# EFFECTIVENESS OF SHORT FOOT EXERCISE ON PAIN AND KNEE FUNCTION IN PATIENTS WITH MEDIAL COMPARTMENT OSTEOARTHRITIS KNEE

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***Abstract:*** This study has been undertaken to study the effectiveness of short foot exercise(SFE) in patients with osteoarthritis(OA) of medial compartment of knee to reduce knee pain and to improve function of knee joint**.** Knee OA is chronic degenerative joint condition with variety of contributing factors. In middle aged and older adults knee OA is major contributor to joint pain and disability. As during most of weight bearing activities flat foot maybe associated with internal rotation of lower limb, which might alter knee joint stress. Degree of foot flattening is strongly linked to severity of knee OA symptoms. Short foot exercise is used to enhance ankle proprioception, overall movement pattern, intrinsic foot muscle strength. Intrinsic foot muscles are essential for plantar arches. It also improves stability and shock absorption. A total 30 participants were included who fulfilled the inclusion criteria. Pre intervention and post intervention assessment were conducted for pain with Visual Analogue Scale (VAS)and for knee function Western Ontario and McMaster Universities OA Index(WOMAC). Participants were allotted in two groups by odd even allocation method. Group A received SFE, knee and hip focused exercises, interferential therapy, ultrasound therapy and Group B received knee and hip focused exercises, interferential therapy (IFT), ultrasound therapy(US). For both groups interventions were given for 5 days/week and for 3 weeks. Results indicated statistically significant improvement in both VAS and WOMAC scores within each group ($p < 0.001$). There was no statistically significant difference ($p > 0.05$) between the groups, though the SFE group showed higher mean improvements, implying clinically relevant enhancement of pain reduction and knee function. Overall, the findings support the effectiveness of SFE in individuals with knee OA in the medial compartment.

***IndexTerms*** **– Medial compartment OA knee, Flat foot, SFE.**

## I. INTRODUCTION

One of the main cause of pain in the joint and disability in a middle aged and older adults is knee OA. [(1)] Knee OA is chronic degenerative joint condition and have several contributing causes. [(2)] Knee OA affects about half of India's older population, which puts a significant strain on the healthcare system. [(3)] OA of knee is also becoming more prevalent in middle aged individuals and this group received less attention in research. For slowing disease progression and decreasing long-term burden early intervention may play significant role. [(4)] In OA of knee joint protective cartilage which covers ends of the bones wears away, as condition worsens bones may deteriorate, spur may form and loose fragments can increase inflammation. In advanced stage, cartilage loss leads to bone to bone contact, which damages joint and increases pain. [(5)] Pain around the knee joint is most typical symptom of OA knee. Pain usually makes it difficult to walk, climb stairs, perform household tasks and maintain posture. [(2)] Identifying and addressing risk factors, especially in the joints that bear weight may lower the chance of developing OA and assist in preventing pain and disability. The mechanical load applied to joints is major contributor to OA as well as it represents one of the risk factor that can be modified most. [(6)]

This study focuses on flatfoot, which is one of the risk factor of knee OA. During majority of the weight bearing activities movement and alignment of the foot and knee joint are interconnected in a closed kinematic chain. Excessively planus foot structure maybe linked with overly internal rotation of the lower extremity in this chain. Exact effect with this rotation is unknown but it might have an impact on the knee joint's mechanical load, this may increase rotational stress on weight bearing structures of tibiofemoral compartments. [(7)] The degree of foot flattening is strongly linked to severity of knee OA symptoms. [(8)] In addition to that foot absorbs mechanical forces from contact with the ground, which affects lower limb and knee joint motion and posture. Studies shown that medial cartilage damage and knee pain are frequently caused by flat feet. [(9)] Studies also suggest that the people with over pronated feet represents clinically significant subgroup in patients with knee OA. Special attention should be given for managing an over pronated foot in treatment of knee OA. [(10)] Foot posture index, elevated navicular drop test value and arch index values indicate that pronated foot is symptom of medial compartment knee OA, when compared with asymptomatic individuals. [(11)]

Navicular drop test is a test used to evaluate medial longitudinal arch. [(10)] Increased navicular drop test value indicates subtalar joint pronation and low medial longitudinal arch. [(12)] VAS is used as it is reliable and valid method to evaluate the pain. [(13)] For assessing knee function WOMAC is reliable and valid outcome. [(14)] It is questionnaire that is self-administrated and it includes 24 items, grouped into three categories: pain, stiffness and physical function. [(15)]

Combined program including quadriceps and hamstrings strengthening exercises is the most beneficial approach for lowering the pain and morning stiffness in people with knee OA. [(16)] The study provided strong, high quality proof that strengthening exercises

of hip abductor are beneficial as rehabilitation for patients with knee OA. [17] Evidence support the efficiency of interferential current therapy in adults with knee OA and it decreases knee pain in terms of short term and long term as well as short term improvement in function as evaluated by the WOMAC. [18] Ultrasound is useful in reducing pain in degenerative conditions in musculoskeletal system when continuous mode of ultrasound is used. [19] Intrinsic foot muscles play crucial role during standing and walking. They are important for supporting the plantar arch as well as to control the foot posture together with surrounding structures. Regular SFE appears to enhance stability and shock absorption thereby improving lower limb biomechanics. SFE is effective exercise for strengthening intrinsic foot muscles. SFE may serve as a helpful approach for addressing conditions associated with excessive foot pronation. [20]

**NEED OF THE STUDY.**

In middle aged and older adults knee OA is major contributor to joint pain and disability. Flat foot is one of the risk factors as over pronation can cause lower limb musculoskeletal conditions. As in most of the activities of weight bearing, closed kinematic chain connects the foot and knee, degree of planus foot may be associated with excessive internal rotation of lower limb. This rotation might affect mechanical stress across knee joint. Foot helps to absorb mechanical stresses from contact with the ground. Due to the abnormal foot alignment it may cause weakening of intrinsic foot muscles. Current treatment method for knee OA often overlook key biomechanical factor, especially over pronated foot. And exercises used in treating flat foot which involves toe bending, toe curling which mainly focuses on extrinsic foot muscles. But SFE will target on intrinsic foot muscles, the muscles which support foot arches. And strengthening of these muscles will be helpful in strengthening arches. This study focuses on the management of flat foot along with knee and hip focused exercises and electrotherapy while treating OA knee. Results of this study may contribute to design effective treatment program for individuals with knee OA along with flat foot.

## RESEARCH METHODOLOGY

This study is an experimental study carried out to evaluate effectiveness of SFE on medial compartment knee OA. Using convenience sampling method total 30 participants were selected in the study. Pre intervention and post intervention assessment was conducted, pain was assessed using VAS and knee function was assessed using WOMAC scale. Participants were allocated into two groups by odd even allocation method. Group A received short foot exercise, knee and hip focused exercises, interferential therapy, ultrasound therapy and Group B received knee and hip focused exercises, interferential therapy, ultrasound therapy. For both the group intervention were given for 5 days per week and for 3 weeks.

SFE- Participants were asked to pull head of first metatarsal toward the heel without flexing toes and elevate medial longitudinal arch. This position would be maintained for 5 repetitions ,1 session/day, 6 seconds hold and 3 seconds rest time.

Hip and knee focused Exercise-Isometric quadriceps with 5 second hold, straight leg raise with 5 sec hold, bridging, isometric hip adductors with 5 second hold, dynamic quadriceps with 5 second hold, side lying hip abduction with 5 second hold, prone hip extension with 5 second hold. Each exercise is done for 2 sets of 10 repetitions for first week, 3 sets of 10 repetitions for second week, 4 sets of 10 repetitions for third week.

### 3.1Population and Sample

30 participants were selected by convenience sampling method. Inclusion criteria included age group: 40 to 80 years, gender: both male and female, Medial compartment knee OA, VAS score- 3 to 9, Navicular drop test more than 10mm and exclusion criteria included previous knee and ankle surgery, neurological condition, inflammatory arthritis.

### 3.2 Data and Sources of Data

Pre and post intervention scores of VAS and WOMAC was data sources. Data was collected at clinics and physiotherapy rehabilitation centers in Pune

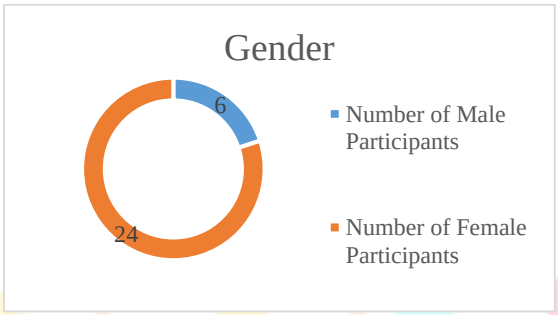
### 3.3 Theoretical framework

Study is based on theoretical understanding that flat foot is linked with knee OA and flat foot can cause excessive internal rotation of lower limb which affects stress on knee joint. There is strong correlation between degree of foot flattening and severity of knee OA symptoms. SFE focuses on intrinsic foot muscles, enhance lower limb biomechanics, intrinsic foot muscles strength, stability and shock absorption.

## IV. DATA ANALYSIS AND INTERPRETATION

**Table no.1** Gender wise distribution of participant

| | Number of Male Participants | Number of Female Participants |
|---|---|---|
| Gender | 6 | 24 |

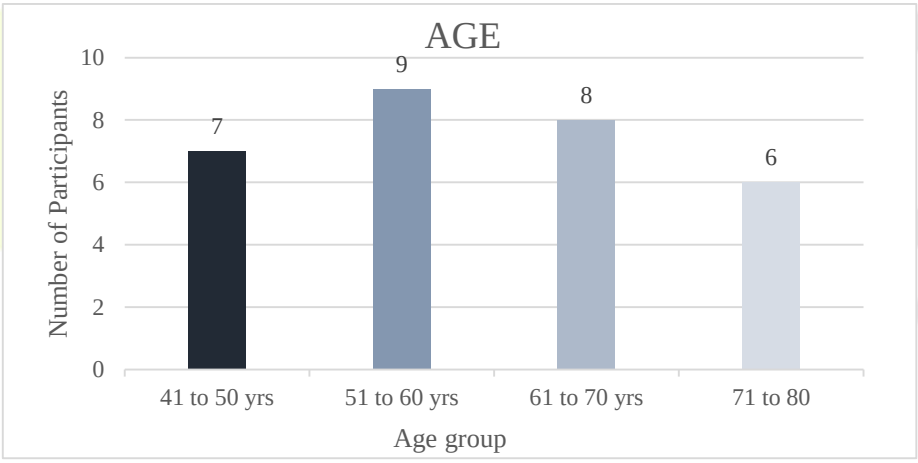



**Graph no.1** Gender wise distribution of participant

**Interpretation**-The above graph shows, out of 30 participants 6 (20%)participants were male and 24 (80%)participants were females.

**Table no.2** Age group wise distribution of participant

| Age Group | 41 to 50 years | 51 to 60 years | 61 to 70 years | 71 to 80 years |
|---|---|---|---|---|
| Number of Participants | 7 | 9 | 8 | 6 |



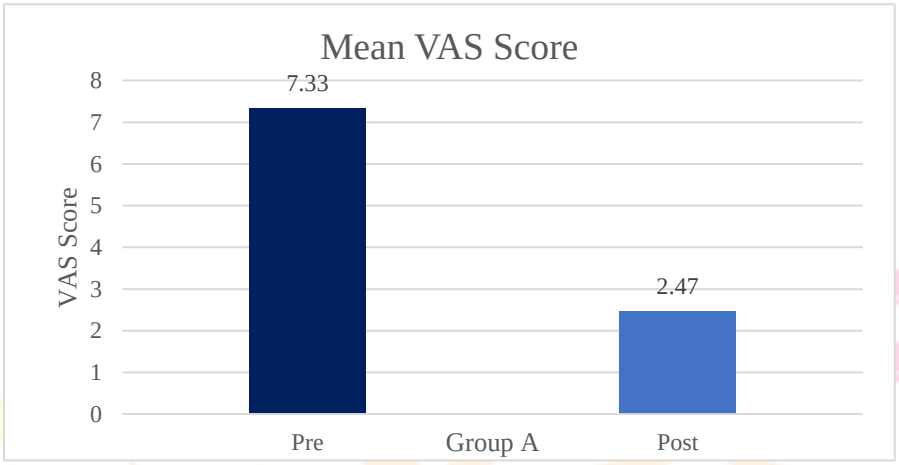

**Graph no.2** Age group wise distribution of participant

**Interpretation**-Above graph shows, out of 30 participants, 7(23.33%) belong to the 41 to 50 age group, 9(30%) belongs to 51 to 60 age group, 8(26.67%) belongs to 61 to 70 age group and 6(20%) belongs to 71 to 80 age group.

**INTRA Group**

**Table no.3** Comparison of the Mean VAS score Pre and post intervention in group A

| | Mean VAS Score |
|---|---|
| Pre | 7.33 |
| Post | 2.47 |

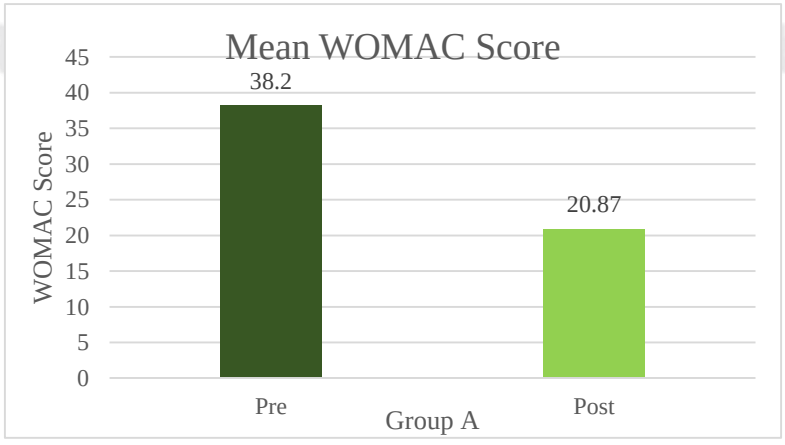



**Graph no.3** Comparison of the Mean VAS score Pre and post intervention in group A

**Interpretation**- Above graph indicates that Group A's VAS scores significantly decreased after the intervention.

**Table no.4** Comparison of Mean WOMAC score Pre and post intervention in group A

| | Mean WOMAC Score |
|---|---|
| Pre | 38.2 |
| Post | 20.87 |

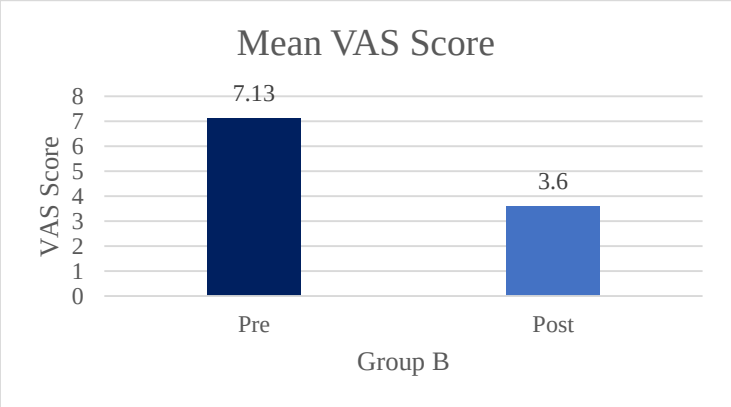



**Graph no.4** Comparison of the Mean WOMAC score Pre and post intervention in group A.

**Interpretation**- Above graph indicates that Group A's WOMAC scores significantly decreased after the intervention.

**Table no.5** Comparison of the Mean VAS score Pre and post intervention in group B

| | Mean VAS Score |
|---|---|
| Pre | 7.13 |
| Post | 3.6 |

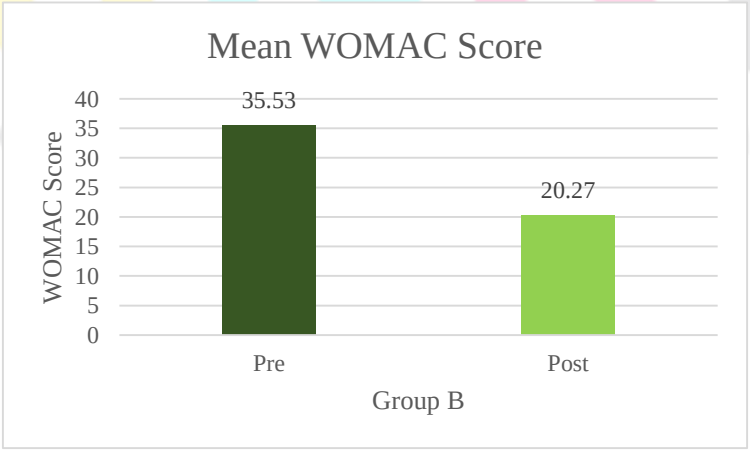



**Graph no.5** Comparison of Mean VAS score Pre and post intervention in group B

**Interpretation**- Above graph indicates that Group B's VAS scores significantly decreased after the intervention

**Table no.6** Comparison of Mean WOMAC score Pre and post intervention in group B

| | Mean WOMAC Score |
|---|---|
| Pre | 35.53 |
| Post | 20.27 |



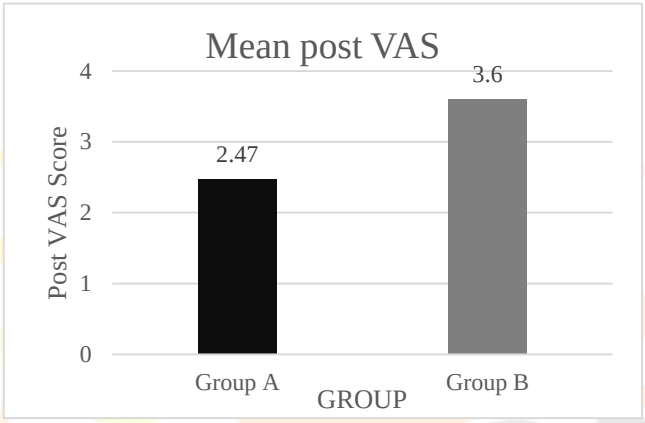

**Graph no.6** Comparison of the Mean WOMAC score Pre and post intervention in group B

**Interpretation**- Above graph indicates that Group B's WOMAC scores significantly decreased after the intervention.

**INTER Group**

**Table no.7** Comparison of the Mean Post-intervention VAS score between Group A and Group B

| | Mean post VAS |
|---|---|
| Group A | 2.47 |
| Group B | 3.6 |

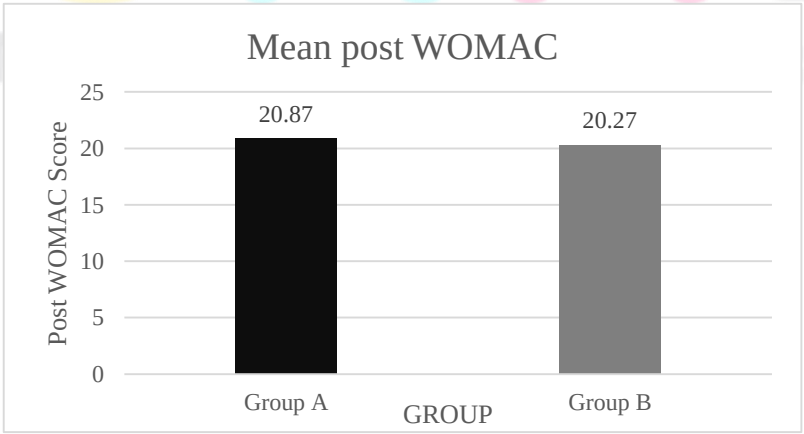



**Graph no.7** Comparison of the Mean Post-intervention VAS score between Group A and Group B

**Interpretation**-Above graph shows lower post intervention VAS score in Group A, which indicates greater reduction in pain compared to Group B

**Table no.8** Comparison of Mean Post-intervention WOMAC score between the Group A and Group B

| | Mean post WOMAC |
|---|---|
| Group A | 20.87 |
| Group B | 20.27 |




**Graph no.8** Comparison of the Mean Post-intervention WOMAC score between Group A and Group B

**Interpretation**-Although the post intervention WOMAC score in Group B appears slightly lower than Group A, this difference may be due to higher mean pre intervention WOMAC score in Group A than Group B.

## V. RESULTS AND DISCUSSION

Table 1. Demographic Characteristics of Participants (N = 30)

| Variable | Mean ± SD | Median | Minimum | Maximum |
|---|---|---|---|---|
| Age (years) | 59.7 ± 8.97 | 59.5 | 45 | 74 |

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| **Group** | Group A (Study) | 15 | 50 |
| | Group B (Control) | 15 | 50 |
| **Gender** | Female | 24 | 80 |
| | Male | 6 | 20 |

The study included 30 participants aged 45–74 years, with a mean age of approximately 60 years. Each group (study and control) consisted of 15 participants, predominantly females (80%).

Table 2. Pre- and Post-Intervention Scores (Overall Participants)

| Variable | N | Mean ± SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|
| VAS (Pre) | 30 | 7.23 ± 1.17 | 7 | 5 | 9 |
| VAS (Post) | 30 | 3.03 ± 1.73 | 3 | 1 | 9 |
| WOMAC (Pre) | 30 | 36.87 ± 11.55 | 37 | 17 | 54 |
| WOMAC (Post) | 30 | 20.57 ± 7.08 | 20.5 | 9 | 35 |

Across all participants, there was a clear reduction in both pain (VAS) and functional limitation (WOMAC) following intervention.

Table 3. Within-Group Comparison – Group A (Study Group)

| Outcome Measure | Test Used | Mean Difference | p-value | 95% CI (Lower–Upper) | Effect Size |
|---|---|---|---|---|---|
| VAS (Pre–Post) | Wilcoxon Signed-Rank | 5 | <0.001 | 4.5 – 5.5 | r = 1.00 |
| WOMAC (Pre–Post) | Paired t-test | 17.3 | <0.001 | 13.4 – 21.2 | d = 2.45 |

The SFE group showed a highly significant reduction in pain (VAS) and improvement in function of knee (WOMAC), both with large effect sizes, confirming substantial clinical benefit.

Table 4. Within-Group Comparison – Group B (Control Group)

| Outcome Measure | Test Used | Mean Difference | p-value | 95% CI (Lower–Upper) | Effect Size |
|---|---|---|---|---|---|
| VAS (Pre–Post) | Wilcoxon Signed-Rank | 4 | 0.002 | 2 – 5 | r = 0.93 |
| WOMAC (Pre–Post) | Paired t-test | 15.3 | <0.001 | 12.7 – 17.8 | d = 3.28 |

Participants in the control group also demonstrated significant improvement in both pain and functional outcomes, indicating positive response to conventional therapy.

Table 5. Between-Group Comparison of Improvement Scores

| Outcome Variable | Test Used | Mean Difference (A–B) | p-value | 95% CI (Lower–Upper) | Effect Size |
|---|---|---|---|---|---|
| ΔVAS (Pre–Post) | Mann–Whitney U | 1.34 | 0.075 | –2.00 – 0.00 | r = 0.37 |
| ΔWOMAC (Pre–Post) | Independent t-test | 2 | 0.352 | –6.54 – 2.41 | d = 0.35 |

Between-group analysis revealed no statistically significant difference in post-intervention change scores. However, the study group exhibited greater mean improvement in both pain and knee function, suggesting a clinically meaningful benefit from the SFE protocol.

**STATISTICAL ANALYSIS**

Data analysis was performed using SPSS Version 26.0. Descriptive statistics were computed for demographic variables and outcome measures. The Shapiro–Wilk test assessed normality. For data showing normal distribution (WOMAC scores), paired sample t-tests were used to compare pre- and post-intervention means within each group. For non-normally distributed data (VAS scores), the

Wilcoxon signed-rank test was applied for within-group comparisons. To determine between-group differences in improvement (Δ pre–post values), independent sample t-tests were used for normally distributed variables, and Mann–Whitney U tests were applied for non-parametric data.

Results indicated statistically significant improvement in both VAS and WOMAC scores within each group ($p < 0.001$). Effect sizes (Cohen's $d > 2.0$ and rank biserial correlation $> 0.9$) confirmed a large magnitude of change. Between-group comparisons revealed no statistically significant difference ($p > 0.05$), though the SFE group showed higher mean improvements, implying clinically relevant enhancement of pain reduction and knee function. Overall, the findings support the effectiveness of SFE in medial compartment knee OA patients.

**DISCUSSION**

OA in the knee joint is most common cause of disability globally. [2] It is chronic degenerative joint disease and having multiple contributing factor, some are modified and some are non-modifiable. Identifying and addressing the risk factors especially in the joints that bear weight may help to reduce the chance of developing OA and help to avoid pain and disability. One of the most adjustable risk factors is mechanical load exerted on the joints and it is major contributor to OA. [6]

This study focuses on flat foot, one of the risk factors of OA in knee. Alignment and movement of foot and knee are linked through a closed kinematic chain, during majority of the weight bearing tasks. In this chain excessive flat foot structure is linked with lower limb overly internal rotation. Exact effect with this rotation is not known, however it might affect the rotational stress on weight bearing structures of tibiofemoral compartment. Altered stress can harm the knee joint's load bearing tissues. [7] Zhang et al. found that severity of foot flattening is closely related with the degree of OA symptoms in knee. [8] In addition to that, foot absorbs mechanical forces from ground contact, which has impact on both the posture and motion of the knee joint and lower limb. Healthy foot contributes in balance. In flat foot cushioning effect of foot is less and this results into increased stress on knee joint which leads to difficulty in walking. According Patil et al. higher Meary's angle and foot arch index were associated with decreased knee function and greater pain as reflected by KOOS score. [9] Individuals with knee OA and flat feet have increased first medial tibiofemoral contact force while walking. [21] In addition to that during walking, medial compartment of the knee is subjected to higher forces than lateral compartment. [10] According to studies medial cartilage damage and knee pain are commonly caused by flat feet. [9] Study shows individuals with medial compartment shows more pronated foot, as compared with people without symptoms as reflected by foot posture index, increased navicular drop test value and higher arch index values. It is suggested to include foot measures in evaluation of individual with knee OA. [11] Genu varum deformity commonly present in patients with medial compartment knee OA. [22,23] During weight- bearing activities, genu varum may result compensatory pronation of the foot to maintain the foot plantigrade. [24] Recent study found that pronation of subtalar joint is increased by the genu varum walking pattern stimulation, which shows that frontal plane knee deformities can affect the kinetics and kinematics of foot while walking. [25] Altered gait pattern is seen in individuals with foot or ankle symptoms. This alters normal biomechanics and it might raise the chance of developing knee OA. [1]

Sadeghi et al. found that the strengthening treatment approach targeting quadriceps and hamstrings muscles together is beneficial in reducing pain and morning stiffness among the patients with knee OA. [16] Sufficient quadriceps and hamstrings strength is essential to perform daily living activities. [26] Thomas et al. found that strong and high-quality proof supporting the use of hip abductor strengthening exercises as an effective rehabilitation method for knee OA patients. [17] According to Chen et al. evidence supports the efficacy of interferential current therapy in individuals having knee OA, indicating decrease in knee pain in terms of both short and long term along with short term improvement in function as determined by WOMAC scale. [18] According to Kamalakannan et al. in the group that performed SFE in conjunction with interferential therapy and isometric exercises showed greater improvements in pain reduction and functional performance. [10] Muftic et al. found that ultrasound with continuous mode is useful in reducing pain in degenerative musculoskeletal conditions. [19]

SFE is commonly used to improve proprioception of ankle and overall movement patterns. It is developed to enhance dynamic standing balance while elevating and supporting foot's medial longitudinal arch. Regular practice of SFE has been shown to enhance stability and shock absorption, thereby optimizing lower limb biomechanics. Additionally, SFE serves as an effective exercise for intrinsic foot muscle strengthening. Manuel et al. conducted RCT to check effect of intrinsic muscle exercise (SFE) on foot pronation, study finding shows no statistically significant difference when compared with control group. However, it was observed that all participants tended to have a lower index of navicular drop and more neutral index value of foot posture. Study concluded that SFE can be effective in treating conditions in which excessive foot pronation is etiological factor. [20] According to Jung et al. the medial longitudinal arch (MLA) angle was significantly smaller during the SFE than during the toe curl (TC) exercise, and the abductor hallucis (AbdH) muscle's EMG activity was significantly higher during the SFE than during the TC exercise. It has been found that SFE is more useful exercise than toe curling exercise in terms of AbdH activity. [27] AbdH muscle functions as an elevator of foot arch. [28] Jung et al. found that using foot orthosis in conjunction with SFE was more beneficial than using foot orthoses alone at increasing the strength of the flexor halluces and abductor hallucis muscle cross sectional area. [29] In proprioceptive training, SFE is initial step which activated somato-sensory afferent pathway from foot sole. [15] Moon et al. reported that immediate improvement is seen in dynamic stability in individuals with excessive pronated feet after performing SFE, explanation for this was given as, SFE results into stimulation of proprioceptors located at the base of the foot which results into enhancing afferent stimulation this consequently improves stability and voluntary muscle activities. [30]

In current study Navicular drop test is used to evaluate medial longitudinal arch. [10] Increased navicular drop test value suggests pronation of subtalar joint and reduced medial longitudinal arch. [12] Using the navicular drop test for evaluation and participant screening, Aditi et al. carried out an observational cross-sectional study among school-age children to investigate the impact of flat foot on health of foot and quality of life. [31] VAS is used to assess pain as it is reliable and valid method. [13] Western Ontario and McMaster Universities OA Index is used to evaluate knee function as it is reliable and valid outcome measure. [14] Also in a study by, Shruti et al. evaluated people with flat foot and knee OA using the Navicular drop test and WOMAC. [32] Both pain and knee function is assessed prior and post 3 weeks intervention.

Primary goal of this study was to check effectiveness of SFE in knee OA individuals. To our knowledge, this is one of the study focused on checking effectiveness of SFE along with knee and hip focused exercise, electrotherapy in knee OA patients with flat foot. The findings of this study may contribute to design more effective treatment strategies for individuals with knee OA along with flat foot. Total 30 participants were selected depending upon the inclusion and exclusion criteria. Subject were included if they fulfilled the following inclusion criteria: age- 40 to 80 years, both males and females, medial compartment knee OA, VAS score - 3 to 9 navicular drop test more than 10mm and exclusion criteria included: previous knee and ankle surgery, neurological condition, inflammatory arthritis. Aim and objective of the study were explained to participants. Odd even numbering method is used for randomisation of participants into study groups. Group A was experimental group and group B was control group. Group A received SFE, knee and hip focused exercises, ultrasound therapy, interferential therapy, whereas group B received knee and hip focused exercises, ultrasound therapy, interferential therapy for three weeks and 5 days /week.

In the current study 20% participants were males and 80% participants were females (Graph no.1). Also 23.33% subject belongs to 41-50 years age group, 30% subject belongs to 51-60 years age group, 26.67% subject belongs to 61-70 years age group, 20% subject belongs to 71-80 years age group (Graph no.2). Graphs no.3 and 5 shows the pre-intervention and post-intervention VAS score of group A and group B. Graphs no.4 and 6 shows the pre-intervention and post-intervention WOMAC score of group A and group B. The results revealed statistically significant improvement ($p < 0.001$) in the VAS and WOMAC scores of each group. Even though between group differences were not statistically significant ($p > 0.05$), the SFE group showed higher mean improvement, suggesting that knee function and pain were improved in a way that was clinically meaningful.

## CONCLUSION

Improvement in terms of pain reduction and knee function is seen in both groups. Between groups there was no statistically significant difference, but in SFE group knee function and pain reduction were improved in a clinically meaningful way. Overall, the findings support the effectiveness of SFE in patients with medial compartment knee OA.

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