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Correlation Between Pes Planus (Flat Foot) and Anterior Knee Pain (Patello-Femoral Pain Syndrome) Among Obese Homemakers

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ABSTRACT

Background: Pes planus causes tibial rotation, that has been suggested to link movements in the foot and lower leg, so an abnormal alignment of the foot can affect the mechanics of the patellofemoral joint which leads to pain. This leads to Anterior Knee pain that aggravates on activities like: Ascending stairs, Kneeling, Frequent sitting and rising. Musculoskeletal disease is a major cause of pain and disability in the community, although it has minimal impact on mortality. Emerging evidence suggests that even small changes in weight-bearing activity, like walking, are sufficient to cause musculoskeletal pain in the obese.
Objective: To find out the correlation between Pes planus and Anterior knee pain in obese homemakers.
Methods: An observational study was conducted in the community of Anand, Nadiad and Ahmedabad. Depending on the selection criteria, participants were selected and informed consent was signed. The respondents were then requested to offer their demographic information.
Statistical analysis was done by first calculating the descriptive analysis and then using Pearson's correlation to find out the association between Pes Planus and Anterior knee pain.
Results: The correlation of Arch Index with Kujala was weak positive (+0.269) and the correlation of Foot posture index-06 with Kujala is excellent (+0.990).
Conclusions: The study showed an Excellent correlation between Pes Planus (FPI-06) and Anterior Knee pain; and a weak positive correlation between Arch Index and ix Anterior knee pain among Obese (according to the Asian BMI criteria) Homemakers. This means that as the Pes Planus is present there is a high possibility of occurrence of Anterior Knee pain

Keywords: Flat Foot, Pes planus, Anterior knee pain, Patello femoral pain syndrome, Obesity, Homemakers

INTRODUCTION

The human biomechanics of the foot is a complex framework designed for locomotion. The anatomical composite elements form a taut structure called Foot Arches. It recognizes three important arches:

- Medial, Lateral longitudinal arches
- Transverse arch

The appearance of arched feet is one of the distinguishing features of human evolution. This arched foot gets affected in some cases and loses its contour resulting in a deformity called pes planus (Flat foot). The mixture of anatomical anomalies and pathological changes is called flat foot. When the foot arches break, the whole foot sole comes into direct or partial contact with the floor, leading to postural deformities. The arch connecting the forefoot and the hind foot has a flexible and springy effect. The foot can be dissipated during weight-bearing, before any of the pressures hit the "Femur and Tibia". The talar head is moved in the middle and away from the navicular to the flat foot. As a

result, both the spring ligament and the tendon muscles are so stretched that the flat-footed person loses the medial longitudinal arch function. [3]

"Patellofemoral pain syndrome" is characterized as a customary knee concern with various etiology and it is characterized as a 3-month patellofemoral knee pain without AP, lateral, and axial X-ray findings.[5][15]

Individuals having PFPS characterize as: Pain on anterior aspect of the knee on activities like: "ascending stairs, squatting, kneeling, frequent sitting and rising from a seated position". Tibial rotation has been suggested to link movements in the foot and lower leg, so an abnormal alignment of the foot can affect the mechanics of the patellofemoral joint which leads to pain.[15]

"Obesity" is characterized as increase in body weight due to excess body fat buildup. The prevalence of obesity is increasing rapidly worldwide. It is linked with higher levels of:

- glucose tolerance
- hypertension
- hyperlipidemia.

Obesity is regarded as the principal risk factor for Non-insulin dependent diabetes and the prevalence of Non-insulin dependent diabetes will be on the higher side of the obesity epidemic. Obesity is a major threat to the humanity. About one billion people around the globe are overweight and 300 million are obese. "Excessive intake of energy-dense, nutrient-poor foods with high levels of sugar and fat, along with significantly reduced physical activity", is expected to be the principal risk factors for obesity. Recent research has shown more musculoskeletal knee and back pain in obese individuals than in non-obese people. [18]

Almost a fourth of both the genders more than 55 years of age encounter knee pain in nearly all days. The reason that increases the stress on the Tibio-Femoral and Patello-Femoral compartments may be due to an excessive knee loading. Major part of the study was concerned on the local effects of knee malalignation. In addition, the foot plays an even more urgent role in soaking up the mechanical tension of ground touch and carving on the knee and all the lower extremities the pattern of body balance and joint motion. [12]

Tibial rotation is the bridge between Patellofemoral pain and foot-overpronation. It is combined with the movements and pronation on the supination of the foot. Current theories suggested that extreme pronation of the foot after mid-stance would disrupt tibia's external rotation. In the case of overpronation, otherwise external tibial rotation. The modification of ankle and foot cinematics will change the normal T-F joint dynamics by establishing a torsional moment at this joint. It is believed that the internal countervailing rotation of the femur will correct the alignment during the extension. This chained pronation of the offset foot.[15]

The flatter arch can cause weight bearing changes in the foot, resulting in pain, annoyance or discomfort in the foot and other lower limb joints due to their biomechanical synchronization. Infrequent or repetitive foot stress can therefore influence the biomechanics and function of proximal joints, which usually translates into knee, hip, pelvis and lower back pain. [9]

Foot alignment affects the muscle function of the lower limbs. The flat-arched population functioned at a higher percentage of their average EMG amplitude compared to normal-arched feet during the contact cycle for anterior tibialis and during the midstance / propulsion for posterior tibialis. The flat arched foot group also functioned during the whole stance cycle for peroneus longus at a lower percentage of their full EMG amplitude than standard arched feet.

These variations in muscle activity which indicate neuromuscular compensation in humans with flat-arched feet to minimize the longitudinal medial arch stress. [6]

Musculoskeletal disease is a major cause of pain and disability in the community, although it has minimal impact on mortality. Despite reports of a near-dose-response association between lower-limb injury risk and weight-bearing activity in the physically fit population, body adiposity was commonly attributed to greater risk of musculoskeletal pain and injury in both military conscripts and the general population. Emerging evidence suggests that even small changes in weight-bearing activity, like walking, are sufficient to cause musculoskeletal pain in the obese. Above all, obesity was clinically concerned with musculoskeletal disorders affecting the "back, shoulder, knee, ankle and foot." [20]

MATERIALS & METHODS

- **STUDY DESIGN**: Cross-Sectional study"
- **STUDY SETTINGS**: Homemakers of Ahmedabad, Nadiad and Anand district.
- **PARTICIPANT RECRUITMENT**: Participants were recruited in a community setting.
- **SAMPLING METHOD**: Convenient sampling method
- **SAMPLE SIZE CALCULATION**: Total sample size=N=74(75) [23]
- **VARIABLES AND ITS OPERATIONAL DEFINATION**:

- Obesity: "Obesity has been defined as an increase in body weight as a result of an excessive accumulation of body fat, and is commonly measured using the body mass index (BMI)". [18]
- Pes Planus: "Pes planus foot deformity is a lowering of the medial longitudinal arch of the foot causing flattening of the foot arch and is most commonly known as flatfoot." [13]
- Anterior Knee Pain: "The anterior knee pain also known as Patellofemoral Pain Syndrome is characterized by a pain in the frontal part of the knee, which is worsened by activities that increase the compressive strength of the patellofemoral joint such as walking, running, jumping, squatting, going up and down stairs and long periods in sitting position." [22]

STUDY DURATION: 4-6months

MEASUREMENT TOOLS:

1. Data collection sheet
2. Graph paper for Arch index
3. Kujala Scoring Questionnaire
4. Fountain pen Ink water for arch index
5. Foot posture index scale
6. Weighing scale
7. Stadiometer (for height measurement)
8. Calculator, Pen, Pencil, Paper

- **PROCEDURE:** Homemakers were detected and inspected according to inclusion and exclusion criteria by a door-to-door programme in the Ahmedabad, Nadiad and Anand districts. The selected homemakers were explained about the study and its purpose. Informed consent was taken in written before the conducting the procedure. Calculation of BMI was done. Obese homemakers were selected as per the Asian BMI criteria. Measurement of Pes planus by Foot posture index-6 and plantar arch index method. Anterior knee pain was assessed by Kujala Scoring Questionnaire

STATISTICAL ANALYSIS

The statistical analysis of the data obtained will be undertaken using IBM SPSS version 23software." Descriptive Analysis (Mean, SD) of the demographic data is calculated. Pearson correlation is used.

RESULT

DESCRIPTIVE STATISTICS:

- ✓ Out of 75 participants:

- ✓ 56 had flatfoot as per the foot posture index. (74.6%)
- ✓ 57 had lowered medial longitudinal arch as per plantar arch index. (76%)
- ✓ 46 had Anterior knee pain. (61.3%)
- ✓ 33 had Anterior knee pain+ Pes planus (44%)
- ✓ 13 had anterior knee pain only due to obesity (17.33%)
- ✓ Only 4 of them had no flat foot but no anterior knee pain despite of obesity. (5.33%)

Table 1: Descriptive statistics for obese homemakers

		Maximum	Minimum	Mean	Standard Deviation
Age (in years)	75	40	25	35.30 years	4.55
BMI (kg/m^2)	75	51	25.4	31.29 kg/m^2	4.37
FPI (foot posture index)	75	12	01	6.89	2.46
PAI (plantar arch index)	75	0.39	0.21	0.29	0.03
Kujala (anterior knee pain scoring questionnaire)	75	100	46	89.41	14.28
Kg= Kilograms; m=meter					

The above table describes the descriptive statistics of the demographic details of Obese Homemakers. Mean age is 35.3 years. Mean BMI is31.29 Kg/m^2. Mean scores of FPI-06 and PAI are 6.89 and 0.29 respectively. Lastly the mean score of Kujala scoring questionnaire is 89.41.

Table 2: Frequency and Percentage of all the outcome measures

Variables	Frequency	Percentage
FPI		
Normal	19	25.3
Pronated Foot	44	58.7
Highly Pronated Foot	12	16.0
PAI		
Normal	18	24.0
Flat Foot	57	76.0
Kujala Scoring Questionnaire		
Normal	29	38.7
Anterior Knee Pain	46	61.3
BMI		
Gr 1 Obesity (25.0-29.9)	32	42.7
Gr 2 Obesity (30.0 and above)	43	57.3

The above table shows the data of different outcome measures and their frequencies and percentages in different categories.

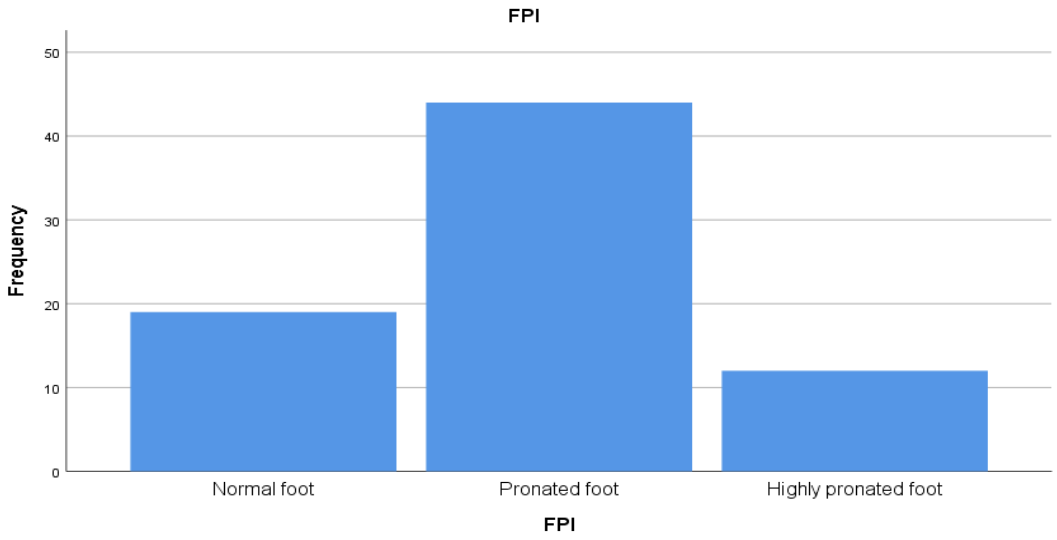

Fig 1: Frequency of samples with Normal foot, Pronated and Highly pronated foot according to Foot posture Index-06 (FPI-06)

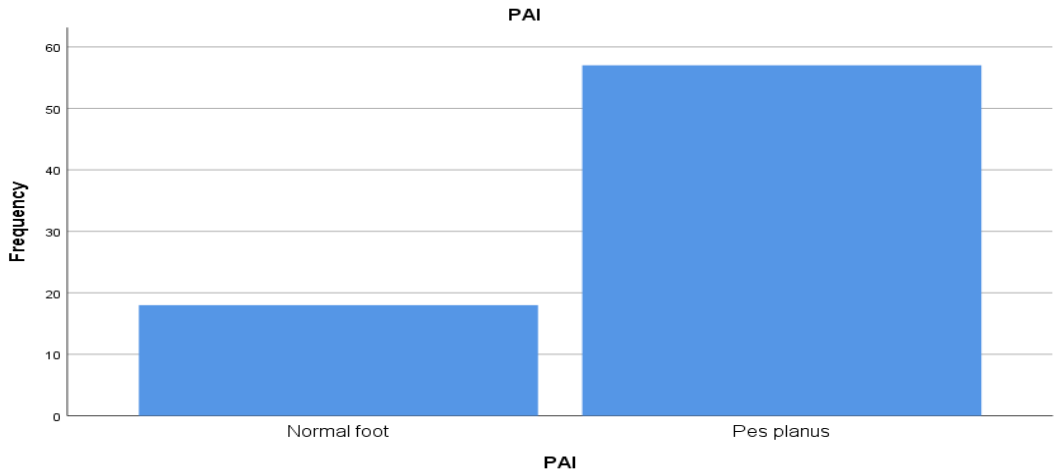

Fig 2: Frequency of samples with Normal foot and Pes Planus according to Plantar Arch Index (PAI)

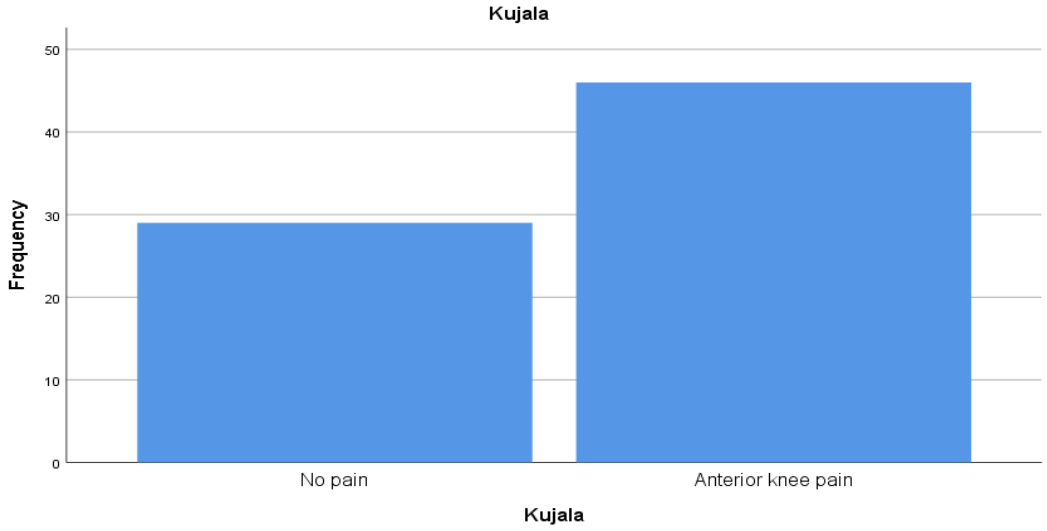

Fig 3: Frequency of samples with and without anterior knee pain according to kujala scoring questionnaire

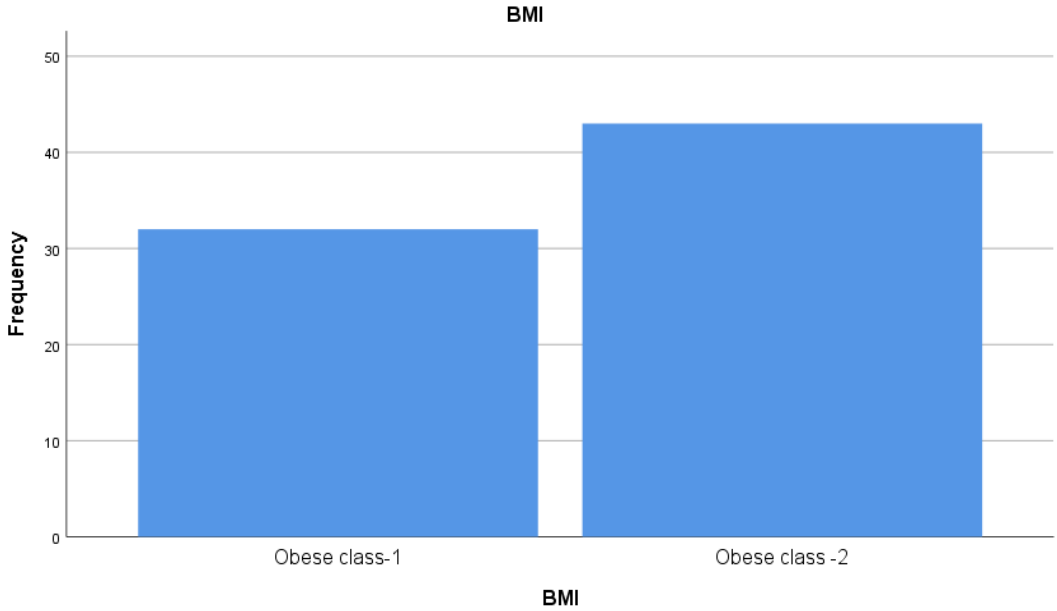

Fig 4: Frequency of samples with Grade: I and Grade: II Obesity

Table 3: Components of Flat foot

COMPONENTS	N	%
Talar head palpation	35/46	76.08%
Curves above & below the Lat malleolus	36/46	78.26%
Inversion/Eversion of Calcaneus	39/46	84.78%
TNJ Bulge	35/46	76.08%
Medial Longitudinal Arch	41/46	89.13%
Abduction/Adduction of forefoot on rearfoot	41/46	89.13%

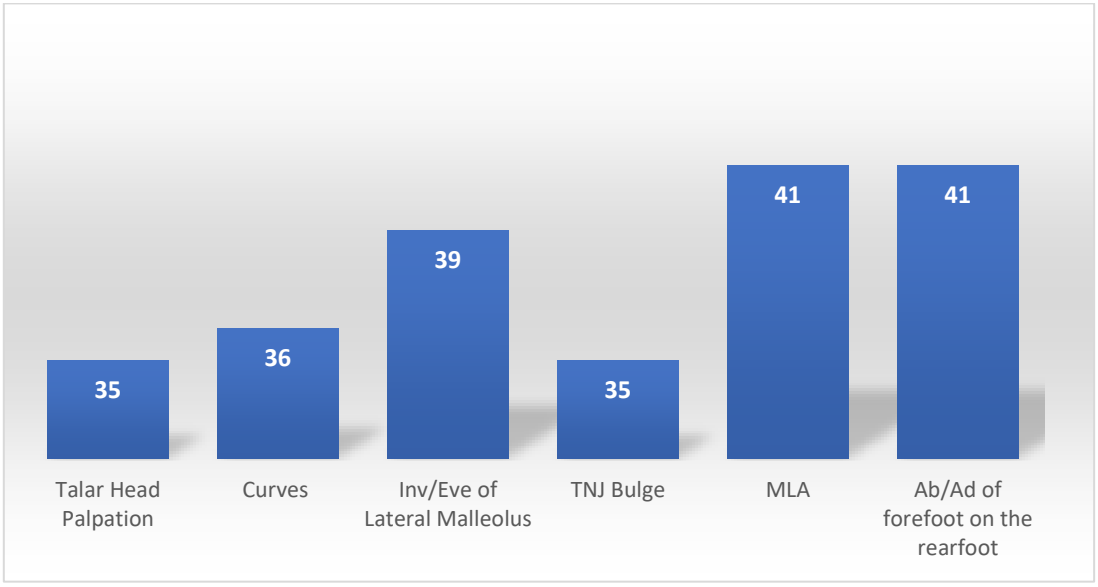

Fig 5: The Bar chart above represents different components of FPI-06 that were positive in samples with Anterior knee pain

Table 4: Correlational analysis between Pes planus and Anterior knee pain

Variable	Statistics	Foot Posture Index	Plantar Arch Index
Kujala (Anterior knee pain scoring questionnaire)	Pearson(r)	+0.99	0.269
	Sig-2- tailed(P)	.000	.020
	N	75	75

There is a Strong positive significant correlation between FPI-06 and Kujala scoring questionnaire and there is a Weak positive significant correlation with PAI and Kujala scoring questionnaire.

Table 5: Correlational analysis between Obesity and Anterior Knee pain

Variable	Statistics	BMI
Kujala scoring Questionnaire	Pearson(r)	0.999
	Sig-2-tailed(P)	.000
	N	75

There is a Strong positive significant correlation between BMI and Kujala scoring questionnaire.

Table 6: Correlational analysis between Pes planus and Obesity

Variable	Statistics	Foot posture index (FPI)	Plantar arch index (PAI)
BMI(OBESITY)	Pearson(r)	+0.993	+0.289
	Sig-2-tailed(p)	*0.000	*0.012
	N	75	75

There is a strong positive significant correlation between FPI-06 and BMI and a weak positive correlation between PAI and BMI.

DISCUSSION

The present study analyzed the correlation between Pes Planus (Flat Foot) and Anterior Knee pain among Obese Homemakers. A population of female homemakers were chosen because as in the earlier studies,

Anterior Knee pain is originally a female dominant condition (mainly in adolescent females). Previous studies found out the probable causes for increased incidences of Anterior Knee pain in women may be due to anatomic factors, namely increased Q angle , increased lateral thrust on the patella and decreased muscular strength, hormonal factors like the effects of oestrogen on connective tissue synthesis and postural factors like wearing high heels and sitting with adducted legs, may explain this propensity[1].

However, there were no enough evidences that explained the relationship between lower extremity alignment alteration and Anterior Knee pain. There were some studies conducted on Military recruits in Israel and one on the Canadian population. [1,5] But there was no study that explained the relationship between Lower extremity alignment alteration (Pes planus) and Anterior knee pain among Obese housewives especially in the Indian population.

The main objective of the study was to find whether there is a correlation between Anterior Knee pain and Pes Planus among Obese Homemakers. Study results suggested an excellent correlation between them. As secondary objectives we also checked the correlation between Anterior Knee pain and Obesity among the population. Results suggested that there was an excellent correlation among these two variables.

Two outcome measures were taken for Flat foot assessment: Plantar Arch Index and Foot posture Index-06. For the assessment of Anterior Knee Pain; Kujala scoring questionnaire was used. The correlation of Arch Index with Kujala was weak positive(+0.269) and the correlation of Foot posture index-06 with Kujala is excellent(+0.990). Though both the correlation were significant, Arch Index had a much lower correlation then Foot posture index-06. There may be some possible reasons for this:

- Low inter and intrarater reliability of Arch index compared to FPI-06 [24,26]
- Arch Index measures only one component that is the Medial longitudinal arch flattening whereas the Foot Posture Index-06 measures all the six components making it more precise.

As per these results it can be considered that the mechanism of Tibial Rotation due to Arch flattening leading to Anterior Knee pain can be considered as a main reason for the cause on Anterior Knee pain among Obese Homemakers.

As a secondary objective of the study we also studied the correlation between BMI and Anterior Knee Pain to check whether obesity plays a role in Anterior Knee pain among Obese Homemakers. There was an Excellent correlation (0.99) between Kujala scoring questionnaire. As per the results Obesity also plays an important role in the occurrence of Anterior Knee pain but it is contradictory to say whether Obesity or Pes planus plays a major role in the Anterior Knee pain, as in this study only obese samples are taken. We also studied that whether there is any correlation between Flexible Pes Planus and BMI.

As per the results we found that:

- Plantar Arch Index and BMI had a WEAK POSITIVE correlation (0.289)
- Whereas Foot Posture Index-06 and BMI had an EXCELLENT correlation (0.993)

As per the results Flexible Pes Planus is having a high correlation with BMI. As BMI increases there are more chances of acquiring Flat Feet. That is, individuals with more weight had a tendency of low arch foot.[4]

Findings of the previous literature indicate that “the severity of pes planus correlates with the prevalence of essential anterior knee pain. Moderate or severe pes planus is associated with nearly double the rate of anterior knee pain, while mild pes planus had no additional correlation for these symptoms.” [5]

Our Findings indicate the high correlation of Pes Planus with Anterior Knee Pain, but we were not able to distinguish the correlation of Pronated and Highly Pronated Foot with Anterior Knee Pain due to the small sample size.

In this study Asian criteria of BMI is used to exclusively study the Asian population of Obese Homemakers. Similarly, as above we were not able to distinguish the individual correlation of Grade-I and Grade-II obese samples. But as per now we know that obesity increases the risk of Anterior Knee pain, so in further studies we can also study the role of Q-angle in this aspect.

This study can help us to further investigate the effect of Orthotics in the reduction of Anterior knee pain, it can prevent the occurrence of Anterior knee pain among Asymptomatic population and can also help decrease the pain intensity and disability in population with Anterior Knee pain[14] which can further lead to reduction in the cases of Patello-Femoral Arthritis. This ultimately leads to lesser disability, a smaller number of replacement surgeries (Financial Benefit).

CONCLUSION

The study showed an Excellent correlation between Pes Planus (FPI-06) and Anterior Knee pain (Kujala Questionnaire); and a weak positive correlation between Arch Index and Anterior knee pain among Obese (according to the Asian BMI criteria) Homemakers. This means that as the Pes Planus is present there is a high possibility of occurrence of Anterior Knee pain.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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