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EVALUATION OF EFFECT OF OBESITY ON FOOT BIOMECHANICS AND FOOT DISABILITY INDEX IN FEMALE ADULT (18-26 YRS) : A CASE CONTROL STUDY

[1]Dr. Pradnya Mahajan, [2]Dr. Krutika Kale, [3]Dr. Poornadevi Rao, [4]Dr. Mukesh Shinde

[1]Assistant Professor, [2]Intern, [3]Professor, [4]Assistant Professor

Dr. Ulhas Patil College Of Physiotherapy, Jalgaon, Maharashtra, India.

ABSTRACT

Background- Obesity is a major rising health related problem. There are many long-term debilitating effects of obesity that may impair quality of life. Of these musculoskeletal disorders, foot problems in obese adults are most important. This may be due to the increased stress placed on the feet through the need to bear excessive mass.

Purpose- The purpose of the study is to compare the effect of overweight on calcaneal eversion, gastrocnemius extensibility and angle of toe-out in female adults. The further aim was to study the effect of obesity on foot disability index in female adult.

Method- Sixty eight females with a mean age of 18-26 years were divided into 2 groups according to there body mass index. Group A (n=20,BMI =25-29.9) was assigned as a test group and Group B (n=34,BMI=18.5-24.5) were assigned as a control. Measurement for Calcaneal Eversion was obtained in prone whilst Gastrocnemius extensibility was obtained in sitting . The Angle of toe-out was obtained during walking.The Foot Disability Index was fulfilled by the participants.

Result- There was significant difference noted ($p<0.05$) between two groups for calcaneal eversion , gastrocnemius extensibility and angle of toe out. No significant difference ($p>0.05$) was found in foot disability index scale between two groups.

Conclusion-Within limits of present study , significant variation was found in CE,ATO(increase) and GE(decrease) in overweight females. No variation was found in foot disability index.

Keywords= Angle of toe-out, calcaneal eversion, foot disability index, gastrocnemius extensibility, overweight.

INTRODUCTION

Obesity is a major rising health related problem. Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. According to **Quetelet's index** it is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2)[1].

According to BMI, general population is classified in five categories: underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), class I obesity - overweight (BMI 25.0-29.9 kg/m^2), class II obesity - obesity (BMI 30.0-39.9 kg/m^2), class III obesity - extreme obesity (BMI > 40 kg/m^2).[2] For adults WHO defines overweight and obesity as Overweight – BMI >= 25 and obesity as >=30.[1]

Classification	**BMI**	**Risk of co- morbidity**
Underweight	15-18	Low
Normal	18.5-24.9	Average
Overweight	25-29.9	Increased
Class I Obesity	30-34.9	Moderate
Class II Obesity	35-39.9	Severe
Class III Obesity	>40	Very Severe

Classification of BMI

Worldwide obesity has nearly tripled since 1975. In 2016, **more than 1.9 billion adult,18 years and older, were overweight** . Of these over 650 million were obese. 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese. Most of the world population live in countries where overweight and obesity kills more people than underweight. 39 million children under the age of 5 were overweight or obese in 2020,[1].The prevalence of obesity is rising. The World Health Organization estimates that more than 1 billion people are overweight, with 300 million meeting the criteria for obesity. 26% of non- pregnant women ages 20 to 39 are overweight and problems are frequent because the interface between body and ground is subjected to high stresses and load.[3]

Obesity is a natural consequence of an imbalance between energy supply and its expenditure. Excessive dietary intake, usually combined with low physical activity, appreciably contribute to an increased weight gain through boosting the proportion of adipose tissue within the body composition.[4]

There are many long-term debilitating effects of obesity that may impair quality of life. These include cardiovascular disease, diabetes mellitus and various musculoskeletal disorder. Of these musculoskeletal disorders, foot problems in obese adults are most important. This may be due to the increased stress placed on the feet through the need to bear excessive mass. The foot problems are frequent because the interface between body and ground is subjected to high stresses and load. The foot provides a stable support for the body, attenuates impact and rotational forces, provides sensory information and combines flexibility and stability for propulsion of the body.[5,6] The rear foot act as a central mechanism and major weight bearing structure during stance. The forefoot should be aligned perpendicular to the bisection of the calcaneus when the joint was placed in subtalar joint neutral. Any deviation from this position, either varus or valgus, was considered abnormal motion and potential injury. Author also coined that individuals with a forefoot varus alignment might compensate through the midtarsal or subtalar joint through excessive pronation. However, excessive pronation has been linked with injuries to muscle imbalance which disrupt normal lower limb alignment. The malalignment is thought to place undue stress and strain on the joints, ligaments and muscles.(7)

WHITNEY Lowe LMT et al. Pronation is a dynamic movement of the foot that includes **dorsiflexion, eversion and abduction of foot**. A foot with overpronation bears more weight on the medial edge. Unless there is a severe, acute injury, overpronation develops as a gradual mechanical distortion. Several factors contribute to developing overpronation including tibialis posterior weakness, ligament weakness, excess weight, pes planus, genu valgum, subtalar eversion or other biomechanical distortion in the foot or the ankle. Obesity is the another cause for overpronation. The architechture of foot is not designed to carry disproportionate weight. As a result, the excessive weight causes subtalar eversion and forces longitudinal arch to collapse. A statistical calcaneal valgus is evident during examination of the foot, and this valgus angulation causes overpronation during the gait cycle. Overpronation can be contributing factor in the other lower extremity disorder If overpronation exists, the shockforce is not adequately absorbed by the foot and is transmitted further up the kinetic chain (8)

A high prevalence of disabiling foot pain and perception of foot deformities, poor foot health and presence of other foot pain have been associated with adults who are overweight and obese.(9,!0) In recent investigation it is found that foot is not immune to the effect of obesity(9) and obesity is strongly associated with non- specific foot pain in general population. Excess bodyweight lead to greater mechanical loading of the foot(11). Elevated plantar pressure have emerged as a problem for high weight adult during gait It has been demonstrated that load carriage could adversely affect a number of physiological parameters such as gait.(12,13) Obesity increases ground contact area of foot altering the plantar pressure distribution and inducing pressure peaks in certain area of foot.(11,14) Plantar loading increases in obese individuals. Many studies examining this point of view has been carried out.(15,16,17,18)

Butterworth,PA, Landorf,K B ,Smith ,S E, and Menz, H B. Obese and overweight adult shows broadening of forefoot regions and increase in forefoot width to foot length ratio. The highest foot pressure measure increases were found under the heel of the foot(rearfoot) and metatarsal head. It was observed that changes in planatar pressure with increased BMI has marked effect on structure and biomechanics of foot .Plantar heel pain seems to be a common problem.(19)

Calcaneal eversion occurs in frontal plane. It is one component of tri-plane motion of pronation of the subtalar joint. Along with this substantial amount of abduction also occurs in transverse plane at subtalar joint. It occurs de to striking lateral aspect of heel during walking and the ground reaction force forces calcaneal to evert . Since the motion is produced by gravity and ground reaction forces, the role of muscles is to decelerate the motion and the muscles lenghthened and activated proprioceptively .The starin created in muscles during deceleration is transformed into concentric motion producing force. When the calcaneus is everted , weight is forced into medial edge of the foot.Obesity can cause overpronation due to subtalae eversion and produces the longitudinal arch to collapse.hence pain at ankle and knee joint occurs.(7)

One of the common muscle imbalances that affect the ankle joint is a tight gastrocnemius-soleus. These muscles use 85% of their voluntary contraction during normal walking to help restrain the body’s forward momentum by working eccentrically and concentrically.(21) It represents angle of foot placement or Fick angle of Tracking angle. It is measured as angle formed by each Foot’s line of progression and line intersecting center of heel and second toe. It is approximately 120-180 from sagittal axis of the body, developing from 50 in children. The angle for men normally is about 70^0 of each foot at free speed walking. The degree of toe out decreases as speed of walking increases in normal men.(22) It may be present due to contracture of the gastrocnemius and soleus.

Butterworth,PA, et al. obesity is strongly associated with planus (low arched)foot posture, pronated dynamic foot function and increased plantar pressure when walking.(23) Among the main problem connected with obesity are toe deformities, widening of the forefoot and heel area, transverse arch collapse in the metatarsal area, flatfootedness (the collapse of the midfoot area of the longitudinal arch) and heel misalignment.(9,23,24,25) A study carried out by **Kristina Tomankova et al** which have confirmed being overweight and obese documents a high BMI having undesirable negative effects on the feet, probably due to greater mechanical loading of the lower limb. It is believed that body fat mass, rather than changes in foot morphology and structure, may be the cause of an increased midfoot contact area and ultimately fallen arches.[26] The purpose of the study is to compare the effect of overweight on calcaneal eversion, gastrocnemius extensibility and angle of toe-out in female adults. The further aim was to study the effect of obesity on foot disability index in female adult.

MATERIAL AND METHODOLOGY

Sample size-

68 female subjects at the age group of 18-26 years were selected

On the basis of BMI, they were divided into 2 groups

34 females with BMI 18.5 -24.5 were assigned to group A (control)

34 females with BMI 25-30 were assigned to group B (overweight and obese)

Study design- Cross-sectional study

Study Type- Case- control study

4. **Study Setting-** Dr.Ulhas Patil medical college and Hospital, Jalgaon.

Duration of study- 6 months.

Target population- Obese and Non Obese female adults of 18- 26 years of age.

Method of sampling- A non-random convenient sample design was choosen.

Selection criteria

Inclusion criteria:

Subjects with informed consent.

Age group of 18-26 years

For obese BMI of 25-29 and for non obese BMI of 18.5-24.9.

Exclusion criteria:

Subject with previous history of -

Congenital deformity

Ligament injury

Other soft tissue injury

Any neurological condition that affects tissue extensibility and balance.

Fracture

Any structural deformity of hip ,knee and ankle.

Limb length discrepancy

Materials required

Informed consent

Pen

Paper

Goniometer

Weighing machine

Measuring tape

Table

10. Outcome measures-

Foot disability index

Calcaneal eversion Range of motion

Gastrocnemius extensibility that is ankle dorsiflexion ROM.

Angle of toe out

11.Statistical analysis-

An unpaired t-test is performed between obese and non-obese individual.

An paired t-test is performed within group i.e. right and left feet of obese individual

and right and left feet of non-obese individual.

The independent t-test were performed using Instat Graphpad computerized software.

PROCEDURE

a) Ethical clearance was obtained from the institutional ethical committee. The permission for research was obtained from principal of Dr. Ulhas Patil College of Physiotherapy.

b) Subjects were screened according to inclusion & exclusion criteria and age matching criteria. The purpose and the procedure of the study was explained to selected participant.

A written informed consent was obtained.

SELECTION OF CASES & CONTROLS

THE SUBJECT WERE ASSIGNED TO ONE OF TWO GROUPS

- **GROUP A (CASE, n =34) :** We defined a case as a obese female age 18-26 years of age, who has BMI in the range between 25-29.9 obese group.
- **GROUP B (controls , n=34) :** We defined a control as a normal healthy female age 18-26 years of age, who has BMI in the range between 18.5-24.5.

To avoid bias in the study we selected age & gender matched criteria.

e) Selected participant were evaluated for the calcaneal eversion, gastrocnemius extensibility, angle of toe out by following assessment and procedure .

Foot disability index scale was given to subjects.

METHOD

Measurement of Calcaneal Eversion (ICC-0.6)

- Subtalar joint eversion was determined with subjects positioned prone with lower half of calf off the edge of plinth.
- First identify the calcaneus and lines was drawn along the midlines on the posterior third of calf and calcaneus.

Range of eversion was measured using a gonimeter.

The axis of goniometer was placed between the malleoli in the frontal plane.

- The stationary arm of goniometer was placed over the line on the posterior region of the calf and the movable arm was placed over the line of posterior calaneus

The calcaneus was passively everted to obtain subtalar joint range of motion (ROM).

The normal range for calcaneal eversion is 5-10^0

figure no. 1

figure no. 2

Measurement of Gastrocnemius extensibility (ICC= 0.83)

- The subject was positioned in sitting position and a marker was used for making the fibular head, lateral malleolus , base of 5th metatarsal tuberosity and 5^{th} metatarsal head.

- The stationary arm of the gonimeter was placed along the long axis of fibular by using the mark on the fibular head and the lateral malleolus.

The moving arm of the gonimeter was then placed parallel to the lateral border of the foot by using the marks on the base and head of 5 metatarsal.

The axis of the gonimeter was kept on the lateral border of the foot.

- The zero position dorsiflexion was defined as 90^0 between the long axis of fibula and the lateral border of the foot.

All the measurement was recorded as the subject achieved maximum dorsiflexion.

The normal range for dorsiflexion is 15-20^0.


figure no.3


figure no. 4

<u>Measurement of the Angle of toe out(ICC =0.95)</u>

□ It represents the angle of foot progression and it is formed by each foot's line of foot progression and line intersecting the center of heel and second toe.

The subject was instructed to walk away .

From the 2nd footprint, three consecutive footprints were evaluated for ATO .

The normal angle of toe-out is 13^0.


figure no.5

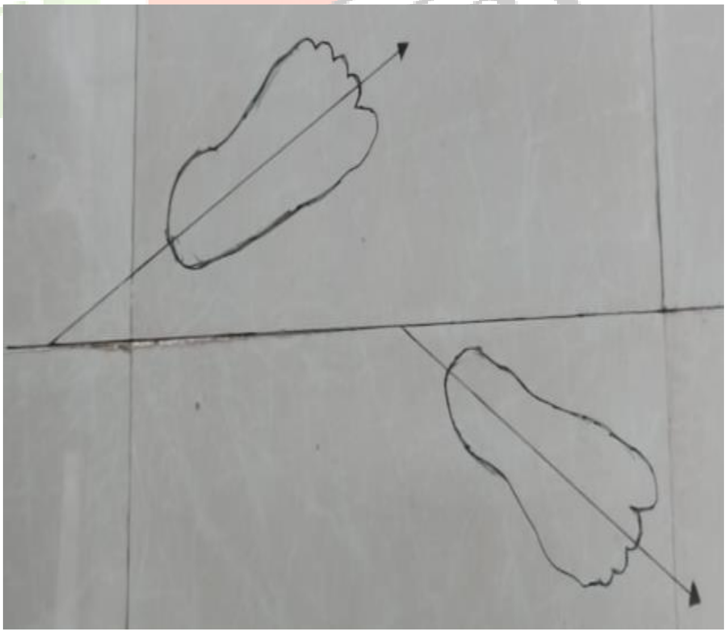


figure no. 6

FOOT AND ANKLE DISABILITY INDEX (ICC =0.89)

- FOOT AND ANKLE DISABILITY INDEX was used as valid and reliable measure of pain and disability.
- The Foot and Ankle Disability Index is 26 items questionare , which contains 4 pain related items and 22 activity related items.
- The total score is out of 104 points and justifies no disability.

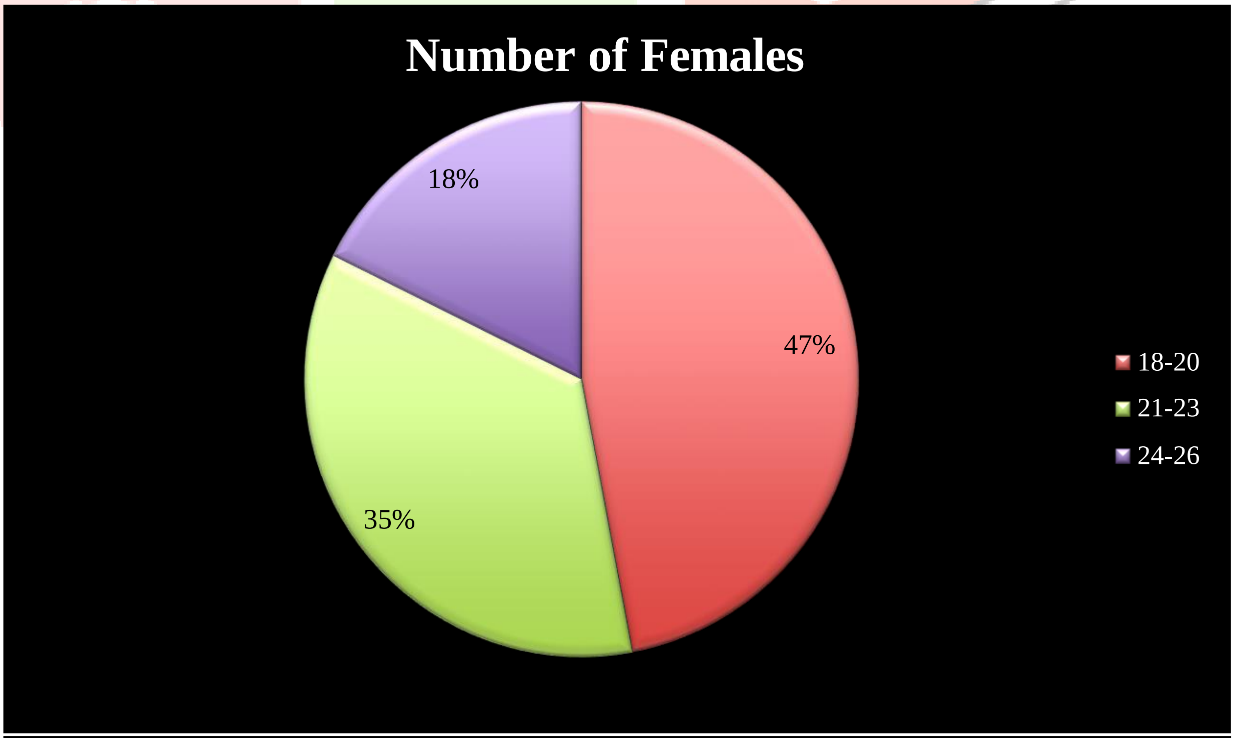
DATA ANALYSIS

The data was analysed in excel sheet. Instat graphpad was used to calculate the mean, standard deviation and p-value .Unpaired t-test was performed in to compare values of obese and non obese individuals .
Paired t-test was performed between obese individual right and left foot and same for non- obese individual.

Table 1 : showing age distribution of females adults

Age	Number of females	
	OBESE	NON-OBESE
18-20	16	16
21-23	12	12
24-26	06	06

Graph 1 : showing age distribution of female adults



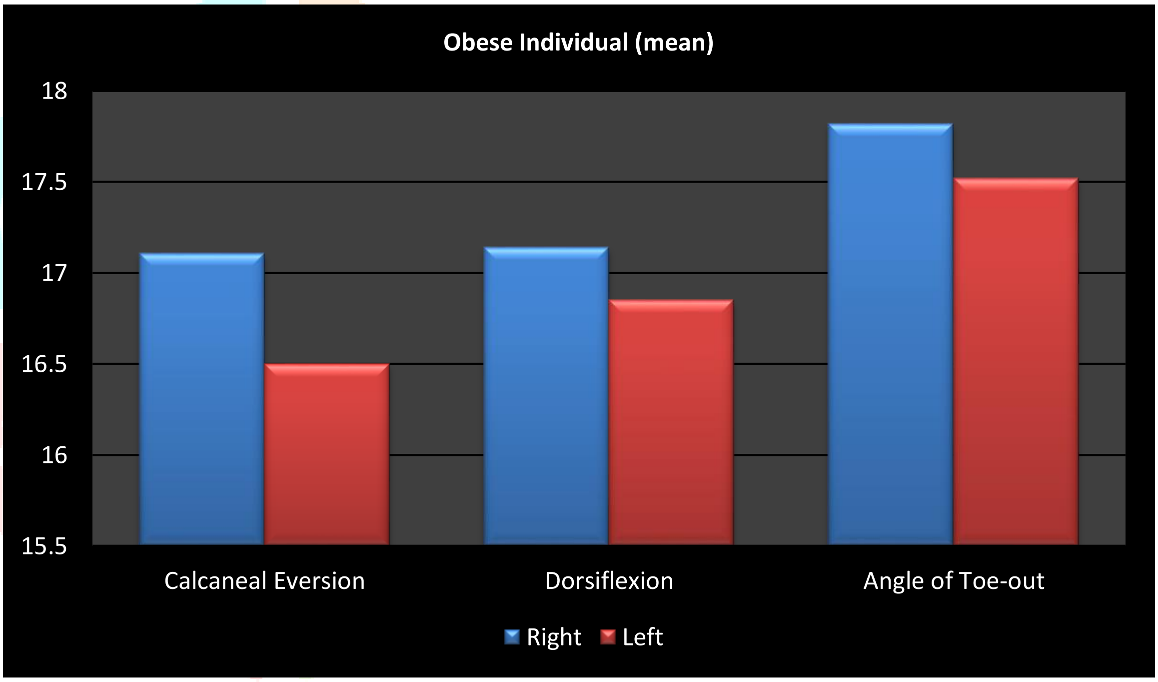
Inference :

In age group of 18-20 ,16 female adults were obese and 16 were non-obese ,whereas in age group of 21-23 , 12 female adults were obese and 12 were non-obese and in the age group of 24-26, 06 female adults were obese and 06 were non-obese.

Table 2 : to evaluate effect of obesity on right & left foot biomechanics of female adults(mean) in obese individuals.

Biomechanical Parameters	Obese right foot	Obese left foot
Calcaneal eversion	17.11	16.50
Dorsiflexion	17.14	16.85
Angle of toe out	17.82	17.52

Graph 2 : to evaluate the effect of obesity on foot biomechanics of female adults(mean) in obese individual.



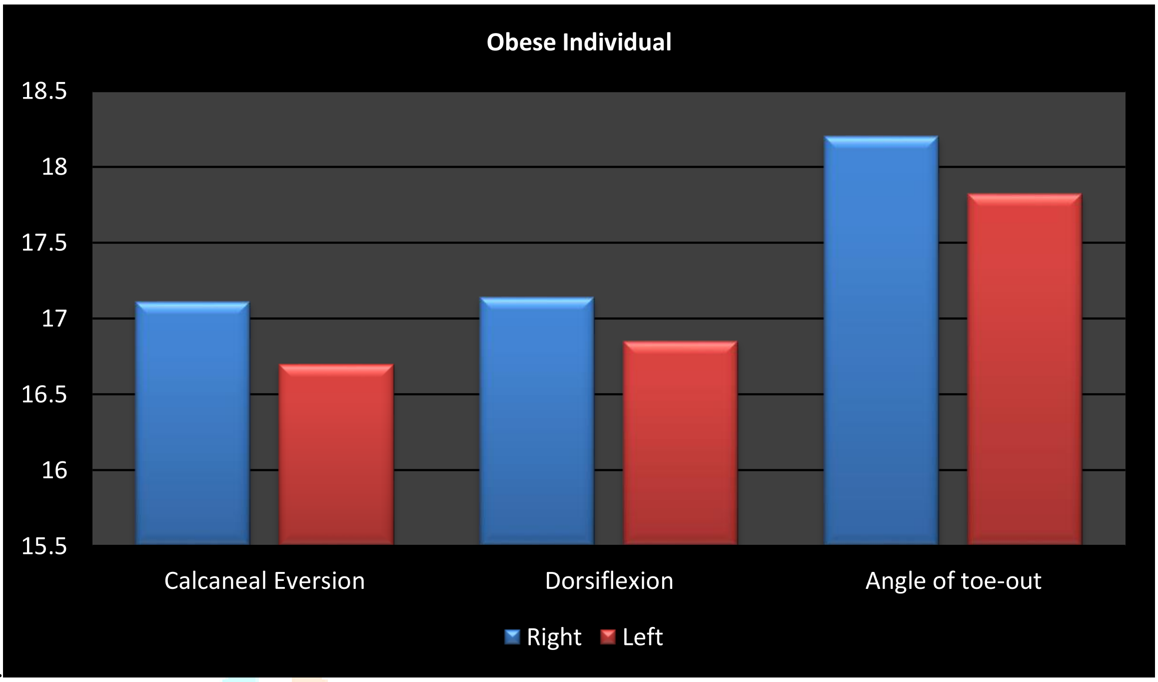
Inference :

From the above mentioned table it is inferred that the value of **mean** of right foot parameters as compared to left was found to be more .

Table 3 : to compare the effect of obesity on right and left ankle biomechanics in female adults in obese individual in using paired t test.

Biomechanical Parameter	Right (mean±SD)	Left (mean±SD)	p-value	Significant
Calcaneal eversion	17.11±2.5	16.70±2,85	0.006	Significant
Dorsiflexion	17.14±1.90	16.85±2	0.10	Significant
Angle of toe-out	18.20±2.12	17.82±2.13	0.010	Significant

Graph 3 : to compare the effect of obesity on right and left ankle biomechanics in female adults in obese individual using paired t test.



t.

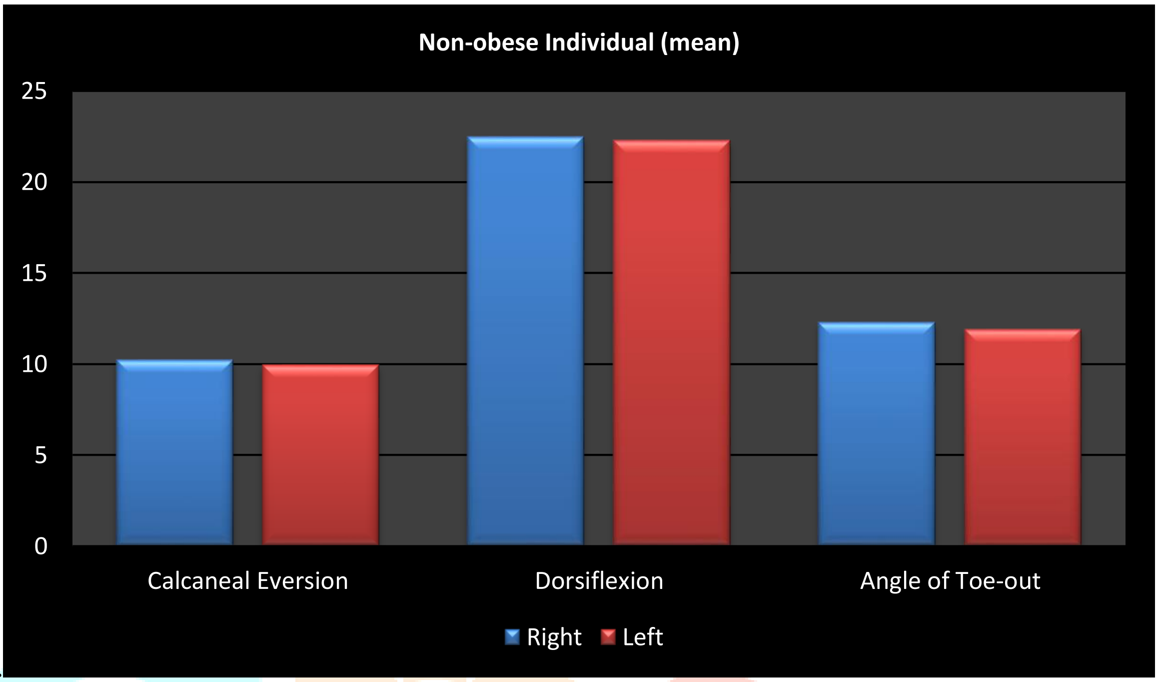
INFERENCE :

From the above mentioned table it is inferred that there is a significant difference between right and left foot of calcaneal eversion, dorsiflexion and angle of toe-out in obese individual.

Table 4 : to evaluate effect of obesity on right & left foot biomechanics of female adults (mean) in non-obese individuals.

Biomechanical parameters	**Non-Obese right foot(mean)**	**Non-Obese left foot (mean)**
Calcaneal eversion	10.23	9.94
Dorsiflexion	22.5	22.29
Angle of toe out	12.29	11.91

Graph 4 : to evaluate effect of obesity on right & left foot biomechanics of female adults(mean) in non-obese individual.



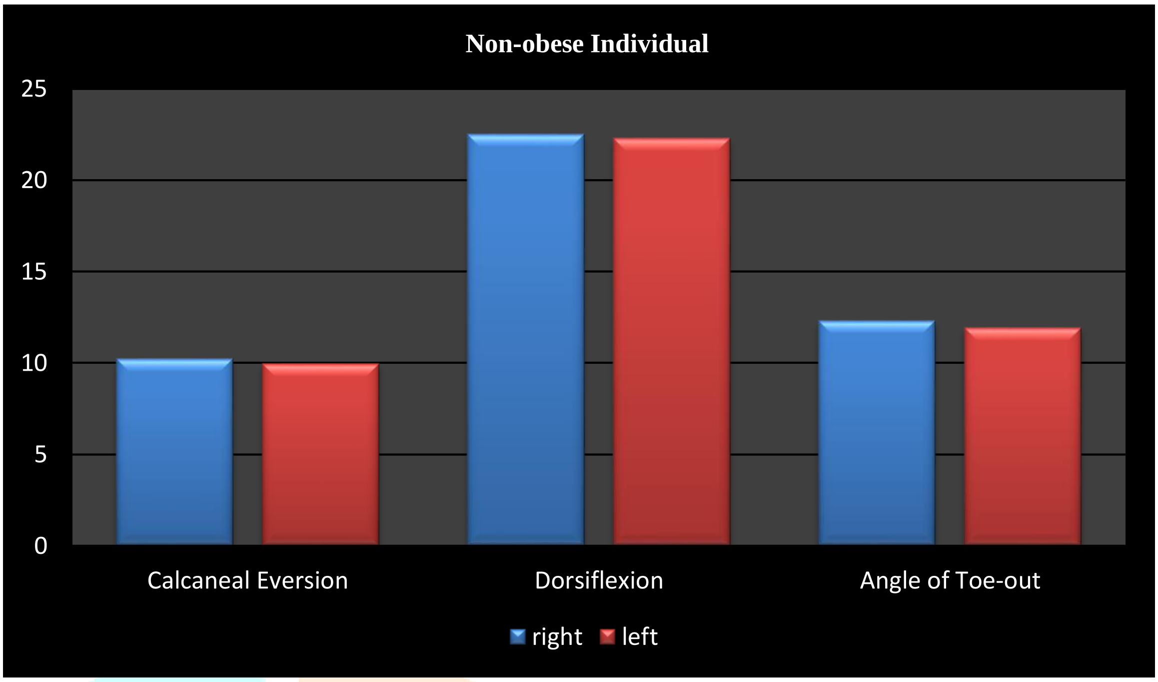
INFERENCE :

From the above mentioned table it is inferred that the value of **mean** of right foot parameters as compared to left was found to be more .

Table 5: to compare the effect of obesity on right and left ankle biomechanics in female adults in non-obese individual using paired t test.

Biomechanical parameter	**Right** (mean±SD)	**Left** (mean±SD)	**p-value**	**Significant**
Calcaneal eversion	10.23±1.04	9,94±0.88	3.273	Not significant
Dorsiflexion	22.52±1.95	22.29±1.97	2.766	Not significant
Angle of toe-out	12.29±0.83	11.91±0.83	0.001	Significant

Graph 5: to compare the effect of obesity on right and left ankle biomechanics in female adults in non-obese individual using paired t test.



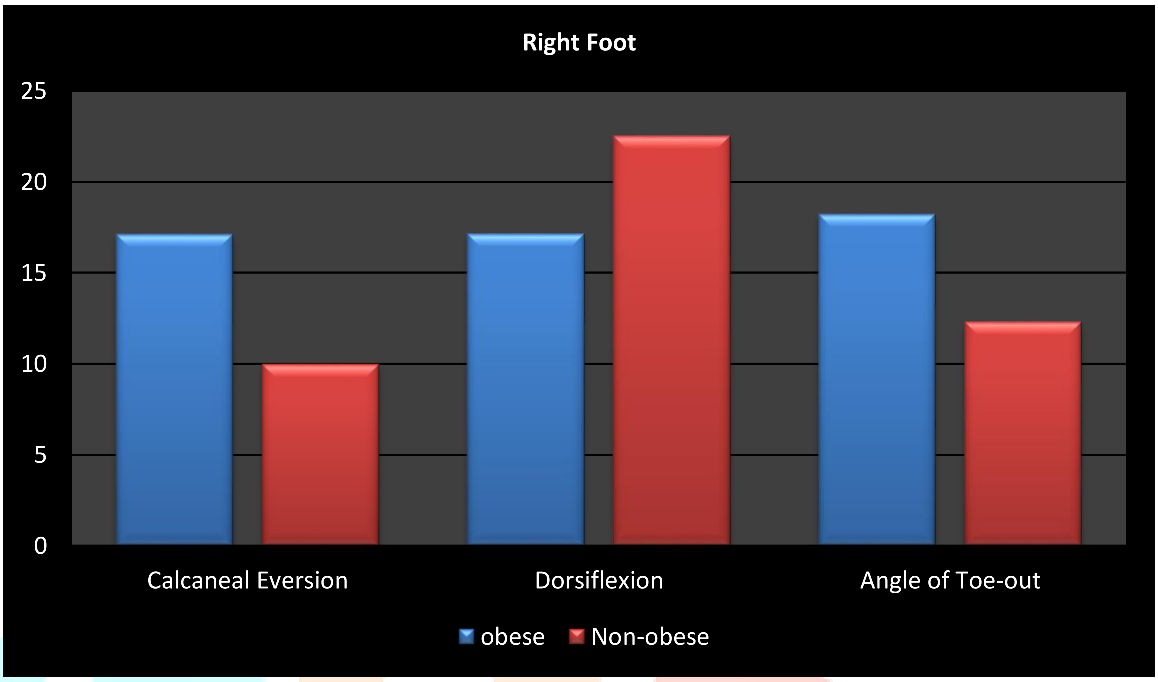
INFERENCE :

From the above mentioned table it is inferred that there is no significant difference found between right and left foot of calcaneal eversion and dorsiflexion whereas a significant difference was found in angle of toe–out.

Table 6 ; to compare the effect of obesity on right ankle biomechanics between obese and non-obese young female using unpaired t test.

Right Biomechanical Parameters	**bese female (mean±SD)**	**n-obese female (mean±SD)**	**p value**	**Significance**
Calcaneal eversion	17.12±2.51	9.97±1.90	0.0001	Extremely significant
Dorsiflexion	17.15±1.91	22.53±1.96	0.0001	Extremely significant
Angle of toe out	18.21±2.13	12.29±0.84	0.0001	Extremely significant

Graph 6 ; to compare the effect of obesity on right ankle biomechanics between obese and non-obese young female using unpaired t test.



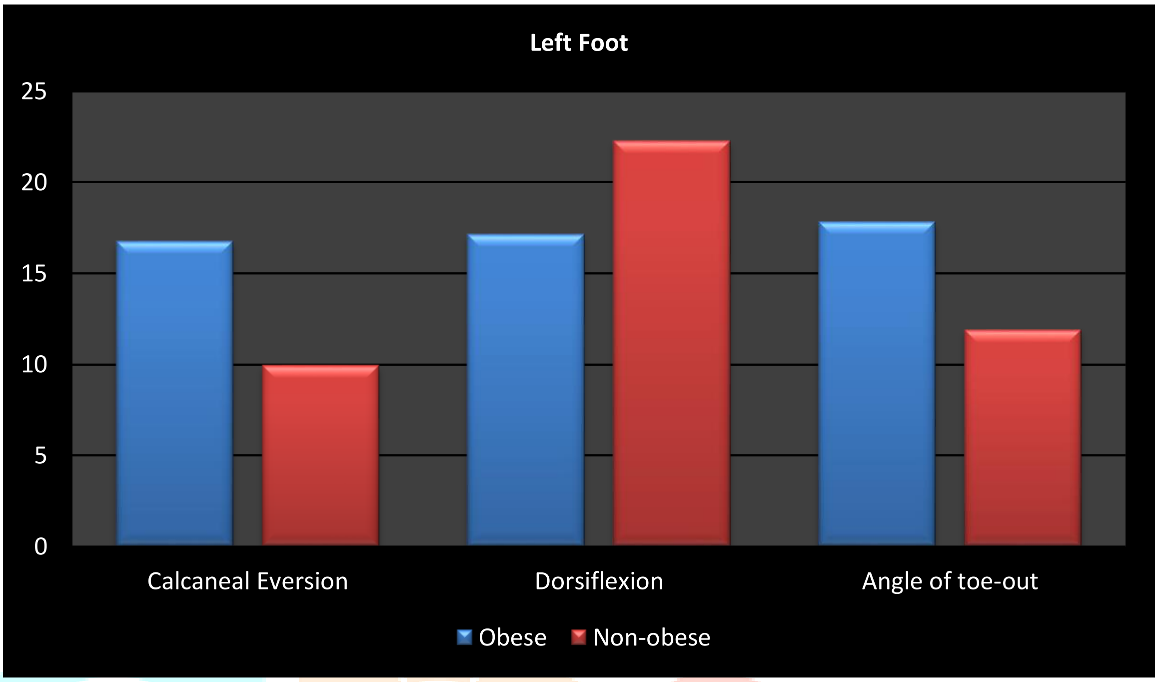
Inference :

From the above mentioned table it is infered that the results are statistically extremely significant of calcaneal eversion. Dorsiflexion and angle of toe out in female adult.

Table 7; to compare the effect of obesity on left ankle biomechanics between obese and non-obese young female using unpaired t test

Left Biomechanical parameters	**Obese female (mean±SD)**	**Non-obese female (mean±SD)**	**p value**	**Significance**
Calcaneal eversion	16.76±2.82	9.94±0.89	0.0001	Extremely significant
Dorsiflexion	17.15±2.00	22.29±1.96	0.0001	Extremely significant
Angle of toe out	17.82±2.14	11.91±0.83	0.0001	Extremely significant

Graph 7 ; to compare the effect of obesity on left ankle biomechanics between obese and non-obese young female using unpaired t test.



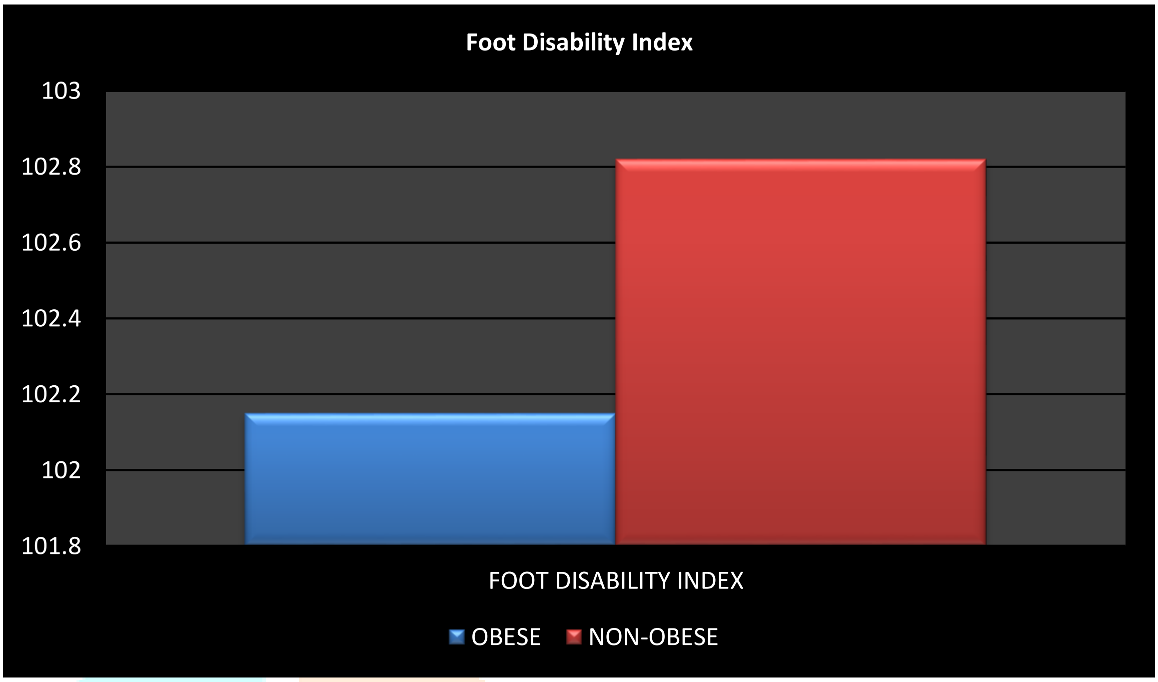
Inference :

From the above mentioned table it is infered that the result is statistically extremely significant of calcaneal eversion, dosiflexion and angle of toe out.

Table 8: to compare the effect of obesity on foot disability index in obese and non-obese female adult .

Foot disability index	**)bese female (mean±SD)**	**Non-obese female (mean±SD)**	**p value**	**Significance**
	102.15±1.672	102.82±1.52	0.0898	Not significant

Graph 8 : to evaluate the effect of obesity on foot disability index in obese and non-obese female adult using unpaired t test.



Inference :

From the above mentioned table, it is inferred that there is no significant difference of effect of obesity on foot disability index in obese and non-obese individuals.

RESULTS

1. Total 68 subjects were included in the study. There were no dropouts. Out of 68 subjects 34 were allotted to non-obese female adults and 34 were allotted to obese females with age matching criteria. In the **table 1** three subgroups of **age** were divided between obese and non-obese individual . In 18-20 years of age in which 16 obese & 16 non obese females were there then in 21-23 years of age there were 12 obese females 12 non-obese and in 24- 26 years of age 6 obese and 6 non-obese females were there.
2. From the **table 2** evaluating effect of obesity on right & left foot biomechanics of female adults (mean) in **obese individuals,** the value of **mean** of right foot parameters as compared to left was found to be more.
3. From the **table 3 showing** comparison between the effect of obesity on right and left ankle biomechanics in female adults in **obese individual** using **paired t test** the results were found that the calcaneal eversion, dorsiflexion and angle of toe out was more of right foot as compared to left. .A significant difference between right and left foot was found with a p value of calcaneal eversion = 0.006 , dorsiflexion = 0.10 and angle of toe-out = 0.010.
4. From the **table 4** evaluating effect of obesity on right & left foot biomechanics of female adults (mean) in **non-obese individuals.** the value of **mean** of right foot parameters as compared to left was found to be more
5. From the **table 5** comparison between the effect of obesity on right and left ankle biomechanics in female adults in **non-obese individual** using **paired t test** the results were found that the calcaneal eversion, dorsiflexion, and angle of toe out was more of right foot as compared to left. There was No significant difference found between right and left foot of calcaneal eversion(p=3.273) and dorsiflexion (p=2.766) whereas a significant difference was found in angle of toe–out (p= 0.001).
6. From the **table 6** comparison between effect of obesity on ankle biomechanics between **obese and non-obese female (right foot). An unpaired t test** is performed between both the groups. The result in the present study shows that there is more calcaneal eversion and angle of toe out in obese female as compared to non obese and less dorsiflexion in obese group as compared to non obese. The result were found to be statistically extremely significant (p value=0.0001)
7. From the **table 7** comparison between effect of obesity on ankle biomechanics between **obese and non-obese female (left foot). An unpaired t test** is performed between both the groups. The result in the present study shows that there is more calcaneal eversion and angle of toe out in obese female as compared to non obese and less

dorsiflexion in obese group ascompared to non obese. The result were found to be statistically extremely significant (p value=0.0001)

8. For the **table 8** showing comparison between **foot disability index** in **obese and non- obese female** an **unpaired t test** was performed. The results in the present study shows that there is no significant difference between both groups (p value=0.089).

DISCUSSION

This study was conducted with a purpose to evaluate the effect of obesity on foot biomechanics and foot disability index in female adults. This was a cross sectional study performed on 68 female adults of age group between 18- 26 years , out of which 34 participants were obese and 34 participants were non-obese. The BMI was calculated first using quetelets index to rule out any error. Then the biomechanical parameters
Calcaneal eversion , gastrocnemius extensibility and angle of toe out were measured of both the groups.

Obesity in simple terms may be defined as a state of imbalance between calories ingested versus calories expended which would lead to excessive or abnormal fat accumulation. BMI is a measure of weight corrected for height which reflect total body fat and had been most accepted parameter for defining overweight.(27)Obesity leads to increase in occurrence of diverse disease either independently or in association with other diseases and exacerbates disease progression as well as adversely affecting foot function. Increased weight on the feet significantly increases foot contact area ,with increases pressure on these area ,leading to increased foot problem such as pain,vascular and neuropathic disease , deformity and joint mobility.(28) Researcher suggest a link between higher body mass and flattening of arches. Extra weight puts stress on the foot causing flattening of the arches. In weight bearing there is flatness of longitudinal arch which is usually accompanied by out toeing.(30)
Foot pain is associated with pain in other joints, reduced health related quality of life and obesity. One of the mechanism that may link increased body weight and foot pain is mechanical loading . Increased BMI is known to contribute to elevated peak plantar pressure and this elevated peak plantar pressure are associated with foot pain. It seems intuitive, then that as body weight increases ,plantar pressure increases , overloading plantar tissue and causing pain.(31)

The chief objective was to evaluate the effect of obesity on foot biomechanics and foot disability index in female adult (18-26 years)

Outcome measure in the study showed the following results :

The result showed there is a significant difference between obese and non-obese group in Calcaneal Eversion (p value =0.0001) Gastrocnemius extensibility (p value=0.0001) angle of toe-out (p value = 0.0001).

This findings are supported by a research done by **Megha Masaun, P. Dhakshinamoorthy , Rahul Singh Parihar (2009)** conducted study on comparison of calcaneal eversion, gastrocnemius extensibility and angle of toe out between normal and overweight female which was done in 40 subjects with a mean age of 24.3 years and divided into 2 groups with a mean age of 24.3 years. They concluded that Calcaneal Eversion and Angle of Toe out are greater in overweight whereas Gastrocnemius Extensibility is less in overweight when compared with normal subjects(32)
Calcaneal eversion is more due to excessive load which leads to more overpronation and it subsequently leads to alteration of the pathomechanics.
Harris and Beath suggested that gastrocnemius extensibility is less in overweight females and the lead cause to this is excessive pronation which causes shortnening of tendo-achilles and instability at the subtalar and midtarsal joint.(33) .Muscle length adaptation results from changes in the number of sarcomere in series, which depend on the imposed length of the muscle,not on the level of muscle activation and tension.

Kendall el al. concluded that in a weight bearing position, there is flatness of longitudinal arch that is usually accompanied by increased angle of toe out . An out- toe position was found in subjects with tight gastrocnemius . Such result may be obtained because of out toeing in walking may be due to tightness of tendo-achilles in overweight females.(30)

In previous research done by **Aparna Sarkar, Ashima Sawhney (2017)** on the effect of BMI on biomechanics of adult female foot in 20 female subjects and concluded that calcaneal eversion is greater in overweight females but was statistically insignificant , angle of toe out is greater in overweight females and gastrocnemius extensibility is less in overweight females.[34]

In another research conducted by **Pooja P. Popat, Ankur R. Parekh (2014)** on Biomechanical variation of joint angles in overweight female and concluded that within the limits of present study, significant variation was found in calcaneal eversion, angle of toe out(increases)and gastrocnemius extensibility (decreases) in overweight females.[35]

In our result , there was no significant difference in foot and ankle disability index was found individual in obese and non-obese .(p value = 0.0898)
This result are found in contrast to research done by **Stephanie K.Tanamas, Anita E.Wulka, Patrica Berry,Hylton B.Menz, Boyd J. Strauss, Miranda Davies –Tuck ,Joseph Proieto , John B. Dixon.**

Graeme Jones and Flavia M. Cicuttini on Relationship between obesity and foot pain and its association with fat mass , fat distribution and muscle mass. Obesity Body Composition and Footpain And concluded that there is positive association between increased BMI and foot pain and disability.[36]
In our research study was conducted in young females hence no statistically significant difference is found in Foot disability index.

CONCLUSION

The study concludes that Calcaneal Eversion and Angle of toe out is greater in overweight females as compared to normal subjects and was statistically extremely significant whereas Gastrocnemis extensibility is lesser in overweight females as compared to normal subjects and it was statistically extremely significant.
It is fond that there was no statistical significant difference between obese and normal females in the foot disability index.

Limitation

Only female adult group was considered.

In terms of ankle biomechanics only Rom and ATO is taken.

Future scope & suggestions

We can conduct the evaluation of dynamic foot biomechanics using kinematic and kinetic analysis system i.e throught three dimentional analysis,foot posture index, pronation angle and kinetic using force plate on the same group of subjects.
Navicular drop test can also be taken.

Clinical Implication

During evaluation of obesity , foot problems should also be considered as it is a major weight bearing structure for mechanical loading and can disturb kinetic chain. there is pain in the subsequent joint hip, ankle and knee.

Potential Confounder

In our study of effect of obesity on ankle biomechanics footwear and small calcaneum could be a potential confoundernbecause it is also risk factor for alteration in biomechanics of foot and foot pain.

Generalisability

The study has good generalisability. The study results can be applicable for same group of cases of age between 18-26 years years on large population.

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