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# RESEARCH ARTICLE

## A STUDY ON RELATIONSHIP BETWEEN BMI AND PREVALENCE OF FLAT FOOT AMONG THE ADULTS USING FOOT PRINT PARAMETERS.

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### Manuscript Info

### Abstract

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### Introduction:-

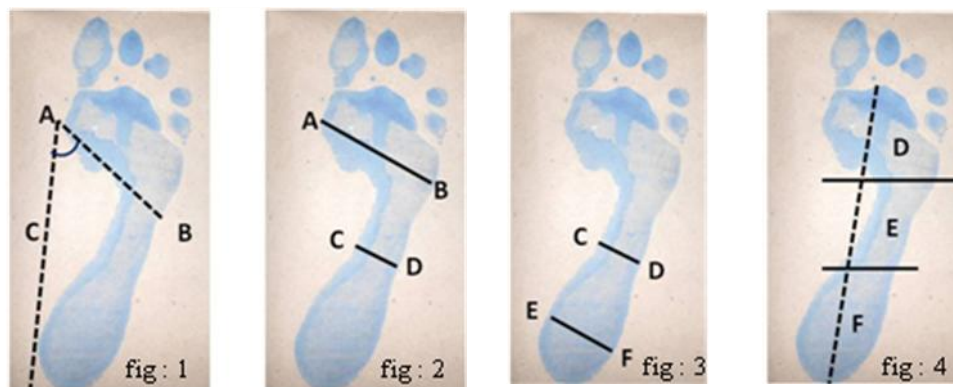
Obesity is a state where there is an abundant storage of adipose tissue that has a denying effect over the health, according to world health organization (WHO) in the year 2014, 600 million were obese in that 1.9 billion were young adults [1,2]. Increased body fat that has been accumulated to an extent that it may have a negative effect on health, leading to reduced life expectancy and/or increased health problems [3]. Every 1 out of 5 adults are suffering from foot pain [4]. Foot pain is reported commonly in overweight and obese individuals [5] and increased BMI [6]. Flat foot is a biomechanical disorder in which the arches of the foot becomes flattened, and alters the transmission of forces from superior extremities to the ankle and the foot [7]. Excessive fat deposition leads to increased loading of pressure over the arches causing flat foot [8, 9]. Obesity, illness, faulty biomechanics and prolonged stress to the feet can develop flat foot [10]. In obese individuals there are changes in foot due to excessive mechanical loading during walking [11]. Footprint parameters act as an essential tool in assessing the differences in foot morphology and foot types [12-20]. Individual wide variations of foot arch can be revealed using foot print parameters [13]. These foot print parameters are systematically used to assess the configuration of the arch [12, 13, 17-19]. Arch height is a simple and effective parameter in assessing the medial longitudinal arch height [21]. Footprint angle (FA) and Chippaux-smirak index (CSI) are the most effective parameters to assess the characteristics of foot morphology [22, 23, 25, 26]. Studies have shown the prevalence of flat foot in general population but the distribution of the flat foot problems are high in overweight and obese individual, this lacunae of knowledge in literature about the obese individuals foot problems can be achieved by this study. Hence the aim our study is to evaluate the prevalence of flat foot in normal, overweight and obese individuals and to establish the relationship between BMI and morphology of the foot using foot print parameter.

### Material and methods:-

The study was conducted in 412 healthy volunteers and grouped based on the body mass index (BMI) into underweight (24males and 22females), desirable weight (69males and 65females of BMI<25), overweight (52males and 32females BMI 25-29.9), obese (58males and 45females BMI 30-39.9) and in morbid obese (26males and 19females BMI 40 and above), between the age group 25years to 40 years. Individuals with open wound or recent surgery to their feet were excluded. The following details were took from each subject: name, age, gender, height(cm), weight(wt), lower limb length, physical activities and its duration in hours per week. Body mass index (BMI) was calculated as weight (kg) divided by square of the height in meter. In full weight bearing foot prints of both feet were impregnated using non irritant blue ink in a 60 cm length x 60cm breadth of paper. From each impregnated foot prints, the parameters arch (Clarke) index, Chippaux-smirak index, Staheli index, and arch index were measured. All the participants in the study were obtained by the formal informed consent, and this study was approved by institutional ethical committee (IEC)- NI/14/DEC/44/93.

### Outcome measures:-

- ❖ **Arch (Clarke) index** (ABC angle) (fig:1): Line A is the angle at the medial most margin of the forefoot and hindfoot, line B connects the medial side of the foot to the medial most part of the metatarsal region [25,27,28].
- ❖ **Chippaux-Smirak index** ( $100 \times CD/AB$ ) (fig:2): The ratio between CD/AB, Line AB is the wider zone of forefoot and line CD is the narrowest width of the midfoot [12,25,27,28].
- ❖ **Staheli index** ( $CD/EF$ ) (fig:3): The ratio between CD/EF, line CD is the narrowest width of the midfoot and line EF is the wider zone of the hindfoot [25,26,28,35].
- ❖ **Arch index**  $E/(D+E+F)$  (fig:4): This is the ratio of the area of toeless footprint, a line joining the middle of the 2<sup>nd</sup> toe to the posterior most midpoint of the heel. Two perpendicular lines to this line divides the footprint into 3 equal parts [24,25,27,29].



**Table 1:-** difference between normal foot and flat foot.

Parameters	Normal range	Flat foot
Clarks index	31° - 45°	> 45°
Chippaux-smirak index	25% - 45%	>50%
Staheli index	0.5 - 0.7	> 0.7
Arch index	0.21 - 0.28	>0.28

### Results:-

The observations were statistically analyzed using SPSS 20 version. Comparison of the groups were done between the variables, and the p value <0.05 were considered as statistically significant. The results thus obtained are tabulated in table 2, 3, 4.

**Table 2:-** The characteristics of subjects (Mean±SD).

Gender	Height (cm)	Weight (kg)	BMI
Males	174±5.4	88.9±20.7	29.33±4.3
Females	162±3.4	76.4±16.4	27.45±4.1

**Table:3:-** The prevalence of flat foot in males and females.

Gender	No of subjects	Flat foot	%
Males	229	90	24.59%
Females	183	82	22.04%
Total	412	172	46.63%

**Table:4:-** The prevalence of flat foot based on BMI.

BMI	Males	Females
Underweight	24.83%	36.36%
Desirable weight	24.64%	32.31%
Overweight	44.23%	56.25%
Obese	55.17%	62.22%
Morbid obese	73.08%	69.95%

The prevalence of flat foot in this study is 24.59% in males and 22.04% in females as shown in table:3 and ( $p \leq 0.05$ ) that there is strong relationship between BMI and morphology of the foot. When the BMI increases the prevalence of the flat foot also increases. The study population are categorized based on the BMI and the result shows that the prevalence of flat foot is high in males 73.08% and in morbid obese group as shown in table:4.

### Discussion:-

The study was designed to analyze the prevalence of flat foot using foot print based on the BMI. As hypothesized the incidence of flat foot was high among the obese and morbid obese group. Since raised BMI have negative effects over the musculoskeletal system our study limits the focus within the structure of arches of the foot. In our study 412 individuals foot arch were studied it showed that 46.63% of the subjects had flat arched foot. Raised BMI level is associated with flat foot and increases the plantar pressure during walking [41, 42]. Studied the footprints of 649 subjects of anambra state between the age group of 18-27 years and stated that 8.9% of the individuals are affected with flat foot [34]. The author studied the foot morphology and stated the prevalence of low arched and flat arched foot in the study population in our study we have compared the foot morphology with BMI and found a correlation  $p > (0.05)$  between the foot morphology and body composition. Davida louise et al studied the plantar peak pressure of 33 subjects between the BMI and plantar peak pressure during walking and stated that there is an increased plantar pressure in the medial longitudinal arch during walking [40]. [43]Based on denis method the foot print of 228 subjects were screened and found a correlation between the BMI and arches of the foot among the age group of 18-25 years, around 28.61% individuals found to be having flat arched foot, the author used a Denis method tool to grade the flat foot, in our study we have used Chippaux-smirak index, Clarkes angle, Staheli index, and arch index and we have found and compared the regions of the different regions of the foot. In our study the incidence of flat foot is high in morbid obese males 73.08% and in morbid obese females 69.95% morbid obese group is the most affected group in our study, as the BMI raises the incidence of flat foot increases.

### Conclusion:-

The study indicated, increased fat mass over the body causes the raise in the BMI leads an exertion of greater force over the sole of the foot. Obesity not only affects the foot by causing pain it also leads to other musculo-skeletal problems which in turn results in disturbances in walking and other weight bearing activities. In conclusion overweight and obesity has to be reduced to minimize the biomechanical problems.

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