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THE EFFECT OF INTRINSIC FOOT FLEXOR STRENGTHENING ON FOOT FUNCTION AMONG SUBJECTS WITH FLAT FOOT – AN EXPERIMENTAL STUDY

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ABSTRACT

Background - The intrinsic foot muscle (IFM) has a determinant role in the standing position and in walking. Weakness of the short or intrinsic muscle of the foot is related to greater incidence of pronation, fasciitis, sprains, and injuries of other body parts. Therefore, its training is considered relevant to maintain the core system of the foot.

Method- Total 63 subjects having flat foot were selected according to the inclusion and exclusion criteria. Each subject was given informed consent form and was screened for flat foot using FADI.

Result- Independent t test was used for between group analyses. Since the p-value is greater than the typical significance level of 0.05, there is no statistical significance of the interventions in both the groups. The p-value is 0.106 (assuming equal variances), which is greater than 0.05. Hence we fail to clearly state which intervention is effective among individuals with flat foot as both the group has similar outcome.

Conclusion- Hence, we conclude that there is no significant difference between Experimental and Control group post treatment.

Keywords: FADI, subjects with flat foot, foot function, intrinsic foot flexors

INTRODUCTION

The structure and dynamicity of foot arches are essential for functions of foot like shock absorption, body weight transmission and to act as a lever for propelling the body forward during locomotion. Medial Longitudinal Arch (MLA) of foot is higher than the Lateral longitudinal arch and its curvature flattens to variable degree during weight bearing. Pes planus is a medical condition where the curvature of MLA is more flat than normal and entire sole of the foot comes into near complete or complete contact with the ground. The height of MLA is most important measurement in determining the degree of pes planus **[1]**. The intrinsic foot muscle (IFM) has a determinant role in the standing position and in walking. Its function is considered primordial in maintaining the plantar arch and controlling foot posture along with the rest of its anatomical structures (i.e., bones, ligaments, extrinsic muscles, and fascia). Weakness of the short or intrinsic muscle of the foot is related to greater incidence of pronation, fasciitis, sprains, and injuries of other body parts. Therefore, its training is considered relevant to maintain the core system of the foot **[2]**. Since the pronation of the foot is related to weakness of the intrinsic plantar muscles, by enhancing this musculature through exercises, it is believed that the associated hyper-pronation could be recovered or decreased **[3]**.

The feet appear to be flat in infants due to presence of fat. The arches become prominent when the child starts walking and the foot starts bearing the weight. The arches of foot rapidly develop between two to six years and become structurally mature around 12-13 years. Prevalence of flat feet is higher in children due to ligament laxity and declines with age. The prevalence rate of flat foot is 10.75% among 18-25 year old Indian population. Prevalence of flat foot in a population of 18 to 25 years old physiotherapy students was 11.25% and all subject affected with bilateral flat foot **[4]**.

The Foot and Ankle Disability Index (FADI) was created to evaluate functional limits caused by disorders affecting the foot and ankle. ADL Difficulty and Severity of pain Measurement are the two components of FADI. FADI with higher score indicating lower disability **[6]**.

The Short foot exercise (SFE) - It emphasizes metatarsophalangeal and proximal interphalangeal joint flexion during balancing activities while minimizing distal interphalangeal flexion. This activity has been recommended as a means to improve neuromuscular control and intrinsic foot strength. The exercise is performed by the

subject utilizing the intrinsic muscles of the foot to draw the metatarsal heads back toward the heel. The intent of this exercise is to "shorten the foot" without curling the toes. This motion should cause slight arch elevation without engaging the long toe flexors. The intensity of the exercise is submaximal in nature and emphasizes proper technique and the acquisition of new physical skill **[3]**.

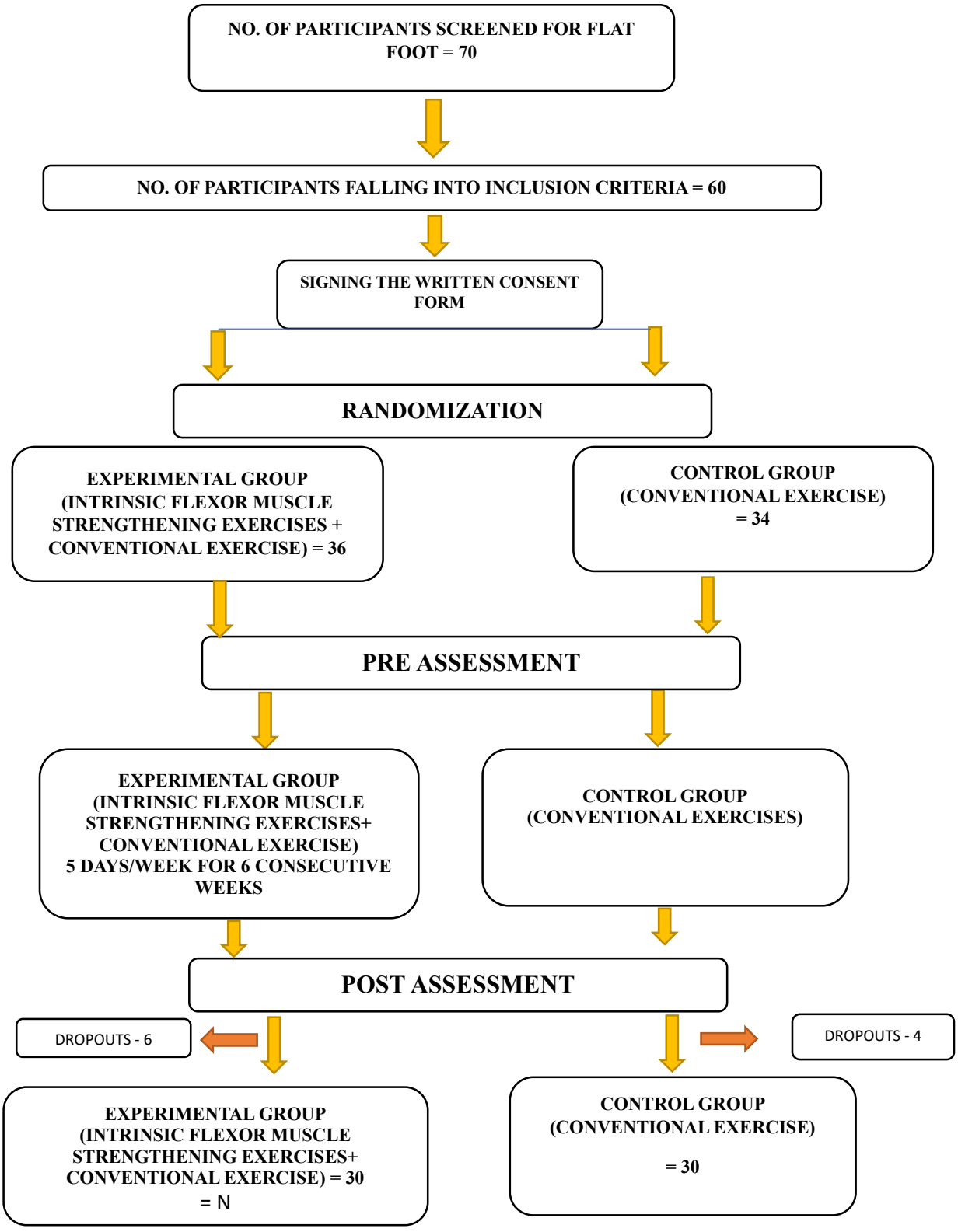
METHODOLOGY

PROCEDURE

The study was conducted among college level individuals between 18 to 25 years of age to find the effect of intrinsic foot flexor strength training on foot function among subjects with flat foot. The participants were enrolled according to the inclusion and exclusion criteria. 76 participants were screened for inclusion criteria and 70 individuals fulfilling the inclusion criteria were recruited for the study. Once the consent form was signed, participants were divided into Group A and Group B. All the participants were assessed pre and post intervention for Foot and Ankle Disability Index. In Group an Intrinsic flexor muscle strengthening exercises with conventional exercises were given and in Group B only conventional exercises were given for 6 weeks. Group A had 30 participants and Group B had 30 participants out of which Group A had 6 dropouts and Group B had 4 participants.

Table 1: Exercise protocol for Experimental group [5] and Conventional group

	SHORT FOOT EXERCISE PROTOCOL	CONVENTIONAL TREATMENT
1.	According to the principle of progressive overload, the intensity of exercise was divided into 2 levels.	Calf stretch Tennis ball rolls
2.	For weeks 1–3, the SFE was performed in a sitting position and subsequently performed in standing for weeks 4–6.	Calf raise/ heel raise Towel curls
3.	For weeks 4–6, the SFE was performed in the single-leg stance to provide bodyweight resistance.	Toe raise
4.	In both seated and standing positions, the SFE was held for 5 s, with 12 repetitions forming 1 block, and 3 blocks completed per training session, with a 1-min rest period between blocks. Three sets were performed 4 times a week.	Plantar fascia stretches


NO. OF PARTICIPANTS SCREENED FOR FLAT FOOT = 70
NO. OF PARTICIPANTS FALLING INTO INCLUSION CRITERIA = 60
SIGNING THE WRITTEN CONSENT FORM
RANDOMIZATION
EXPERIMENTAL GROUP (INTRINSIC FLEXOR MUSCLE STRENGTHENING EXERCISES + CONVENTIONAL EXERCISE) = 36
CONTROL GROUP (CONVENTIONAL EXERCISE) = 34
PRE ASSESSMENT
EXPERIMENTAL GROUP (INTRINSIC FLEXOR MUSCLE STRENGTHENING EXERCISES+ CONVENTIONAL EXERCISE) 5 DAYS/WEEK FOR 6 CONSECUTIVE WEEKS
CONTROL GROUP (CONVENTIONAL EXERCISES)
POST ASSESSMENT
DROPOUTS - 6
DROPOUTS - 4
EXPERIMENTAL GROUP (INTRINSIC FLEXOR MUSCLE STRENGTHENING EXERCISES+ CONVENTIONAL EXERCISE) = 30 = N
CONTROL GROUP (CONVENTIONAL EXERCISE) = 30

RESULTS

The study included total 63 participants, in which 31 participants were included in Gorup A (experimental group) and 32 were in Group B (Control group). All the subjects were assessed according to the inclusion criteria after their consents. The baseline data was entered in excel and descriptive statistics was calculated for the same. The statistics were calculated from SPSS version 23.

Table 2, Figure 1 show the gender distribution in group A and B respectively and mean age in both the groups. The histogram displays the graphical presentation of the data.

Table 3 is the descriptive statistics in which Group A Pre and Post mean is 61+_9.46 and 79+_9.07 respectively. For Group B pre and post mean values are 59+_10.18 and 73+_8.20 respectively. The mean difference of Group A is 18.5 and B is 14.1 respectively. The descriptive statistics concluded that there are more differences found between pre and post FADI scores in Group A compare to Group B. The histogram **(Figure 2)** is the descriptive statistics of the Group A and B with their means and Standard Deviations.

As the data followed the normality, paired sample t test was used to find the comparison between the two groups.

Table 4 represents the paired sample t test between group. The mean value of Group A and B is -18.50 and -14.10 with $p < 0.05$ which says that the negative value of mean difference is because the FADI score is more in Post treatment assessment and there is significant difference between pre and post Score after treatment.

Table 5 is the independent t test for between group analyses. Since the p-value is greater than the typical significance level of 0.05, in Levene's Test we fail to reject the null hypothesis of equal variances. The p-value is 0.106 (assuming equal variances), which is greater than 0.05. Therefore, we do not have enough evidence to reject the null hypothesis of no difference in means between the two groups.

Hence, we conclude that there is no significant difference between Experimental and Control group post treatment.

Table 2

		Group A	Group B
Gender	Male	13	15
	Female	27	15
Mean	Age	22.83	22.13

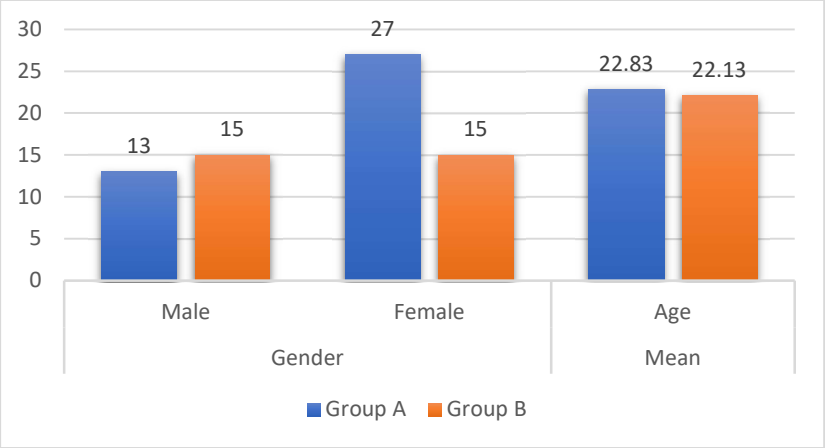


Figure 1

Table 3

Descriptive Statistics			
		Mean	**Std. Deviation**
Group-A FADI	**PRE**	**61.10**	**9.46**
	POST	**79.60**	**9.07**
Group-B FADI	**PRE**	**59.50**	**10.18**
	POST	**73.60**	**8.20**

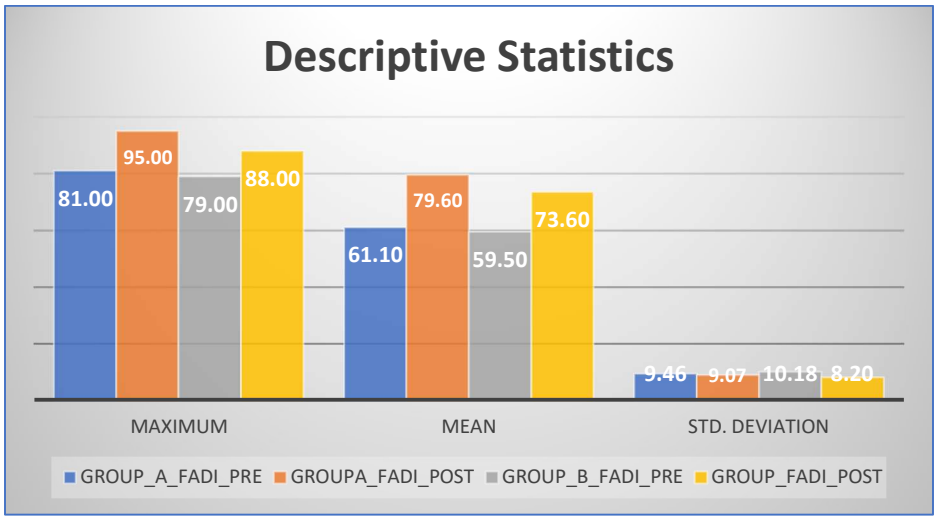


Figure 2

Table 4

Paired Samples Test						
		Paired Differences		**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**			
Group A	**PRE-POST**	**-18.50**	**5.22**	**-19.39**	**29**	**0.000**
Group B	**PRE -POST**	**-14.10**	**3.95**	**-19.54**	**29**	**0.000**

Table 5

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Between Group Analysis	Equal variances assumed	0.009	0.924	1.642	58	0.106	7.60	4.62	-1.66	16.86

DISCUSSION

This study focus to determine the effects on foot function among participants who have flat feet due to intrinsic foot flexor strengthening. 70 participants were selected for the study on the basis of inclusion criteria and were included in the study with their consent. Participants were divided into two groups using closed envelop method. Group A and B had 36 and 34 participants in which Group A had 6 dropouts and Group B had 4 dropouts at the end of 6 week of training program, post FADI was used measured the foot function.

Participants in our study has been diagnosed as having flat feet using assessment. While specific strengthening exercises, the intervention group participated in a structured programme of intrinsic foot flexor strengthening activities. Before and after the intervention period, both groups underwent assessments for a variety of foot function metrics.

Study done by Manuel Pabón-Carrasco, evaluated the muscle tone after performing the SFE and defended an increase in power of the muscles involved in maintaining the plantar arch concluded that SFE training significantly improves proprioception and dynamic balance in patients. This study states that SFE helped to improve stability and core system of the foot. This exercises provided benefits related to the position, stability, muscle tone and biomechanics of the foot **[2]**.

Another Study was done by Do-Young Jung, he suggested that the Toe Curl and Short Foot exercises are commonly used to strengthen foot intrinsic muscles. The SF exercise is especially performed for balance training and enhancing the longitudinal and transverse arch. Short Foot exercise is a more useful strengthening exercise than Toe Curl exercise in activating the Abductor hallucis muscle and in preventing lowering of the medial longitudinal arch **[7]**.

Current study showed that those in the intrinsic foot flexor strengthening group had significantly improved foot function. More specifically, there was a significant improvement in dynamic stability during weight-bearing activities, a decrease in pronation during gait, and a noticeable increase in arch height. These beneficial alterations were in line with the strengthening effects seen in the intrinsic foot flexors, pointing to a clear link between specific exercise programs and better foot biomechanics. Group A and Group B participants showed significant improvement after 6 weeks' exercise program. There was no significant difference when compared between Group A and Group B post exercise session as both the groups showed similar result after exercise session for 6 weeks.

CONCLUSION:

The recent study was aimed to check the effect of intrinsic foot flexor strengthening on foot function among subjects with flat foot. Based on the result and data analysis it was concluded that both the Group A and B showed improvement after 6 weeks' intrinsic muscle strengthening but when compared between Group A and B there was no such significant improvement.

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