Foot Orthoses for Pediatric Flexible Flatfoot: Evidence and Current Practices Among Canadian Physical Therapists

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Purpose: This study aimed to examine the evidence for flatfoot intervention in children with gross motor delay of neurological origin, and to understand how physical therapists use foot orthoses (FOs) to treat this population. Methods: Thirty-four physical therapists employed in Canadian publicly funded pediatric centers were surveyed to explore current practices and beliefs related to FOs. Results: Responses are discussed in the context of the research literature. Objective physical examination and differentiation between developmental and pathological flatfeet can help clinicians to identify suitable FO candidates, monitor foot posture over time, and evaluate treatment effectiveness. Conclusions: An evidence-informed approach to assessment and intervention has the potential to improve clinical outcomes for clients with pediatric flatfoot. (Pediatr Phys Ther 2015;27:53–59) Key words: child, developmental disorders, flatfoot/classification/physiopathology, neurological disorders, orthotics, physical therapy, survey

INTRODUCTION

Although children with flexible flatfoot and gross motor delays are commonly referred to physical therapists (PTs) for treatment, the significance of flatfoot, its relationship with gross motor proficiency, and treatment efficacy continue to be debated. Flexible flatfoot (also referred to as pes planus, pes planovalgus, calcaneovalgus, etc) is clinically typified by excessive subtalar joint pronation, flattening of the medial longitudinal arch, and valgus position of the calcaneus during weight bearing. Not all flatfoot presentations are the same. Most flat feet are pain free, flexible, developmentally common, and unlikely to require treatment. A smaller number of children, those with painful, nondevelopmental flatfoot, which accompanies underlying pathology, may benefit from intervention. Many children present with asymptomatic flatfoot and gross motor delay, with or without an accompanying neurological or developmental diagnosis. These children fall between these 2 categories, an ambiguous zone that lacks definitive indications for the treatment of foot posture. An evidence-informed understanding of this prevalent condition could assist clinicians in assessing and identifying children at risk for symptomatic flatfoot, as well as those who may benefit from foot orthoses (FOs), to avoid unnecessary or inappropriate, more invasive intervention.

An association between flatfoot and pain/disability, formed over a century ago, has persisted without substantive evidence. For children with flatfoot, treatment is often sought by parents and provided by well-intentioned health care practitioners, concerned about preventing future morbidity. Yet, flexible flatfoot is part of a normal developmental profile. Present from birth, flexible flatfoot gradually diminishes with age, though the exact incidence is unknown because of the absence of a standard definition and assessment methods. In children who are typically developing, the incidence of flatfoot varies with age, decreasing from 54% at 3 years to 24% at 6 years, with a further decrease to 17% in 6- to 12-year-old children. Physiological flatfoot is also associated with...
ligamentous laxity, obesity, and male sex.\textsuperscript{10,11} Wearing shoes at a young age,\textsuperscript{12} and family history.\textsuperscript{2} Although some individuals with flatfoot have concurrent pain and disability and do benefit from FOs,\textsuperscript{13,14} treatment of childhood flexible flatfoot has not been shown to prevent flatfoot, pain, or disability in adulthood.\textsuperscript{1,7,8,15} The significance of flexible flatfoot and its associated signs (eg, excessive pronation) during gait remains unclear.\textsuperscript{16,17}

The role of flatfoot as a cause of musculoskeletal conditions such as plantar fasciitis, patellofemoral syndrome, and low back pain is also under debate. Meta-analyses have not demonstrated that flatfoot causes patellofemoral syndrome\textsuperscript{18} or low back pain,\textsuperscript{19} or that FOs can prevent these conditions.\textsuperscript{19} Although there are numerous reports describing an association between pain and flatfoot,\textsuperscript{20} they represent primarily cross-sectional or cohort studies, incapable of demonstrating a causal link. For conditions such as flatfoot and low back pain, which occur so frequently in the population, further research is needed to demonstrate that these co-occurrences are not purely coincidental, or that some other factor is responsible for both the flatfoot and the painful condition.\textsuperscript{7} For example, in a large landmark study of army recruits, Harris and Beath\textsuperscript{21} found that a shortened Achilles tendon was associated with painful flatfoot, but not asymptomatic flatfoot.

Still, FOs are widely used to treat children with flatfoot. They are presumed to prevent excessive pronation,\textsuperscript{22} provide neuromuscular re-education and normalize body mechanics,\textsuperscript{23} alleviate symptoms and prevent deformity,\textsuperscript{18} and/or help shape the child’s developing arch.\textsuperscript{2} But, despite the widespread support and clinical use of FOs, their mechanism of action remains debatable\textsuperscript{13} and most evidence for their use is anecdotal.\textsuperscript{14} In children without underlying pathology, FOs have not been demonstrated to affect gross motor skills or pain,\textsuperscript{22} foot shape or arch development.\textsuperscript{2,7,24} A recent Cochrane review\textsuperscript{25} identified a lack of quality evidence for managing children’s flatfoot using FOs, exercise, or other conservative intervention, as assessed by arch height, gait parameters, or gross motor skills. As providing FOs is not without costs and potential harms to the child, such as lower self-esteem,\textsuperscript{7,26} consideration of the best available evidence should help clinicians to identify children who may benefit from FO intervention, as well as critically assess and monitor treatment outcomes in this population.

**Classification and Treatment of Flatfoot**

Flatfoot classification schemes have been described in the form of clinical pathways,\textsuperscript{9} and other descriptive frameworks for differential diagnosis and management.\textsuperscript{5,7,8} The term asymptomatic physiological flatfoot may be used to describe feet that are pain-free and flexible. In children without underlying disease, a foot that can be passively corrected to an anatomically neutral position, and an arch height that is reduced on weight bearing but increases upon closed chain plantar flexion characterize asymptomatic physiological flatfoot. For such children treatment is generally not warranted.\textsuperscript{5,7,8,27}

Treatment is warranted, however, for painful flatfoot.\textsuperscript{5,6} Pain is the only symptom for which the effectiveness of customized FOs is supported in children with flexible flatfoot. Foot orthoses can reduce pain in children with juvenile idiopathic arthritis,\textsuperscript{26} but for children with flatfoot who do not have any underlying pathology, pain tends to decrease over time, regardless of whether they are treated with FOs.\textsuperscript{22}

When flatfoot is associated with underlying pathology (eg, congenital vertical talus, ligamentous laxity, genetic conditions, or flatfoot because of muscle imbalance), expert opinion endorses intervention.\textsuperscript{5,7} This condition may be called pathological flatfoot; the flatfoot may be stiff, cause disability, and tend to persist over time. For these children, the primary cause of the flatfoot (eg, structural deformity) and the natural history of the underlying disease should guide treatment.\textsuperscript{9} Treatment should be simple, involving stretches, footwear, orthoses, and applied with discretion.\textsuperscript{5}

The rationale for FOs is primarily theoretical: including effects on comfort, cushioning, proprioceptive feedback, biomechanics, and bony alignment.\textsuperscript{29} Some deem FOs to be the standard of care to promote stability and functional mobility in children with hypotonia\textsuperscript{30}; others regard their use in neurological populations as scientifically unfounded.\textsuperscript{4}

The efficacy of FOs to improve function and gross motor skills in children with motor delays has not been demonstrated.\textsuperscript{30-32} Many studies lack a control group,\textsuperscript{33} or are single case studies,\textsuperscript{31,34,35} designs that preclude differentiation among the effects maturation, physical therapy treatment, and FOs. Small improvements have been observed in a few case studies\textsuperscript{31,34,35} and a small cohort study.\textsuperscript{33}

Other studies\textsuperscript{32,36} of FOs’ effects on static foot posture and gait variability report statistically significant results with unclear clinical significance. This lack of clarity arises from inadequate control of external factors such as intergroup baseline variability in the arch index,\textsuperscript{32} or absence of data describing the control group’s calcaneal posture.\textsuperscript{36}

Clearly, children with asymptomatic flexible flatfoot and gross motor delays of neurodevelopmental etiology, such as cerebral palsy, Down syndrome, or spina bifida, require judicious assessment and clinical reasoning to judge whether the flatfoot is symptomatic/pathological or asymptomatic/developmental.\textsuperscript{5,7,27} This is arguably the most challenging category of flatfoot to manage, as there is little guidance available in the literature, few objective measurement tools, and little to indicate the point at which treatment is warranted.

Therefore, the purpose of this study was to survey PTs working in pediatric settings, to explore their beliefs and practices regarding FO intervention for flexible flatfoot. Primarily, it was hoped to establish (1) how many PTs were currently using FOs for asymptomatic flatfoot;
METHODS
Participants
Publicly funded rehabilitation centers or hospitals with a children's physiotherapy department were identified through an internet search. Search terms such as “Canadian pediatric physical therapy,” “Canadian public health care centres,” “Children's hospitals in Canada,” and “Publicly funded pediatric physical therapy in Canada” were used. Twenty-five facilities in 9 provinces were contacted by phone to explain the purpose of the survey and request a contact e-mail address for a pediatric department PT. Responses were received from 21 facilities that subsequently received the study information and a link to the internet-based survey (FluidSurveys.com) via e-mail. Contacts were invited to share the study information with all PTs in their department, and participants were given 3 weeks to complete the survey. The survey was approved by the Research Ethics Board of the author's home health region.

Survey
The survey included 14 multiple-choice and free-text questions, based on the current literature, and designed to explore PTs’ use of FOs in pediatric practice. Questions explored a range of relevant topics, including therapists’ descriptions of the types of FOs used, perceptions regarding the benefits, indications, and rationale for using FOs, assessment methods, and treatment duration.

RESULTS
Respondents
Forty-six PTs from 17 facilities in 7 provinces responded, with 34 therapists from 13 facilities in 6 provinces completing the survey (Table 1). Of survey completers, 91% reported working exclusively in pediatrics, and the remaining 9% reported 25% to 99% pediatric caseloads. Fifty-six percent of respondents had PT experience of 20 years or more, 32% had 10 to 19 years, and 12% had less than 10 years.

Thirty-three of the 34 respondents reported using FOs in their practice. Of those, 56% indicated that they fabricated the FOs themselves. Of these 21% did so without involvement from other professions. Orthotists were the main profession involved in fabricating FOs for PTs who did not make their own (n = 14). Education about FO use and fabrication was reportedly obtained through in-house mentoring (44%), courses (38%), and textbooks (18%).

Description of FOs Fabricated or Recommended by PTs
Materials/Type. Of the 71% of respondents who reported using FOs that were custom-made on-site (either by the PT or another professional), 46% fabricated them from Aquaplast, and 46% were unsure of the materials used. Twelve percent of respondents used FOs that were custom-made off-site from materials such as foam, or polypropylene or other semi-rigid material. Eighteen percent used off-the-shelf FOs, all from Cascade DAFO, Inc (Ferndale, Washington).

Length of FO
The Figure illustrates how often 3 different FO lengths/designs were reportedly used, and how frequently PTs used each type. In general, longer FOs were used more often than shorter ones.

Posting. The majority (76%) of respondents reported incorporating extrinsic posting to further support the FO. Of this group, 62% posted the hindfoot, and 38% posted the forefoot. Some respondents commented that the decision to post was dependent upon the degree of correction desired, and the support provided by the shoe.

Desired Foot Joint Alignment in the FO. Respondents commented that numerous factors influence decisions about alignment, such as the child's tolerance for correction, foot flexibility, the goal of the orthotic, and the child's age and functional level. Eighty-two percent of respondents preferred to achieve a well-aligned neutral position whenever possible; 73% indicated that they would attempt to support the foot in subtalar joint neutral, whereas 11% preferred moderate calcaneovalgus.

<table>
<thead>
<tr>
<th>Province</th>
<th>Respondents (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia</td>
<td>3</td>
</tr>
<tr>
<td>Alberta</td>
<td>5</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>8</td>
</tr>
<tr>
<td>Ontario</td>
<td>12</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>4</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>1</td>
</tr>
<tr>
<td>Not stated</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. Percentage of respondents recommending full length, 3/4 length, and heel cup orthoses, and the percentage of time that each type of foot orthosis is recommended.
Accommodation of foot deformity was reportedly used by 15% when correction to neutral was not tolerated.

Indications and Rationale for Prescribing FOs: Impairments, Diagnosis, and Age

Respondents were given a list of potential reasons for recommending FOs that might be identified on physical examination, and asked to select 1 or more potential indication for FO use (Table 2). They were also provided with a list of neurological and developmental diagnoses, and asked to identify the populations for whom FOs are most often considered (Table 3). Most respondents identified more than 1 impairment indication and more than 1 population for whom FOs are typically used. Responses about the age at which FO intervention should be initiated were varied (Table 4).

Assessment and Monitoring of the Intervention’s Effectiveness

Table 5 lists items that PTs commonly observe or measure as part of the ongoing evaluation of children with FOs. Thirty-two respondents provided information about monitoring the effectiveness of the FO intervention.

Of respondents who recommend FOs in the presence of excessive pronation and calcaneovalgus (Table 2), 67% did not use a specific test to determine the presence of subtalar joint pronation and calcaneovalgus. Of those that said they used a specific test, the methods were widely varied, but generally encompassed observational assessment of weight-bearing and non–weight-bearing foot and lower extremity alignment and biomechanics, and static and dynamic balance. No information emerged to specify how these measures of foot posture were interpreted or used to inform treatment decisions.

Duration of Intervention

Twenty-nine therapists answered questions about the length of time FOs tended to be required. Almost one third indicated the length of time was dependent on the child, on the basis of ongoing reassessment of symptoms. A further 21% indicated they were unable to estimate how long their clients tended to require FOs. These 29 PTs also provided reasons that FO intervention might be discontinued; 83% indicated more than 1 reason. Foot posture reaching...
normal appearance was noted by 65%, and 56% reported this was the family’s decision because of effort or cost.

Rationale and Perceived Efficacy

Thirty-two respondents answered questions about perceptions of the effects of FOs. Ninety-four percent of this group agreed that FOs are beneficial for children. These respondents were allowed to indicate more than 1 reason that they thought FOs were effective (Table 6). Of those who indicated that FOs are helpful for children, 83% believed that FOs create their effect via 3 or more of mechanisms.

Twenty-eight participants responded to questions about whether they thought FOs had any negative effects. Nearly two thirds reported no negative side effects. Of the 39% who indicated that there might be negative effects, concerns included psychological effects, negative effects on foot biomechanics in gait, and cost.

DISCUSSION

These survey results describe several aspects of FO use in pediatric PT practice, and highlight valuable considerations with respect to the application of the current literature to practice. The use of FOs seems to be quite widespread among PTs, who make them, order them commercially, or work with other professionals such as orthotists. Survey results show a lack of consensus regarding the clinical application of FOs, which might reflect the lack of best practice information in the literature.

Despite the lack of high-quality evidence, PTs have a clear role with respect to flatfoot assessment, determining appropriate PT intervention, and monitoring for changes in foot posture, function, and symptoms. A systematic assessment using objective reliable measures should be undertaken to categorize each child as having asymptomatic developmental flatfoot, asymptomatic nondevelopmental flatfoot, or symptomatic nondevelopmental flatfoot. Although physiological flatfoot improves over time, the pathological or nondevelopmental flatfoot tends to worsen. Asymptomatic nondevelopmental flatfoot should be monitored for potential changes in the child’s physical presentation, especially the onset of pain, or a decrease in arch height over time that would not be expected in the natural history of flatfoot.

Distinctions of flatfoot type do not seem to be applied consciously by PTs, but could help guide intervention. Treatment should also take into account and address the underlying pathology, appropriate to the nature of the condition and clinical findings. Although the literature supports foot pain as the primary indication for using FOs, this indication was only identified by 50% of respondents. Instead, foot posture (eg, excess pronation) emerged as the strongest indicator for FO use, even though the significance of foot posture with respect to gross motor function or future pain has not been established. Although asymptomatic developmental flatfoot does not typically warrant intervention or lead to symptomatic flatfoot, children with pain should be treated.

Physical therapists also reported frequent initiation of FO intervention for children younger than 3 years, even though flatfoot is developmentally normal at this age. This finding may reflect a tendency for young children referred to the PT to be more medically involved with underlying neurological conditions and severe, pathological flatfoot. Although expert opinion may support the use of FOs in children with nondevelopmental flatfoot, evidence to determine their efficacy is insufficient. For this group, objective outcomes should be used to quantify salient impairments, identify progression of deformity, judiciously identify candidates for FO intervention, and quantify the effects of treatment. Treatment goals and expectations should be clearly stated, and FOs should be discontinued when effectiveness is not objectively demonstrated.

The survey results suggest that PTs monitor foot posture and make treatment decisions based on physical impairments and function. Yet, few respondents identified standardized or objective outcome measures used to identify candidates for FOs, or monitor FOs’ effects over time. Focused assessment remains a significant challenge without a standardized definition of flatfoot, an understanding of the significance of variables such as calcaneal inclination, and well-tested methods to reliably measure them. Measurement practices could be improved. Measures such as the arch index or Foot Posture Index should be considered.

Common measures such as goniometry also have a role in a thorough physical assessment, to differentiate asymptomatic developmental flatfoot from flatfoot occurring secondary to muscle imbalance or plantar flexor contracture. As Achilles tendon tightness has been linked to symptomatic flatfoot, ankle dorsiflexion range of motion in subtalar joint neutral with the knee extended should be monitored over time. This type of flatfoot is associated with potential disability; therefore, stretching and possibly ankle foot orthoses (but not FOs) may be helpful. Understanding of the effect of the underlying pathology on observed impairments could guide management and help differentiate physiological from pathological flatfoot.

The pediatric flatfoot proforma is perhaps the best evidence-based tool currently available to guide decisions.

<table>
<thead>
<tr>
<th>Potentially Beneficial Effect</th>
<th>Respondents %</th>
</tr>
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<tbody>
<tr>
<td>Promote musculoskeletal development via improved foot and lower</td>
<td>93</td>
</tr>
<tr>
<td>extremity alignment</td>
<td></td>
</tr>
<tr>
<td>Improved stability and balance</td>
<td>90</td>
</tr>
<tr>
<td>Improved gross motor skills via enhanced lower extremity and foot</td>
<td>76</td>
</tr>
<tr>
<td>alignment</td>
<td></td>
</tr>
<tr>
<td>Pain reduction</td>
<td>66</td>
</tr>
<tr>
<td>Satisfaction of parents’ treatment expectations</td>
<td>21</td>
</tr>
<tr>
<td>Enhanced medial longitudinal arch development</td>
<td>18</td>
</tr>
</tbody>
</table>

*Respondents were invited to select more than 1 response if applicable.
about whether to treat a child with flatfoot. The proforma is based on whether the foot is flexible or rigid, and whether it is symptomatic or asymptomatic.

These survey results suggest that FOs are being used for children with asymptomatic flatfoot. This practice may be linked to 2 common beliefs (1) that flatfoot causes pain and disability, and (2) that there are no negative consequences of FOs; however, these beliefs have not been substantiated.

Investigations into possible harms associated with FOs have not been reported. For example, Carmick suggests that supramalleolar and ankle foot orthoses restrict metatarsalphalangeal joint extension in terminal stance and pre-swing and may have deleterious effects on gait biomechanics. Similar concerns may apply to inflexible FOs. Rao and Joseph suggest that time spent barefoot before age 6 years promotes arch development, implying that FOs may negatively affect foot posture.

Survey results further highlight a lack of consensus regarding the most appropriate time to initiate or discontinue intervention with FOs. Responses related to treatment duration and age at treatment initiation varied, reflecting the wide range of diagnostic and clinical presentations seen by PTs, clinicians’ experiences, and the lack of evidence on which to base treatment decisions.

The results of this survey suggest that FO treatment decisions made according to current flatfoot assessment methods are largely dependent on the clinician’s subjective judgment. This suggests a role for systematic evidence-informed assessment with the intent to differentiate between flatfoot types described earlier and careful monitoring of treatment outcomes using objective measures. Methods such as the single-subject experimental design and the patient-generated index to quantify treatment outcomes and make pretreatment and posttreatment comparisons can promote the objective evaluation of treatment efficacy.

Respondents identified mentoring as the most common source of FO education, suggesting that much of the information clinicians rely on for fabrication and integration of FOs into practice may be less current, and open to scientific bias. However, clinical practice has been said to require a combination of both science and art. With this in mind, a balanced approach may consider research evidence while respecting clinical experience, but it must maintain an objective eye on each client’s goals and outcomes.

Recommendations for Clinical Practice

Physical therapists contribute to decisions about flatfoot management as part of the child’s health care team. The following points may assist the clinician managing a child with flatfoot:

- A thorough objective examination employing standardized, reliable, and sensitive measures can help detect change over time.
- Classification of flatfoot in conjunction with objective monitoring of foot posture and symptoms can help clinicians identify children most likely to benefit from FOs—those with symptomatic flatfoot.
- Treatment should be tailored to the physical findings and based on current evidence of treatment efficacy. Pain is the primary evidence-informed indication for FOs. Flatfoot with Achilles tendon tightness is better addressed by stretching or ankle foot orthoses than FOs.
- Function should be a key treatment indication and outcome measure. If an FO trial is provided for a child with asymptomatic flatfoot and gross motor delay, a standardized gross motor assessment is recommended to compare performance with and without FOs.
- Acknowledge parents’ concerns and provide evidence-based information. Reassure them that asymptomatic developmental flatfoot does not usually warrant intervention or lead to symptomatic flatfoot. Rather than recommending FOs, Staheli and Hefli suggest advising parents about things known to help children with asymptomatic flatfoot—reducing obesity, limiting screen time, engaging in healthy lifestyle behavior, and limiting shoe wear.

Limitations

This study represents an initial examination of a complex set of conditions whose treatment is based on limited research evidence and knowledge. The survey was brief to maximize the response rate, while exploring the multifactorial clinical problem-solving process associated with FO intervention. Phone surveys or focus groups would facilitate a more comprehensive exploration of this relatively unexamined area.

Recommendations for Future Research

High-quality studies are needed to compare outcomes between larger samples of children with and without FOs, particularly for children with neurodevelopmental disabilities and asymptomatic nondevelopmental flatfoot. More evidence is needed to determine whether foot posture or FOs affect gross motor skills. Longitudinal studies could examine the relationship between pediatric flatfoot, and pain and motor function in adulthood. Case studies are traditionally dismissed as yielding low levels of evidence, yet single-case experimental designs and the patient generated index may advance clinical practice and research.

A standard definition of flatfoot would improve generalization of findings and may help clinicians to better describe their clients’ feet, detect the point at which FOs may be warranted, facilitate monitoring of asymptomatic nondevelopmental flatfoot, and prevent overuse of FOs.
CONCLUSIONS

In the absence of evidence supporting the efficacy of FOs for pediatric flatfoot, it is suggested that they be used judiciously, and only in situations where benefits are quantifiable. Using a classification scheme and objective examination to distinguish asymptomatic from asymptomatic flatfoot, and developmental from nondevelopmental flatfoot, the clinician can determine a treatment approach that is appropriate to the pathology. This approach, which is consistent with the best available research evidence, can help clinicians identify suitable candidates for FOs and critically evaluate treatment outcomes.

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