Effects of barefoot walking on the flat foot in school going children: A Randomised control trial

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**ABSTRACT**

Flat foot is also called Plano-valgus foot, and it is a term, that is commonly used in describing flat foot. Some studies have suggested, that certain foot-specific exercises and barefoot weight bear walking can change foot function like flat foot, and also confirm that shoed walking children are more likely to get a flat foot. An Assessor blinded, Randomized controlled trial with thirty-eight children with flat foot aged 6 – 14 years, both male and female were randomised to the control group (n= 19) and intervention group (n=19). The control group had performed barefoot walking for 45 minutes a day for eight weeks, and the intervention group had received foot-specific exercises with barefoot walking for eight weeks. Foot posture was evaluated by the arch index, while the Oxford foot and ankle questionnaire was used to measure the subjective well-being of children. Measurements were taken before and after the eight weeks of intervention. The outcome of the randomised control trial showed that the barefoot walking group faired far better than that which didn’t (p-value <0.05). The intervention group outcomes measure Arch Index, and Oxford Foot and Ankle Questionnaire were p-values is <0.05 from seventh and eighth weeks. This study results suggest that barefoot walking and specific foot exercises are effective in improving the flat foot in school-going children.

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According to the available literature, children of the current generation are more likely to be affected by flat foot compared to the population of older generations, as they were more time on barefoot. So very few studies have shown the value of flat foot barefoot walking, and no study shows that barefoot walking improves flat foot in school children (DAoUt et al., 2009; Chang et al., 2014).

Walking barefoot works by reinforcing the essential footstep in the body, there is less chance of impact and joint torque than in a shoe, and it also reactivates muscles that have shrunk in shoes, reactivates nerve endings, balances system, stimulates reflex massage at the bottom of the feet and even has anti-inflammatory benefits by shielding all this reveals that going barefoot provides (Hashimoto and Sakuraba, 2014; Elftman, 2003).

Some studies have suggested, that certain foot-specific exercises and barefoot weight bear walking can change foot function like flat foot, and also confirm that shoe walking children are more likely to get a flat foot (Hutchison, 2018; Vulcano, 2016). The objective is to assess the effect of barefoot walking with or without foot-specific exercises to improve foot function in school-going children.

MATERIALS AND METHODS

An assessor-blinded randomised controlled trial was conducted from September 2019 to February 2020, at Dakshina Kannada Zilla Panchayat Higher Primary School, Babbukatte Mangaluru, India. The total sample size for the study was 38, from which 19 participants recruited for each group. Flat foot children were allocated in this study by using the computer-generated random numbers with concealed allocation method for an eight-week study period.

The inclusion criteria were age between 6 to 14 year of school-going children with both gender children included and no recent foot injury or lower extremity pain from almost six mon, and they had no history of foot and ankle surgery in their lifetime.

The exclusion criteria were, a child having hallux rigid and plantar fascitis and musculoskeletal injuries from the last six months, any mental disorders, and limb length discrepancy. The effect size was of a 5% level of significance; 80% power sample was calculated by using G* power sample size software. A total of 38 participants were included.

The control group (Group A) was advised only barefoot walking (Figure 2). The physiotherapist instructed the children had to be barefoot for 45 min a day during school time, and they had to avoid prolonged wearing a shoe for eight weeks. They were walking inside or outside the home or in school for at least 45 min bare feet every day, five times a week for eight weeks.

When it comes to the intervention group (Group B) barefoot walking + specific foot exercises were suggested to the participants, the investigator instructed them to walk barefoot and to do a specific foot exercise program without shoes for the eight week study period. During school time, children could use school shoes. Still, while doing exercise, they should be on barefoot for at least 45min a day, five times a week and specific foot exercise program, we included a towel gathering exercise for 15 min: instructing the child to perform the towel-gathering exercise (scrunching a towel lying on the floor with the toes) for 15 min daily (Figure 3). Yet another exercise was heal cord stretches; stand facing a wall with one leg forward and slightly bent at the knee, instruct the participants to keep his/her other leg straight behind and then both the heels should be flat on the ground and then instructing them to keep both heels on the ground and asked to press their hips towards the wall gently (hold for 30 seconds and then relax for 30 seconds and then repeat for 10times). The next exercise was toe spread; sitting on a chair with both feet placed flat on the floor: Tell the child to spread toes as far apart as possible. Hold out for five sec., and then relax for twos (Figure 4). The next was posterior tibialis exercises seated: For this, the participant had to sit cross-legged and tie the band of resistance around the foot and the other end of the band had to be underneath to the other foot. The ankle had to be relaxed, and the participant had to move the foot upwards towards the roof and then return to the starting position slowly (Figure 5). Exercises were performed for both feet with a dosage set at (3 sets, 10reps).

Ethics

The study was approved by the Nitte Institute of Physiotherapy Institutional Ethics Committee, Mangaluru, Karnataka, India on 11th March 2019 with ref. No. NIPT/IEC/Min/020/2018-19. It was registered at the CTRI under the reg. No CTRI/2019/03/018207. The participants were informed about the process of the study and the right to withdraw their participation from the study at any time, and their consent was obtained.

Outcome Measures

Both group participants were identified flat foot by simple ink method and evaluated by outcome measures Arch Index and Oxford Foot and Ankle Questionnaire for children. Outcomes were collected every week on the last day for eight weeks by two
physiotherapists, who had no information on the subjects and purpose of the study. The Oxford Ankle and Foot Questionnaire for children (OXFAQ) were used to measure subjective well-being for children (age 5-16) year affected by foot and ankle conditions (Arbab et al., 2018). The Arch Index was used to check the distance of the ankle axis (Menz et al., 2012; McCrory et al., 1997).

Statistical Analysis
The demographic data Age and Gender were analysed by using descriptive statistics. Descriptive statistics, including mean, standard deviation, n (%), chi-square test, and independent t-test, were used to check the homogeneity of the descriptive statistics. Inferential statistics between the two groups comparisons were analysed by using unpaired test then with the group comparison which was analysed by using t-test and by software SPSS version 21.0 and p-value less than 0.05 considered significant for the study.

RESULTS
Table 1, shows the demographic data (Age and Gender) of the subjects in both the groups, in which p-value is >0.05, hence Gender is homogenous, and baseline characteristics were analysed by independent t-test. The p-value is >0.05, so baseline characteristics, Age, OXFAQ, AI are homogeneous.

The recruitment and participant flow chart is represented in Figure 1. A total of 105 children were assessed for eligibility during September 2019. It also shows the gender-wise distribution of the subjects in both the groups, in which participants aged from six years to 14 years were included in this study, 38 subjects (13 boys, 6 girls) in the intervention group and (11 boys, 8 girls). The mean age of the intervention group participants was 9.42 years (SD= 2.07), and the control group participants were 9.79 years (SD=2.07), and the obtained p-value is >0.05.

Table 2, shows descriptive and inferential statistics of the OXFAQ and Arch Index. OXFAQ scores of baseline measurement to 6th week there are no significant changes with a p-value of >0.05. While in the 7th and 8th week it showed -value <0.05 which is a statistically significant change, in group B week 3rd to week 8th with a p-value of <0.05 showing statistically significant change, while in group A of AI within-group comparison of children with the flat foot from baseline through 8th week with a p-value of >0.05 showing no statistically significant change. But group B of AI in within-group comparison of children with the flat foot showed 3rd week to 8th week with a p-value of <0.05 showed a statistically significant change. BOX FAQ: Baseline Oxford Foot and Ankle Questionarrie, W1OXFAQ: week 1 Oxford Foot and Ankle Questionarrie, W2OXFAQ: week 2 Oxford Foot and Ankle Questionarrie, W3OXFAQ: week 3 Oxford Foot and Ankle Questionarrie, W4OXFAQ: week 4 Oxford Foot and Ankle Questionarrie, W5OXFAQ: week 5 Oxford Foot and Ankle Questionarrie, W6OXFAQ: week 6 Oxford Foot and Ankle Questionarrie, W7OXFAQ: week 7 Oxford Foot and Ankle Questionarrie, W8OXFAQ: week 8 Oxford Foot and Ankle Questionarrie. BAI: Baseline Arch Index, W1AI: Week 1 Arch index, W2AI: Week 2 Arch index, W3AI: Week 3 Arch index, W4AI: Week 4 Arch index, W5AI: Week 5 Arch index, W6AI: Week 6 Arch index, W7AI: Week 7 Arch index, W8AI: Week 8 Arch index.

DISCUSSION
The objective of the study was to evaluate the effect of barefoot walking on the flat foot in school-going children. Very little information was found in the literature on the question of whether barefoot walking and foot-specific exercise can alter the foot function and foot shape. The results of this study indicate that there were statistically significant changes seen on the Group B that is barefoot walking and foot-specific exercises help to alter the foot structure and foot function and the data supports that experimental hypothesis. That is “there will be a significant effect of barefoot walk training and foot exercises in the flat foot in school-going children”. In reviewing the literature, data was found on the incidence that was 36% in which male incidence is 63.2%, and the female incidence is 36.8% which is a similar study done by Martin Pfeiffer et al. where the incidence of a flat foot is 30% in a group of 5-13 years children.

Then in the methodology part, we included children between the age group 6 to 14 years, there were several possible explanations for this. A possible explanation for these is that children start walking from the age of three years. The structure of the foot arch is visualised and grows gradually during childhood. It is the growth process of children when foot bones...
Figure 1: Consort flow diagram of the study

Figure 2: Participant walking bare foot

Table 1: Demographic data at baseline, mean (SD) for the Intervention group and Control group

|                      | Group A(n=19)       | Group B(n=19)       | p-value* |
|----------------------|---------------------|---------------------|----------|
| Age (years)          | 9.79 ± 2.07         | 9.42 ± 2.31         | 0.68*    |
| Gender, n boys/girls | 11/8                | 13/6                | 0.501#   |
| OXFAQ                | 142.3 ± 2.98        | 142.31 ± 3.41       | 0.63*    |
| AI                   | 0.32 ± 0.18         | 0.33 ± 0.02         | 0.29*    |

*Analyzed independent, t-test, #- chi square test, OXFAQ-Oxford Foot and Ankle Questionnaire, AI- Arch Index, Group A-Control group, Group B-Intervention group
complete their ossification by age 15-20. Thus the age group of 3-15 year is essential for the growth of the foot structure. The current study included both gender males and females in which previous studies did not show any prevalence (Gooding et al., 2016). Then we used simple ink method process for diagnosing flat foot because it is cost-effective and simpler than radiography without any radiation to diagnose flat foot, and we used graph sheets for the printing of foot because from the graph. We could easily calculate the arch index by dividing forefoot, midfoot and hindfoot.

Between-group: The current study results that from week seventh and eighth, a statistically significant change was seen, there were several possible explanations for this result. The contraction of foot muscles occurs in a barefoot population at the time of pronation that reduces strain on tissues. Muscle strength was an essential factor in the normal development of the arches. Children were likely to develop flexible arch when they went barefoot and also, and there is evidence showing that wearing shoes regularly before age six years can aggravate flat foot. So from the current study, we sug
Table 2: OXFAQ and Arch Index measures for Control group and Intervention Group

| Outcome | Control (Group A) | Within Group p-value* | Intervention (Group B) | Within Group p-value* | Between Group p-value# |
|---------|-------------------|-----------------------|------------------------|-----------------------|------------------------|
|         | Mean difference± SD |                       | Mean difference± SD |                       |                        |
| OXFAQ BOX FAQ | 142.6±2.98 | 0.24 | 142.3±3.41 | 0.197 | 0.76 |
| W1OXFAQ | 142.6±3.0 | 0.33 | 142.3±3.41 | 0.187 | 0.72 |
| W2OXFAQ | 142.5±3.06 | 0.79 | 142.3±3.38 | 0.002 | 0.92 |
| W3OXFAQ | 143.0±2.81 | 0.22 | 143.7±2.40 | 0.001 | 0.49 |
| W4OXFAQ | 143.4±2.71 | 0.11 | 144.2±2.29 | 0.001 | 0.34 |
| W5OXFAQ | 144.0±2.44 | 0.22 | 145.6±3.13 | 0.001 | 0.14 |
| W6OXFAQ | 143.9±2.46 | 0.02 | 146.2±3.05 | 0.001 | 0.14 |
| W7OXFAQ | 144.5±2.00 | 0.005 | 146.5±2.95 | 0.001 | 0.02 |
| W8OXFAQ | 144.6±2.02 | 0.005 | 147.0±3.12 | 0.001 | 0.008 |
| Arch Index | BAI | 0.32±0.0188 | 0.3326 | 0.33 | 0.33 |
| W1AI | 0.32±0.0187 | 0.3325 | 0.32 | 0.33 |
| W2AI | 0.32±0.0186 | 0.3324 | 0.328±0.22 | 0.187 | 0.43 |
| W3AI | 0.322±0.0185 | 0.3323 | 0.327±0.028 | 0.001 | 0.48 |
| W4AI | 0.321±0.0184 | 0.3322 | 0.025±0.0032 | 0.001 | 0.63 |
| W5AI | 0.321±0.0183 | 0.332 | 0.022±0.0084 | 0.001 | 0.21 |
| W6AI | 0.32±0.0182 | 0.331 | 0.024±0.0112 | 0.001 | 0.10 |
| W7AI | 0.322±0.0181 | 0.330 | 0.001±0.0134 | 0.001 | 0.05 |
| W8AI | 0.32±0.0180 | 0.3309 | 0.0024±0.0152 | 0.001 | 0.03 |

*within group paired ‘t’ test, #between group independent ‘t’ test

Parents to encourage kids to go barefoot wherever it’s safe. The adaptive change was seen after 6 weeks. The results of this study show non-significant change from week 1 to week 6 the reason is, in the rainy season, it’s difficult to barefoot that is the foremost and second reason it’s very difficult to strengthen the foot muscles in the short term, evidence also shows that to increase foot muscles, it takes almost 3 to 4 weeks.

Within Group: As from AI and OXFAQ, contrary to expectations, this study did not find a significant difference from baseline to the second week because it takes almost 15-20 days to strengthen foot muscles. The current study result shows that from the third week to eight weeks, there are significant changes in both the outcome measures. A possible explanation for this is barefoot, and exercises have shown to promote the structure of arches. From this research, we believe that barefoot activity and exercises were related to sensory stimulation will create a protective increase in muscle tone that can raise the arch. This is consistent with research by Robbins and Hanna, who found that the barefoot activity created significant increases in adult arch height. This finding corroborates with the ideas of Gould, who suggested that excessive pronation before age seven.

![Figure 5: Participant performing Posterior tibialis exercise on sitting position](image-url)
will shape it in such a way that it forms with a downward slope, rendering it unable to support the talus adequately. Walking barefoot works by reinforcing the essential footstep in the body; there is less chance of impact and joint torque than in a shoe. It also reactivates muscles that have shrunk in shoes, reactivates nerve endings, balances system, stimulates reflex massage at the bottom of the feet and even has anti-inflammatory benefits by shielding all this reveals that going barefoot provides.

Another possible explanation for this is that the development of talar shelf is important for the development of a functional medial longitudinal arch, as it helps the osseous architecture to regulate motion and increase muscle tone at this time, allowing for the creation of a healthy arch and foot-specific exercises like towel gathering exercises, heel cord stretching, toe spread and posterior tibialis exercises which strengthen the lower leg muscles of the child, particularly in the posterior tibialis, internal/external rotational exercises play a role. The normal purpose of exercises is to develop muscles, and the goal is to improve certain muscles, which are supposed to support the longitudinal arch in the flat foot. The change was due to training in foot movement that strengthened foot muscles, however, that several children who got strength in their feet after exercises. Epidemiological and case studies indicated that walking barefoot could benefit safely. The present study showed that barefoot walking and foot-specific exercises correlate with observable, important, and potentially beneficial differences. With this, we conclude that treating children with a flat foot is successful with barefoot walking and foot-specific exercises, before the age of 14 years. A limitation of this study is that the numbers of participants were relatively small and weather plays a major role (as in rainy season) it’s difficult to do barefoot walking.

CONCLUSIONS

In the present study, we concluded that barefoot walking training and foot-specific exercises improve the flat foot in school-going children. Research data supports foot-specific exercise program advantages and consistent enforcement over an eight-week duration, which has been reported. Barefoot walking and specific foot exercises are generally recommended, particularly in early life for better development of the structure of foot arches.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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