

Original Article

OBSERVATIONAL STUDY ON FOOT PRESSURE DISTRIBUTION IN YOUNG AND ADULTS

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ABSTRACT

In the recent years, the plantar pressure has widely been accepted as a vital biomechanical parameter to evaluate human biomechanics.. The present study endeavours to find the effect of age in foot pressure distribution and its influence over medial, lateral, anterior and posterior mask of foot pressure distribution. It is an observational and comparative study on foot pressure distribution in young (25-35 years) and adults (40-60 years). Materials such as anthropometric rod, weighing machine and Podia Scan including Harrison mats have been used for the purpose of this study. Both an inter group and intra group comparison has been made. The mean and SD values of medial & lateral masks in the case of young subjects were 16.98±2.80 & 16.13±2.77, while these were 13.72±1.59 & 19.38±1.58 in old subjects indicating the lateralisation of weight bearing in adults. Nevertheless, the difference in plantar pressure distribution was not statistically significant when anterior mask ($t=1.819$, $p<0.05$) and posterior mask ($t=1.907$, $p<0.05$) were compared between young and adults.

KEYWORDS: Foot pressure Distribution (FPD), Young and Old, Podia Scan, BMI

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INTRODUCTION

In the recent years, the measurement of plantar pressure distribution has widely been accepted as a vital biomechanical parameter to evaluate human biomechanics. The distribution and magnitude of plantar pressure can provide useful information to diagnose various Foot, Knee & Hip disorders¹. It is one of the most important clinical tools that aids in diagnosing as well as treating gait and weight distribution disorders. Additionally, strategies for preventing patho-mechanical weight bearing can be devised on the basis of evaluation of FPD. Age-related anatomical and physiological changes in foot, fore leg, thigh bone and ligament structure affect FPD during standing. Gait analysis of the healthy elderly people has revealed decreased stride length, reduced step force and increased

variability in gait parameters. These findings also indicated that unsteadiness during walking is increased in the community-dwelling elderly people, posing a risk for falls ². Age has a significant role in shifting of weight from medial to lateral and independently associated with lower pressure under the heel, midfoot, and hallux in the multivariate analysis³. It means FPD is a significant tool to prevent various musculoskeletal problems in weight bearing joints. The present investigation aims to know the effect of age in foot pressure distribution and its influences over medial, lateral, anterior and posterior mask of foot pressure distribution in young and adult age groups. It is a comparative study on foot pressure distribution in young and adult persons. An intra group comparison has also been made.

Further, the present study describes the normal values of FPD and the influence of age on it. It will be of significant help for the correction of weight distribution and also to prevent the patho-mechanical changes in various musculoskeletal disorders.

METHODOLOGY & MATERIALS

The present study is an observational study based on comparison made between young and adult. An intra group comparison with respect to FPD was also made between medial mask and lateral mask, and anterior mask to the posterior mask. The study was held at Knee Clinic, Rotary Club, SST Nagar, Patiala. A prior consent was taken from each subject before the commencement of the study. The present study has been conducted on the individuals in the age group of 25-35 years (young) and 40-60 years (adult). Both males and females participated equally in the study. BMI was controlled between 19 kg/m² to 25 kg/m². Any pathological conditions like fracture, tumour, soft tissue injuries and other infected diseases were excluded. The total numbers of subjects were 50 in each group. Random sampling method was used for the purpose of this study. The materials used for the study include Podia Scan, Anthropometry Rod, Weighing Machine, Harrison Mats, Podia Scan made and calibrated by Diabetic Foot Care of India, Chennai.

The foot pressure distribution was taken on Harrison mats in standing position; and the FPD was processed in Podia scan software. Foot pressures were colour coded and measured in N/cm². Over weight bearing and double print have been excluded. Subjects were made to stand very close to Harrison mats. They were asked to put the non examination foot on Harrison mat followed by another foot. The subjects were then asked to semi squat by 20-30° flexion of knee in close kinematic position. After that examination foot was taken out first, followed by non-examination foot to avoid double pressure. The same procedure was repeated for the other foot. Foot prints were scanned and processed in Podia scan software and colour coded according to the pressure and measured in N/cm². Each footprint was divided into six divisions like Upper Medial (UM), Upper Lateral (UL), Middle Medial (MM), Middle Lateral

(ML), Lower Medial (LM) and Lower Lateral (LL). Each subject's medial mask was calculated by mean pressure distribution of UM, MM and LM while lateral mask was calculated by mean of UL, ML and LL. The same procedure was followed for calculating anterior mask (UM, UL) and posterior mask (LM, LL). Mean values and SD were presented in the graph and tables. The paired t test was used to compare between medial mask vs. lateral mask and anterior vs. posterior. For data analysis, Graph pad software was used and p<0.05 was considered as a significant level.

RESULTS AND TABLES

Table 1: Demographic Data.

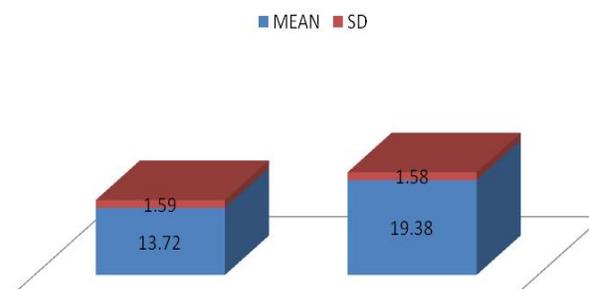
S.No.	Parameter	Young Mean & SD	Adult Mean & SD
1	Age	28.52 ± 6.78	52.42 ± 6.23
2	Height(cm)	169.75 ± 7.735	168.4 ± 7.61
3	Weight(Kg)	59.66 ± 9.222	61.91 ± 8.57
4	BMI	21.07 ± 3.289	22.19 ± 2.05

The demographic data used for the study is presented in Table 1. Mean and SD values calculated for the young and adult height, weight and BMI are exhibited at a glance in the table.

Table 2: Comparison of Medial vs. Lateral Mask of Weight Bearing within adult Group.

Areas	Mean & SD	t-value	P-value
Medial mask	13.72 ± 1.59	9.8	P<0.05
Lateral mask	19.38 ± 1.58		

Fig. 1: Mean & SD of Medical and lateral Mask Weight Distribution of Adult Subjects.



The mean and standard deviation values presented in Table 2 enable us to have a comparison of medial mask and lateral mask of adult subjects. The table given above clearly displays that the mean & standard deviation values of medial and lateral mask for adult subjects under observation are 13.72 ± 1.59 & 19.38 ± 1.58 respectively. The t-value is 9.800

which is found to be significant. This suggests that the difference between the medial mask and lateral mask of weight bearing among the adult subjects is statistically significant. The same findings have also been presented in figure 1.

Table 3: Comparison of Medial vs. Lateral Mask of Weight Bearing within young Group.

Areas	Mean& SD	t-value	p-value
Medial Mask	16.98 ± 2.80	1.066	NS
Lateral Mask	16.13 ± 2.78		

It is observed from the table 3 that mean and standard deviation values of the medial and lateral mask for young subjects are 16.98 ± 2.80 & 16.13 ± 2.78 respectively. The table clearly reveals that the t- value is 1.066 and it is found to be non significant (p>0.05). The data is also exhibited in the figure 2 given below.

Fig. 2: Mean & SD of Medical and lateral Mask Weight Distribution in young Subjects.

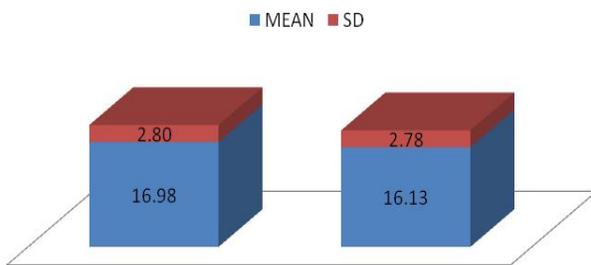
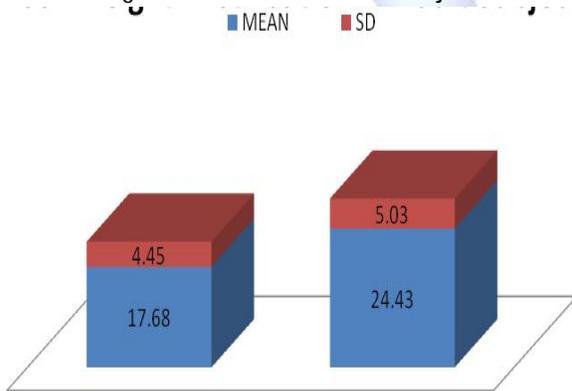


Table 4: Comparison of Anterior vs. Posterior Mask of Weight Bearing within adult Group.

Areas	Mean & SD	t -value	p-value
Anterior Mask	17.68 ± 4.45	3.91	P<0.05
Posterior Mask	24.43 ± 5.03		

Fig. 3: Mean & SD of Anterior and Posterior Mask Weight Distribution of Adult Subjects.



The mean and standard deviation values demonstrated in Table 4 enable us to make a comparison of anterior and posterior mask of adult subjects under observation. The values are

found to be significant (p<0.05). It is evident from the table that mean and standard deviation values of anterior and posterior mask for these subjects are 17.68 ± 4.45 and 24.43 ± 5.03 respectively. The t- value is 3.91 and it is found to be significant. The data shown in the above table is also displayed in figure 3.

Table 5: Comparison of Anterior vs. Posterior of Weight Bearing within young Group.

Areas	Mean & SD	t -value	p-value
Anterior Mask	19.23 ± 4.83	2.571	P<0.05
Posterior Mask	22.61 ± 5.03		

Table 5 carries the data showing a comparison between anterior and posterior mask positions. The t-value is 2.571 and it is found to be significant (p<0.05). This indicates that the mean posterior mask (22.61) is significantly greater than the mean anterior mask (19.23) for the young subjects. The data provided in the above table is also highlighted in figure 4.

Fig. 4: Mean & SD of Anterior and Posterior Mask Weight Distribution in young Subjects.

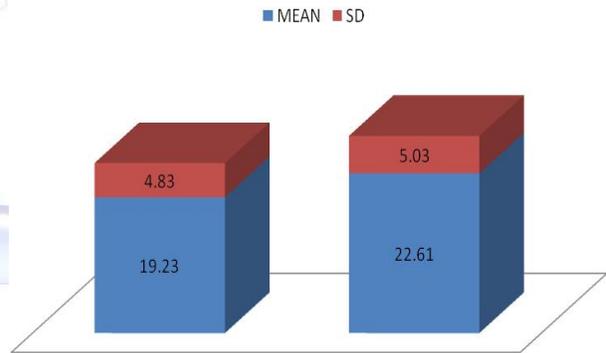


Table 6: Comparison between Young and Adult Subjects' Plantar Pressure Distribution in mask.

Areas	Adult Group Mean& SD	young Group Mean& SD	t-value	p-value
Lateral mask	19.38 ± 1.58	16.13 ± 2.78	7.477	P<0.05
Medial Mask	13.72 ± 1.59	16.98 ± 2.80	7.448	P<0.05
Anterior Mask	17.68 ± 4.45	19.23 ± 4.83	1.819	NS
Posterior Mask	24.43 ± 5.03	22.61 ± 5.03	1.907	NS

The table given above highlighted the mean & SD values of FPD, viz. lateral mask, medial mask, anterior mask and posterior mask in adult and young subjects under study. The data also presents a comparison between both these groups of subjects. The difference in the mean

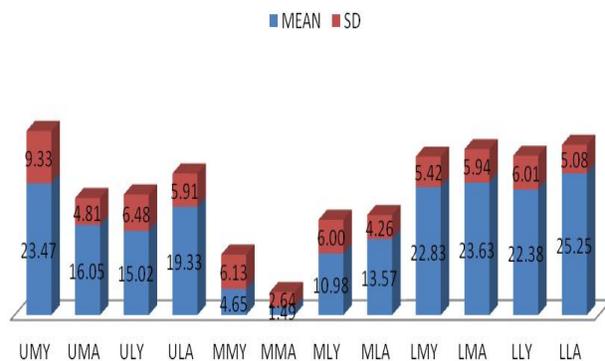
values are found to be significant in lateral mask ($t=7.477$) and medial mask ($t=7.448$) while non-significant in anterior mask ($t=1.819$) and posterior mask (1.907).

Table 7: Comparison between Young and Adult Subjects' Plantar Pressure Distribution.

Areas	Young Subjects' Mean & SD	Adult Subjects' Mean & SD	t - value	p-value
UM	23.47 ± 9.33	16.05 ± 4.81	4.064	P<0.05
UL	15.02 ± 6.48	19.33 ± 5.91	2.952	P<0.05
MM	4.65 ± 6.13	1.49 ± 2.64	2.668	P<0.05
ML	10.98 ± 6.00	13.57 ± 4.26	2.055	P<0.05
LM	22.83 ± 5.42	23.63 ± 5.94	0.6041	NS
LL	22.38 ± 6.01	25.25 ± 5.08	0.2355	NS

The table given above highlighted the mean & SD values found in six portions of FPD, viz. upper medial(UM), upper lateral(UL) middle medial(MM), middle lateral(ML), lower medial(LM), lower lateral(LL) in adult and young subjects under study. The data also presents a comparison between both these groups of subjects. The difference in the mean values are found to be significant in upper medial ($t=-4.064$), upper lateral ($t=2.952$), middle medial ($t=2.662$) and middle lateral ($t=2.005$), while non-significant in lower medial ($t=0.6041$) and lower lateral ($t=0.2355$)

Fig. 5: Mean & SD of Foot Pressure Distribution in young and Adult Subjects



DISCUSSION AND CONCLUSION

The subjects included in this study were divided into two groups: young and adult, with the Mean & SD values of age = 28.52 ± 6.78 and 52.42 ± 6.23 respectively. Each group comprised of 50 subjects with equal sex ratio. Subjects were screened and BMI was calculated which was observed to be normal (19-25) in both the groups. Means of peak pressure were calculated and converted into percentages of six divisions, Means of peak pressure were calculated and

converted into percentages of six divisions, viz. UM UL MM ML LM LL in addition to Anterior, Posterior, Medial, and Lateral masks. Percentages of pressure were compared between groups as well as within groups. The value of $p<0.05$ was considered as a significance. Data was analysed in Graph pad Prism 5 and displayed in tables 1-7 with graph presentation (figures 1-5).

When medial mask was compared with lateral mask, it was revealed that mean FPD was significantly greater on lateral aspect than the medial aspect among adults. On the other hand, young group did not exhibit such difference indicating that weight bearing was almost equal on medial and lateral aspects in young individuals. Hessert et al.(2005) observed the similar changes, though FPD was measured during normal walking⁴. They reported that elderly people exert less pressure and force under the medial masks of the foot during heel touch and toe- off phase. This implicates that elderly subjects preferentially bear weight on the lateral foot during normal walking.

In addition to this, comparison of FPD between young and elderly groups suggested that medial weight bearing was significantly less in elderly than their younger counterparts. This finding further strengthens the lateralization of weight bearing in elderly. The results obtained in the study conducted by Rai and Aggarwal (2006) demonstrated that for most subjects (mean age 29 ± 13 years) normal foot pressure patterns are highest under the 2nd and 3rd metatarsal region and this was in agreement with the earlier studies¹. (Duck worth et al 1982 , Plank & potter 1995 and Hughes et al 1989). Thus, it is reasonable to state that foot pressure is not well distributed in adults.^{5,6,7}

Nevertheless, the difference in plantar pressure distribution was not statistically significant when anterior and posterior masks were compared between young and adults. This is in contradiction with the findings of Hessert et al (2005) who reported that in the posterior masks, the older subjects exerted lower maximum pressure and force on the calcaneus region when normalized for body weight. In their study, in the anterior masks, the elderly subjects also exerted lower normalized mean pressure and lower

normalised mean force compared to young subjects. The reason for the contradiction in the results could be that the previous study was conducted during walking where as the present study was conducted during standing. This highlights the need of further research in this area.⁴

Thus, the present study has evaluated foot pressure distribution in relation with anatomical regions of foot in standing. It was observed that the weight bearing in anterior and posterior masks was similar in both young and adults where as the adults exhibited tendency of less weight bearing on medial mask of foot in comparison with young individuals. Consequently, it may be concluded that age has a significant role in FPD from medial to lateral in adult's foot. These age-related weight shifting findings have a great impact on walking and may pose a challenge to adult population.

Conflicts of interest: None

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