal motion, especially inversion. (12) The cause of tarsal coalition is assumed to be a lack of differentiation of mesenchymal tissue, with subsequent failure of formation of the normal joint. Confirmation of this hypothesis is difficult, but is supported by the finding of intertarsal bridges in fetal tissue. (13)

2.3 Peroneal spasticity It’s a type of rigid flatfoot which is accompanied by contraction of the peroneal muscles. The etiology is not clear. Correction of the deformity seems to be prevented by tension of the peroneal muscles, and there has been wide acceptance of the thesis that the deformity is caused by peroneal muscle spasm induced by painful stimuli arising from the tarsal joints. It has been assumed that these stimuli result from abnormal stresses thrown upon the tarsal joints by severe degrees of weak flat foot. The concept, therefore, has been that of a weak flat foot which originally was flexible but which was transformed later into a rigid flat foot by the development of peroneal spasm.

2.4 Iatrogenic Flat foot Due to excess surgical interventions

2.5 Traumatic Flat foot as a calcaneal fracture that inverse the angle and produces collapse of the plantar arch. Scaphoid dislocation also produces a shortening of the arch. Depends of the prognostic it will be necessary to treat with surgical intervention.

3. Skewfoot

Young children with persistent and rigid forefoot adductus deformity sometimes present with a pain and callus formation at the base of the fifth metatarsal or the medial side of the hallux. Parents could report that children don't like to stand in their shoes, not having clear the reason.

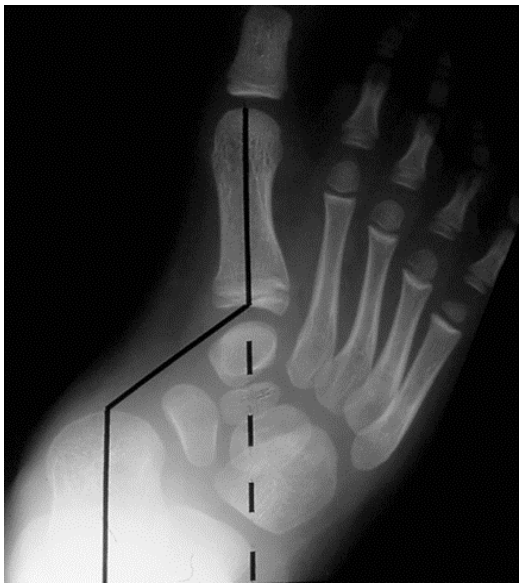


Figure 4.3. AP radiograph of the foot demonstrating skewfoot deformity. This deformity is characterized by translation of the parallel axes of the talus (solid line) and first metatarsal (dashed line) and results in forefoot adductus and hindfoot valgus. (Source:http://www.jaaos.org/content/22/10/623.short)

Valgus deformity in the hindfoot can be better appreciated in older children or adolescents and adults. In these older individuals, the hindfoot has ussually become to the typical deformity seen in a flatfoot with full eversion of the subtalar joint and lose of the longitudinal arch with a midfoot sag. There is now concordance in the clinical appearance of the foot in the frontal and sagital planes. Shortening of the tendo-Achilles is noted mostly in the older child with symptomatic skewfoot. Their symptoms are identical to those seen in individuals with flexible flatfoot with short tendo-Achilles, ocasionally impingement pain in the sinus tarsi region. It will be very important the clinical examination of the hips of a child with an aparent skewfoot because of the incidence of congenital hip dysplasia in children with metatarsus adductus. (20)

4. Other kinds of flat foot due to:

Neurologic Abnormalitites: Patients with cerebral palsy, syndromes, myopathies, and other forms of neurological impairment can develop Plano-valgus foot deformity of variable degrees of severity. Several techniques have already been described to resolve the deformity with variable results. Talonavicular arthrodesis is a well-known technique in adult patients, but to our knowledge (5)

Muscular abnormalities: The clinical features which distinguish a flat foot due to muscular dystrophy or atrophy can be a prolonged history of some degree of foot disability extending during the childhood, the degree of disability tending to increase. There is often a hereditary tendency.

Flat-foot deformity which is mobile. It disappears when the feet are freed of weight-bearing, and appears when the patient stands. It can be corrected by muscular effort. Other signs we can find are a short Achilles tendon, which limits dorsiflexion at the ankle joint, hypermobility of the mid-tarsal and subtalar joints. This often results in instability of the feet during the childhood **(6, 7, 8).**

Genetic syndromes: In a Study with 50 children with Down syndrome (DS) was found that the 50% of the patients had Flafoot. Physical examination of the lower extremities showed the presence of bony deformities of the forefoot in 90% of DS children. Another study of podiatric problems among children with DS showed several clinical conditions such as pes planus feet, split toenails, fissures and abnormal pressure sites(9) . In case of Marfan syndrome the problems of those patients severe flat feet, foot pain, weakness of foot/ankle mechanics, significant calluses, bunions, toe deformities. In this cases orthotic treatment does not change growth of foot or create higher arches, it will be useful thought if pain is present. Custom-made soft orthotics may be needed to assure the proper fit essential for effective treatment. Surgery is indicated only if foot deformities and pain do not respond to conservative treatment. There is no proven success using artificial ankles or toe joints in the management of Marfan feet according to the Marfan Foundation studies.(10)

Collagen disorders:

Pes planus is a frequent abnormality in the Ehlers Danlos Syndrome (EDS).During childhood, the longitudinal arch frequently appears to be normal when no weight is being borne. The most severe flat feet usually give no pain, and difficulty in fitting shoes is the main problem. The implications of foot pan disability in the EDS upon daily life activities have been reviewed by Berglund et al(11)

Treatments

There are many treatments that have proved to be effective controlling the pronation forces of children flatfoot. The purpose of the orthotic treatment through the ground reactive forces (FRS) and muscle moments are:

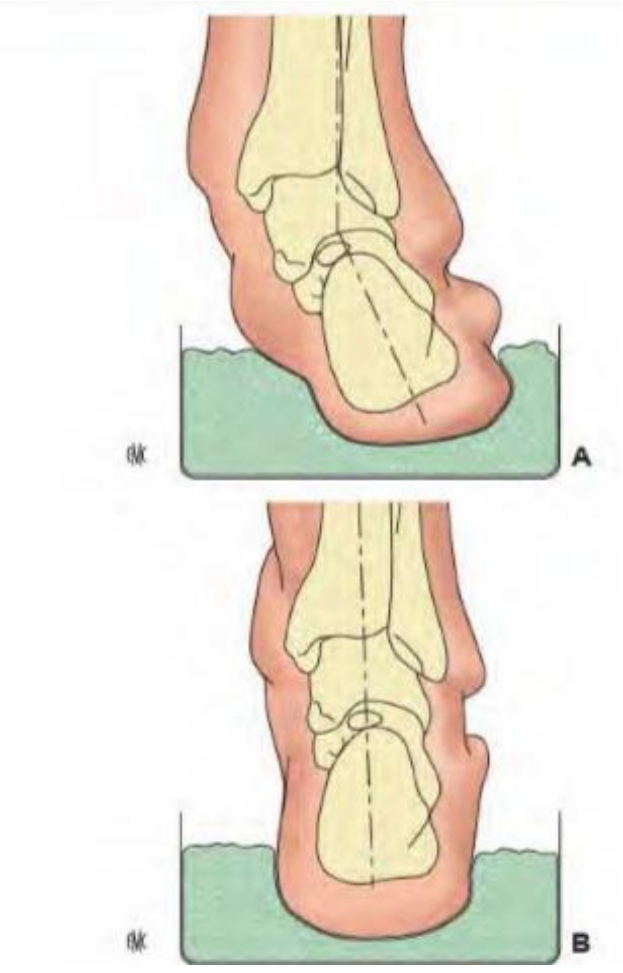
First of all, to modify the axis position of rotation of the subtalar joint (STJA) placing the shaft in the first intermetatarsal space. To decrease the magnitude of the pronation moment. We need as well to slow down the speed of the pronation movement .Should create a balance of forces between pronator and supinator moment through the plantar orthotics to reduce the tensile forces and plantar fascia ligament on the inner column.

I found as well, some articles where the Mulligan concept is included as a treatment for pediatric flatfoot. This is a technique that corrects positional errors. In the musculoskeletal system dealing with flat foot is used as reference the valgus hind foot which is corrected by forced variation using taping and exercises.

The Results of one study made in a school based in the Mulligan concept (15) showed improvement in short term of the arch and reduction of pain associated with flat feet. The Mulligan concept strengthens the foot ligaments improving and increasing the plantar arch and therefore reduce the valgus hind foot.

The correction of the deformity is a controversial issue on which there is consensus and justifies the development of research in this area. Many authors argue that flat feet in young children is a physiological phenomenon that is corrected with age (4), which in most cases resolves spontaneously and does not determine a greater incidence of pain and functional limitation, with respect to those who have defined their longitudinal arch , recommending avoid using orthotic devices.

Figure 4.4 a.normal position b.neutral position



5 MATERIAL AND METHODS

5.1 The studies included in this bibliographic review examine the association between pes planus in children and the ideal treatment for those cases and were obtained from English, Korean, Iranian and Spanish language peer-reviewed scientific journals. The articles with surgical interventions as a treatment were eligible for inclusion provided that it's a valid treatment that can be applied to children with pes planus syndrome as well. Studies included were from 2006 to 2015 to ensure up-to-date results. Articles published before 2006 were not included in the review, but in the introduction of my bibliographic study. Patient case studies between 3-14 years and adolescents up to 17 years old were used.

Studies that examined pes planus in adults and the influence of pes planus in adult or biological foot structures were not included. Studies focused on paediatric pes planus in children younger than three years were not included.

For the comparative review I made a table for a better understanding of the different articles included in this project. Those were prospective studies with a specific number of cases and I separate them by making the Follow structure: Tittle, Author, Year, Age, Number of cases, findings and results.

I made it this way so I can classified them later by the age of the clinics cases and the kind of treatment to divide it into groups and make a better analysis and comparative.

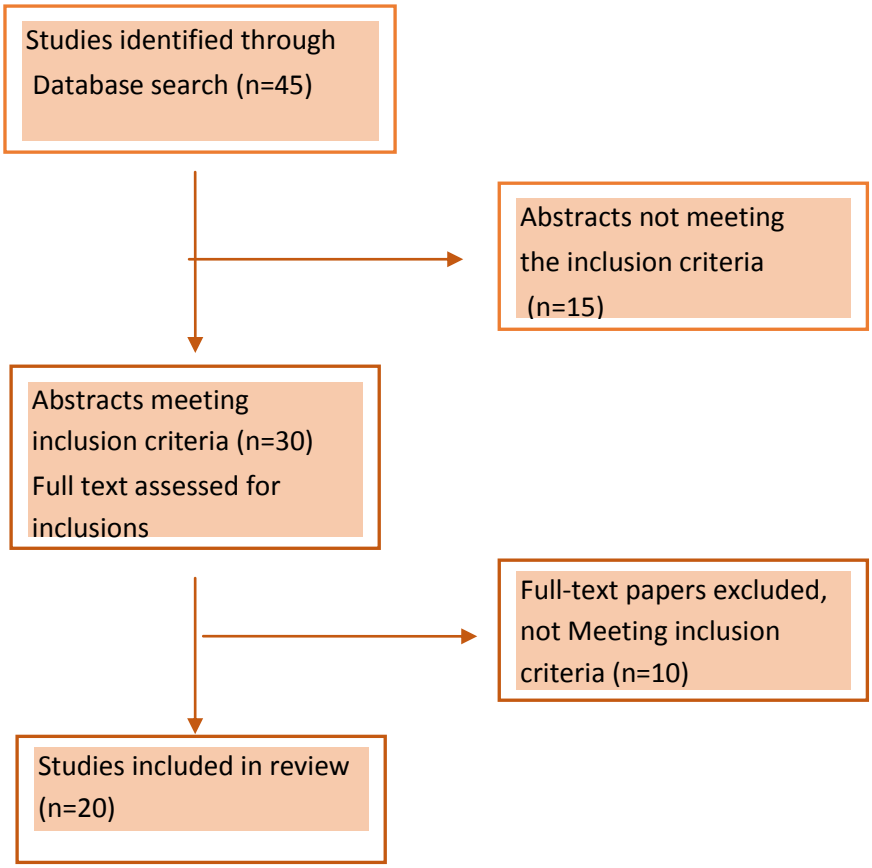
5.2 Keywords: Flatfoot, Children, Diagnosis, Treatment, Orthotics.

5.3 Inclusion and exclusion criteria:

The studies included in this bibliographic review examined the association between pes planus in children and the ideal treatment for those cases and were obtained from English, Korean, Iranian and Spanish language peer-reviewed scientific journals. The articles with surgical interventions as a treatment were eligible for inclusion provided that it's a valid treatment that can be applied to children with pes planus syndrome as well. Studies year range included were from 2006 to 2015 for an updated review. Were included articles which had cases aged between 3 and 14 years and adolescents till 17 years old.

In this review were not included studies that examined pes planus in adults, the influence of pes planus in adult or biological foot structures. Studies focused on paediatric pes planus in children less than 3 years of age, were not included. Articles published before 2006 were not included in the review, but in the introduction of my bibliographic study.

6 RESULTS



45 studies were found with the selected keywords, of which 25 were excluded after reading because they didn't meet the selection criteria. Of the 20 remaining studies, 12 were of conservative treatments for Pes planus, 2 of surgical treatments and 6 were articles related to factors that would potentially be useful as a part of a treatment.

We classified the treatments listed in the studies as surgical or conservative. The table below shows the results of the different treatments. The studies

showed that surgical interventions like talonavicular arthrodesis for neurological flat feet or subtalar implant Maxwell-Brancheau that it's a preferred intervention for painful paediatric flat feet showed a very high percentage of excellent results, although they are used in a few cases for specific patients. On the other hand, it has to highlight the main results obtained by using conservative treatments. However, Martin Pfeiffer's study shows the effect of orthotics in children from 3 to 6 years old and found that more than 90% of children had not needed treatment.

Deirdre's study found no evidence to justify the use of in-shoe orthoses in the management of flexible flat feet in children. The studies showed that not all treatments associated with orthotics produce a clear improvement.

Only one of the articles was against the use of orthoses as a treatment for flexible flat foot, reasoning that they could cause rigidity in flexible flat feet (25).

Two studies showed alternative conservative treatments that gave good results; a combination of physiotherapy with orthotic insoles and the Mulligan Method - a taping system that helps to increase the foot's medial arch.

In five articles included in this review, the authors suggested an increased prevalence of pes planus associated with more weight. One study highlighted the importance of controlling body weight, physical activity, and the duration of foot orthotics' wedging to reduce complications and the consequences of flat-feet. (30) However, the relationship between a child's body weight and pes planus (and the associated effects on pain and function) are inconclusive.

Tittle	Author	Year	Age	Number of patients	Results and Findings
Effects of Custom-Made Rigid Foot Orthosis on Pes Planus in Children Over 6 Years Old	Soo-Kyung Bok, Bong-Ok Kim, Jun-Ho Lim, So-Young Ahn	2014	average age 10.3 years	39 children diagnosed with flexible flat foot	This study revealed that radiological indicators improved significantly after 24 months of custom-made rigid foot orthosis application wich means that a prospective long-term controlled study with radiographical evaluation is necessary to confirm the therapeutic effects of rigid foot orthosis and to determine the optimal duration of wear in children with pes planus, which encourage to treat with Orthoses.
Prevalence of flat feet in preschoolers	Martin Pfeiffer, Rainer Kotz,Thomas Ledl,Gertru e Hauser and Maria Sluga.	2006	3-6 years	948 children	In this article they found that the prevalence of flat foot is influenced by three factors: age, sex and body weight. Significant prevalence of feet flat on overweight children and boys; moreover, developmental delay was discovered arch internal in men. At the time of the study, more 90 % of children had received treatment needlessly.
Flatfoot in school-age children: prevalence and associated factors	Sadeghi-Demneh E, Jafarian F, Melvin JM, Azadinia, Shamsi, Jafarpishe	2015	Average age, 10 years	114 children flatfooted from 667 children studied	The prevalence of flatfoot in this study was 17.1% in the population studied. There was no gender difference but the prevalence of flatfoot did decrease with age. The significant differences were observed in the prevalence of flatfoot between normal-weight, overweight, and obese groups; more overweight participants had flatter feet. In conclusion, they demostrated that development of the longitudinal plantar arch in school-age children is influenced by age and weight. Age and weight were the primary predictive factors of flatfoot.
Diagnosis of Flexible Flatfoot in Children : A Clinical Systematic Approach	Maria Grazia Benedetti, Francesco Ceccarelli, Lisa Berti, Deianira Luciani, Fabio Catani, Marco Boschi and Sandro Giannini.	2011	10-14 years	53 children (21 girls, 32 boys)	Symptoms and functional limitations are often present in children with flexible flatfoot and must be correctly diagnosed to classify it. High BMI and female sex are often related to symptoms of flexible flatfoot. In this study they found that objective clinical measurements, heel valgus and ankle–foot ROM, are necessary to quantify deformities and possibly to assess outcomes after treatment. The treatment for FFF management should be based on symptoms, functional limitation, and foot dysfunction. Also was found that points of maximum pain in the patients with symptoms were mostly in fascia and distal insertion of the posterior tibial tendon and there was a general decreased ability to balance on one foot.

Tittle	Authors	Year	Age	Number of patients	Results and Findings
A Randomized Controlled Trial of Two Types of In-Shoe Orthoses in Children with Flexible Excess Pronation of the Feet	Deirdre Whitford, Adrian Esterman.	2007	7-11 years	178 children	Statistical modeling demonstrated that although for most outcome measures there were statistically significant trends over time, none of the groups they made (including a control grup) had significant changes. A sub-group analysis of those presenting with pain found no significant differences at 3 or 12 months. This study found no evidence to justify the use of in-shoe orthoses in the management of flexible excess foot pronation in children.
Talonavicular Arthrodesis for the Treatment of Neurological Flat Foot Deformity in Pediatric Patients	Geraldo de Coulon, Katia Turcot, Federico Canavese, Romain Dayer, Andre Kaelin and Dimitri Ceroni.	2011	11.3± 2.6 years	18 neurological patients (10 boys, 8 girls)	In this study, the talonavicular fusion completely corrected the deformity, whereas subtalar and calcaneocuboid fusions failed. The talonavicular arthrodesis seemed to be a good therapeutic option to stabilize severe flat foot deformities in neurological patients. They mentioned as well that the main limitation of talonavicular arthrodesis in series cases was observed for patients with severe flat foot that was not passively reducible.
Predictive factors for flatfoot: The role of age and footwear in children in urban and rural communities in South West Nigeria	Temlola Abolarin , Ayola Aiyegbusi, Abidemi Tella, Sunday Akinbo	2011	6-12 years	560 children	This study made a comparison of the prevalence of flatfoot by age group indicated a significant difference at age 10 years and showed that age was a significant ($p < 0.05$) predictor for flat foot while the type of footwear was not. In this study, age is the primary predictor for flatfoot while the type of footwear is not. No treatment was needed.
Resultados del tratamiento quirúrgico del pie plano valgo en la infancia	O. Faour Martín, E. Navarro Nuñez	2009	8–10 years media	55 feet	In cases where conservative treatment is not effective there is the possibility of surgical treatment to prevent the introduction into adulthood of a flat foot pain. This article says that after the colocation of subtalar implant Maxwell-Brancheau, there is an increase of the arch height and this produce spontaneous tension in the posterior tibial tendon and plantar ligament scaphoid but the most beneficial effect they found was that with subtalar implant placement there is a re-establishment of a correct relationship between the Astragalus and calcaneus bone and maintenance of normal physiology between them, long enough to develop a normal growth of both bones in pre-skeletal maturity stages.

Tittle	Authors	Year	Age	Number of patients	Results and Findings
The Effect of Foot Orthotics on Arch Height: Prediction of Arch Height Correction in Flat-foot Children	Jolanta Pauk, Valeriy Ezerskiy	2011	7-15 years	60 flat-footed children(50 girls and 70 boys)	This study suggests a simple model to estimate the arch height correction in flatfooted children without using any sophisticated technology. Their model suggests that the arch height correction is increased by age and place of living, and decreases as body mass increases. They also suggest a link between higher body mass and increased flattening of the arch of the foot during walking. This information is important to reduce the consequences of flat-feet complication via controlling body-weight, physical activity, and the time of foot orthotics wedging.
Evaluación del tratamiento ortopodológico en el pie plano flexible en niños de tres a cinco años de edad	Verónica Padilla Urrea	2011	3-5 years	90 children	This study focus in the quantification of the correction degree, by means of the radio direction finding, in children of 3 to 5 years diagnosed flat standing up flexible, exposed to three different options of treatment within a prospective study during a year.
Prevalencia de pie plano en niños de 3 a 11 años, en la escuela de deportes	Quisbert Bustamante, Amparo Soledad	2006	9-12 Years		This study wanted to prove that the treatment with orthoses in flexible flatfeet modifies the goniometry of the foot. They evaluated the clinical and radiographic changes of the flatfoot and compared the efficacy of the diferents kinds of orthoses in children diagnosed with flexible flafoot and find out if there is a correlation between clinical and radiological methods in the diagnosis and severity of flexible flatfoot. Study inconclusive.
Eficacia del concepto Mulligan para corregir el pie plano en niños.	Villalva Borja, Ligia Priscila	2014	7-12 years	60 boys and girls	The 95% of the experimental group (31) which applied the taping and exercises according to Mulligan concept got an increase of the arch, therefore decreased significantly modifying the articular anatomical structures. The control group (29) which had to do exercise only once a day had a 5% improvement. The characteristic of the research approach was qualitative predominant character using a quantitative approach.

Tittle	Authors	Year	Age	Number of patients	Results and findings
Efectividad del abordaje fisioterápico global a través del método G.D.S. en el pie plano flexible infantil	Ruth Ballestero Pérez.	2010	3-5 years	12 children	The article says orthoses effectiveness are not clear. Because of being cause and consequence of biomechanics alteration, they suggest the use of a method based in by muscle strenght and orthotic treatment to balance all body segments and to improve biomechanical and psychomotor aspects in the child. Treatment with Flexible flatfoot with physiotherapy approach and orthoses is more effective than isolated orthopedic treatment. The study is inconclusive.
The Paediatric flat foot and general anthropometry in 140 Australian school children aged 7 - 10 years	Angela M. Evans	2011	7-10 years	30 children	The results of this study, in contrast to many others, question the association of flat feet and heavy children. A significant relationship between foot posture and weight was identified, but was both weak and inverse. This study presents results which conflict with those of many previous investigations addressing the relationship between children's weight and foot posture. The implication of these results is that heavy children have less flat feet.
Prevalence of flexible flatfoot in Taiwanese school-aged children in relation to obesity, gender, and age	Jen-Huei Chang & Sheng-Hao Wang & Chun-Lin Kuo & Hsian Chung Shen & Ya-Wen Hong & Leou-Chyr Lin	2010	7-12 years	2083 children	The prevalence of flatfoot in children aged 7 and 8 years was significantly higher than in all other age groups. There was an obvious pattern of decreasing flatfootedness with age. Males were significantly more likely to have flatfoot than females. Overweight and obesity were also significant independent predictors of flatfoot. Underweight children had lower odds of having flatfoot when compared with children with normal body weight .
The relationship between paediatric foot posture and body mass – do heavier kids really have flatter feet.	Angela Evans	2013	under 14 years	698 children	This study does not find a positive correlation between increased BMI and flat feet in children. Clinically, these findings question the need for concern about children's BMI as a specific influence on (flatter) foot posture, and also the validity of footprint based measures.

Tittle	Authors	Year	Age	Number of patients	Results and Findings
Rehabilitative treatment in flexible flatfoot, a perspective cohort study	Riccio Ilaria, Gimigliano Francesca, Gimigliano Raffaele, Porpora Giovanni, Iolascon Giovanni.	2009	3.4 years media	300 children bilateral flexible flatfoot	In comparison with orthotic treatment, the rehabilitative approach produces better results in the maintenance of foot flexibility. In their opinion, treatment with orthosis and orthopaedic footwear is no longer opportune. According to recent publications, orthotic treatment might even be dangerous, because it can cause rigidity in a flexible foot. They think that a flexible flatfoot plays a protective role in avoiding not only pain, but also functional alteration and stress fractures. The limitation of their study was that we have no data about children's adherence to the treatment apart from what referred from their mothers.
An investigacion of the factors affecting flatfoot in children with delayed motor development	Kun-Chung Chen, Li-Chen Tung, Chien-Hung Tung, Chih-Jung Yeh, Jeng-Feng Yang, Chun-Hou Wang	2014	3-6 years	121 children diagnosed with delayed motor development male: 81; female: 40)	The results of this study showed that the prevalence of flatfoot in children with motor developmental delay was higher than that in normal developmental children, approximately 58.7%, and that it decreased with age from 62.8% of 3-year-olds to 50.0% of 6-year-olds. The results also showed that motor-developmentally delayed children with flatfoot are at about 1.5 times the risk of normal developmental children. In addition, the prevalence of flatfoot is relatively higher in overweight children with delayed motor development, and that in obese children is even as high as 95.8% (23/24). Children with both excessive joint laxity and delayed development are more likely to suffer from flatfoot. It was found that the prevalence of flatfoot in preschool-aged children with delayed motor development is higher because their foot development is slower than that of normal children and that boys are more likely than girls of the same age to suffer from flatfoot. The prevalence of flatfoot is also higher in overweight children than in normal or underweight children. In addition, children with excessive joint laxity are more likely to suffer from flatfoot. Flatfoot at the preschool stage may affect their future balance in movement. Therefore, if the foot issues of children can be discovered as early as possible, the lower limb balance of children with delayed motor development can be improved, and the deformation of the foot structure and resultant pain can be prevented.

Tittle	Authors	Year	Age	Number of Patients	Results and Findings
Flatfoot in children and adolescents. Analysis of imaging findings and therapeutic implications	C. Bourdet, R. Seringe, C. Adamsbaum, C. Glorion' P. Wicart	2013	7-17 years	35 patients Bilateral neuropatic flatfeet	This original classification system provides therapeutic guidance by helping to match the surgical procedure to the nature and location of the deformities. They used of 3D weight-bearing imaging systems which probably allow further refinements to their analysis and constitutes a promising avenue of research. identified four patterns of PPV: subtalar pes planus (*n* = 16) with marked subtalar valgus and longitudinal sag predominating at the talonavicular joint, midtarsal pes planus (*n* = 12) without subtalar valgus but with marked midtarsal abduction and sag predominating at the cuneonavicular joint, mixed pes planus (*n* = 28) with subtalar valgus, midtarsal abduction, and sag at both the talonavicular and cuneonavicular joints, and pes planocavus (*n* = 9) with sag of the medial arch and cavus deformity of the lateral arch.
Lower extremity kinematics in children with and without flexible flatfoot: a comparative study.	Yi-Fen Shih, Chao-Yin Chen, Wen-Yin Chen, and Hsiu-Chen Lin	2012	9-10 years	30 children 20 flat foot 10 normal foot.	Although children with flexible flatfoot demonstrated a larger calcaneal eversion while standing, no kinematic adaptation during walking was noted in the flexible flatfoot group. More evidence is needed before any clinical implication could be drawn. We suggested that future research should recruit more subjects and take the influence of the mid-foot and forefoot into consideration when examining lower extremity kinematics in children with flexible flatfoot.

7 DISCUSSION

What I've seen during the research of studies looking for pediatric flatfoot treatment is that, there is a need for a directive clinical framework. In many ways it is confused due to different classifications and despite they have well intended preventions there are not common treatments for this syndrome (31).

In the study where they compare possible factors of prevalence of flatfoot (38), showed that age was a significant predictor for flatfoot while the type of footwear was not. In this study, age is the primary predictor for flatfoot, but not the same happens with the study about flatfoot and general anthropometry, with scholars between 7 and 10, where, in contrast to many others, question the association of flat feet and heavy children. A significant relationship between foot posture and weight was identified, but was both weak and inverse. (16) The overweight has a strong impact in a child's health and quality of life, including musculoskeletal complaints. Pes planus hasn't being previously recognized as a concern in children with overweight and obesity as it has in adults. (18) A thorough review of the literature has identified that increasing weight does appear to increase prevalence of pes planus at age of 8 was significantly higher than in other age, but because of differing populations, methodologies and objectives, there is still no clear association. Complications arising from pes planus in obese children, such as pain and limitations in activity, have also not been explored enough. Further investigation into these issues is needed, utilizing longitudinal designs and consistent diagnostic methodologies. However, clinicians should be aware of this association and the potential of flatfeet impacting a child's mobility and well-being (47)

About the use of orthoses, there was only one article from the bibliographic review that pointed the treatment with orthosis and orthopaedic footwear no longer opportune, even more, in their opinion according to recent publications, orthotic treatment might even be dangerous, because it can cause rigidity in a flexible foot. They think that a flexible flatfoot plays a protective role in avoiding not only pain, but also functional alteration and stress fractures (25). The limitation of their study was that they don't have enough data about children's adherence to the treatment apart from what referred from their mothers. So their

study supports that treatment with orthosis is less effective than rehabilitation therapy. In comparison with orthotic treatment, the rehabilitative approach produces better results in the maintenance of foot flexibility.

To make a contrast of results, in the study of effects of custom-made foot orthosis in children over 6 years old, (41) this study revealed that radiological indicators improved significantly after 24 months of custom-made rigid foot orthosis application wich means that a prospective long-term controlled study with radiographical evaluation is necessary to confirm the therapeutic effects of rigid foot orthosis and to determine the optimal duration of wear in children with pes planus, which encourage to treat with orthoses. In this study the control target of the inverted technique is the medial side of the calcaneus, there initially seems to be a change in the hind foot, which is the position of the sagittal and frontal planes of the calcaneus. However, if the foot orthoses are used for more than 24 months, there could be a change in the position of the transverse plane and the sagittal plane of the talus. The more talar inclination is increased, the more there seems to be development of the medial longitudinal arch because of midfoot molding. In reviewing articles regarding flat foot from 1980 to 2012, only three studies had control groups: Whitford and Esterman, Gould, and Wenger et al.(41)

Consistently, flat foot has been found to normally reduce with age. Usual assessment methods are footprint measures, X-rays and visual (scaled) observations. There is not standardized framework from wich to evaluate the pediatric flat foot, so is often unnecessarily treated, being ill-defined and of uncertain prognosis. Customized foot orthoses should be reserved for children with foot pain and arthritis, for unusual morphology, or unresponsive cases. Surgery is rarely indicated for pediatric flat foot (unless rigid) and only at the failure of conservative management. The assessment of the pediatric flatfoot needs to be considered with reference to the epidemiological findings, where there is consensus that pediatric flexible flatfoot reduces with age and that most children are asymptomatic. (31)

The following study about prevalence of flat feet in preschoolers, showed that the prevalence of flat foot is influenced by three factors: age, sex and body weight. Significant prevalence of flat feet on overweight children and boys; moreover, developmental delay was discovered arch internal in men. At the time of the study, more 90 % of children had received treatment needlessly.

This study add a new factor of prevalence, wich is the sex. There are still very few recent articles that add sex as a factor of flatfeet, other articles showed that there was no gender difference but the prevalence of flatfoot did decrease with age. The significant differences were observed in the prevalence of flatfoot between normal-weight, overweight, and obese groups; more overweight participants had flatter feet. They demostrated that development of the longitudinal plantar arch in school-age children is influenced by age and weight. Many of this articles have different ways to diagnose wich makes difficult a proper comparison, it is necessary a common guidelines. The existence of guidelines is not new for the management of pediatric flatfoot and they have most recently been modified and appended to by Harris (1) Pediatric Flatfoot Guidelines developed clinical-care pathways for the diagnosis and treatment of pediatric flatfoot. These guidelines sensibly approach the pediatric flatfoot presentation from the broader context of significant history and findings before reaching a structured diagnosis and treatment. (16) The taking of a thorough and structured history is very important in all clinical situations. In the case of pediatric flatfoot, significant findings may include age, family history, associations like ligament laxity or hypotonia increases joint compensation, or even symptoms, trauma - altered structures may alter foot function, activity, systems review like cerebral palsy, muscular dystrophies, and atrophies, and about the treatment: taking care if has this been previously implemented, was it successful, and if is still required. The focus of these guidelines is rightly centered on an accurate diagnosis. I think that there is insufficient attention given to the other flatfeet subtypes, due to the research I made because the most recent studies focus in flexible flatfeet or surgical interventions for rigid flatfeet.

In cases where conservative treatment is not effective there is the possibility of surgical treatment to prevent the introduction into adulthood of a flat foot pain. (22) One of the articles included in the review says that after the colocation of subtalar implant Maxwell-Brancheau, there is an increase of the arch height and this produce spontaneous tension in the posterior tibial tendon and plantar ligament scaphoid but the most beneficial effect they found was that with subtalar implant placement there is a re-establishment of a correct relationship between the Astragalus and calcaneus bone and maintenance of normal physiology between them, long enough to develop a normal growth of both bones in pre-skeletal maturity stages. This would be an indication for planus valgus symptomatic flatfeet.

Some studies about the best treatment for patients with cerebral palsy, syndromes, myopathies, and other forms of neurological impairment that develop planus valgus foot deformity point the talonavicular arthrodesis as a well-known technique, but was not described before in children with neurological impairment. (5) In this study, the talonavicular fusion completely correct the deformity, whereas subtalar and calcaneocuboid fusions failed. The talonavicular arthrodesis seemed to be a good therapeutic option to stabilize severe flat foot deformities in neurological patients. They mentioned as well that the main limitation of talonavicular arthrodesis in series cases was observed for patients with severe flat foot that was not passively reducible. The main limitations of this study are the absence of a control group (as many other studies I found) treated by other surgical procedures and a relatively short follow-up.

About The alternatives treatments found in this review, when discussing Mulligan's concept related to pes planus and after reading the article with the 95% of success (15) Makes me wonder how does it work so rapidly, despite the high percentage of improvement after the cases did the Muligan exercices and taping, the study does not show a long term result wich It would be very useful to really prove if It's an effective option for treatment. An attempt at explanation about the concept should be made nevertheless (57).

A very interesting article found in this study is an investigation of the factors affecting flatfoot in children with delayed motor development, which I found very important but not many studies about it recently. (37) This study showed that the prevalence of flatfoot in children with motor developmental delay was higher than that in normal developmental children, approximately 58.7%, and that it decreased with age from 62.8% of 3-year-olds to 50.0% of 6-year-olds. The results also showed that motor-developmentally delayed children with flatfoot are at about 1.5 times the risk of normal developmental children. They make a relation of prevalence with weight as well. The sex is again a factor in this study and they found that boys are more likely than girls of the same age to suffer from flatfoot. The sex as a factor of prevalence has not being studied enough, and more investigation is needed to really take it in consideration.

The studies that talk about flatfoot at the preschool stage (38) show that may affect their future balance in movement. In addition, children with excessive joint laxity are more likely to suffer from flatfoot. Therefore, if the foot issues of children can be discovered as early as possible, the lower limb balance of children with delayed motor development can be improved, and the deformation of the foot structure and resultant pain can be prevented.

8 CONCLUSION

Flatfoot has a good established clinical term and a common diagnosis but there is a lack of consensus on the methods of its evaluation and indications for treatment and this makes the professionals choose different treatments as a prevention or a periodic control. Flexible asymptomatic flatfoot in children under the age of seven, does not need use a orthotic insoles, but periodically observation for possible symptoms or signs of deformity progression. Symptomatic forms of flexible flatfoot should be treated with activity modification, stretching exercises and orthoses. If the response is not satisfactory, surgical intervention should be considered.

The proposed guideline and protocol from Harris and A. Evans can contribute to the standardization of flatfoot management for a good assessment.

Children with flatfeet who receive a orthotic treatment for symptomatic pes planus in scholar age (from 6-7 years old) have shown slightly better results than pre-schooler children (younger than 6 years old) that get a orthotic treatment, this makes sense If we think that age is the primary predictor for flatfoot and the weight it's a factor of prevalence but it is possible to reduce the consequences of flat-feet complications via controlling body-weight, physical activity, and the time of foot orthotics wedging, this is not conclusive though. Patient's control that didn't follow any treatment (younger and older than 6 and older) reported improvement as well.

Conservative management for rigid flatfoot may be indicated if it's asymptomatic, but when nonsurgical options failed, operative interventions are warranted for painful flatfeet.

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ACKNOWLEDGEMENTS

I would like to thank Laura Pérez for becoming my Tutor for my final Degree project. Foremost for always guide me throughout the project with ideas and advice to make me do a better work.

I would also like to thank Ben Evans for giving me advice about English grammar and his help during the process of this project.

Finally, but no less important I want to thank my family and friends who gave me a lot of support during the tough moments.