

Pedobarography Study among Malay Population in Kuantan, Malaysia: A Pilot Study

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ABSTRACT

INTRODUCTION: Pedobarography has been widely used in developed countries for few decades. However, in Malaysia it is still in its infancy. Studies showed that the normal values of pedobarography vary between races. To the best of our knowledge there is no standard value available for Malaysian or Southeast Asia. This study is designed to measure the pressure values in the normal foot of Malays in Pahang, Malaysia and its difference between different gender and body mass index (BMI). **MATERIALS AND METHODS:** A total of 400 feet of adult Malay subjects with no existing diabetes mellitus, lower limb and spine pain or problem are measured using Emed-q100 pedobarography device. **RESULTS:** 226 (56.5%) were females. 44.5% were with normal BMI followed by overweight (31.5%), and obese (24%). The mean-maximum-peak pressure (MPP) is 509kPa (SD 167) with no significant difference among gender and BMI. Most (38.5%, n=154) of the peak pressure area (PPA) are observed in 1st metatarsal head and big toe region (1MH&T), followed by 2nd metatarsal head (2MH) (34.3%, n=137). In the normal BMI group, 48.3% were in 1MH&T region while in the overweight and obese groups, 42.1% and 43.8%, respectively were in 2MH. This difference is significant ($\chi^2(df=8) = 36.963, p < 0.001$). There was no significant difference between PPA and gender. **CONCLUSION:** The MPP among Malays in this study was 509kPa (SD 167) and it is not affected by different genders or BMI. The PPA are most commonly fall on 1MH&T. There is a significant shift in the overweight and obese groups to the 2MHT. This finding can be used as initial reference for further studies, in Malaysia particularly.

Keywords

pedobarography, foot pressure, plantar pressure

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Received: 5th May 2021; Accepted: 11th April 2022

Doi: <https://doi.org/10.31436/imjm.v21i3>

INTRODUCTION

Foot plantar pressure (FPP) is the pressure field that acts between the foot and the support surface during our everyday locomotor activities. This pressure can be measured by a few methods. The first to have been documented the FPP was a static foot-print in 1925 where the subject stood on a wire net suspended over an inked mat. Areas with greater pressures stretched this net, pressed harder onto the ink and made darker impressions on the paper. Various such techniques have evolved until the introduction of the currently available plantar pressure measuring devices.¹ In developed countries, this device has been used widely in many fields, from footwear design to foot-related-diseases management and surgical outcome assessment.^{2,3} In Malaysia, this field is still in its infancy.

Studies have shown that FPP differ between different races.⁵ The absence of data of FPP on Malaysians warrants a pilot study for standardization of the population normal FPP to be done, and thus to serve as a basis for further research in this area. This study was conducted among Malays in Kuantan, Pahang, an east coast region of West Malaysia.

MATERIALS AND METHOD

PARTICIPANTS

A total of 400 feet were included in the study. Inclusion criteria were Malays whose age was 18 years old and

above. We excluded people with known spine or lower limb deformity, trauma, or surgery; ongoing musculoskeletal pain of the trunk and lower limbs; or diabetes mellitus.

Procedure and Equipment

We used EMED-q100 pedobarography platform with its EMED/E (Expert) software. The system is used to record and evaluate pressure distribution under the foot in dynamic condition. It consists of a walking platform and sensor panel. The platform measures 700x403x15.5mm. The 475x320mm sensor area contains 6080 number of sensors, making a resolution of 4sensors/cm², with 100Hz frequency. It can measure a pressure range of 10-1270 kPa. Its maximum total force is 193000N

Consenting subjects were identified and brought to Pedobarography Laboratory in orthopaedic clinic, Sultan Ahmad Shah Medical Centre (SASMEC). The weight and height were measured, then the BMI was calculated. The correct technique of walking on the platform was explained and demonstrated to all participants. Trial sessions were conducted for them to get familiarised with the platform.

Once the satisfactory walking technique on the platform has been achieved, measurement of the FPP was taken. As recommended by the manufacturer of the system, a two-step method was used, as this procedure produced data equivalent to mid-gait method when five trials are recorded. The results will be shown in the EMED/E (Expert) software. The peak pressure value was then determined.

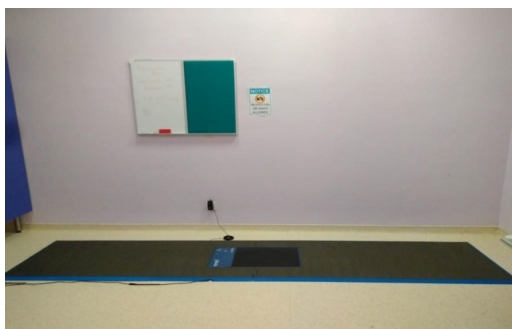


Figure 1: The EMED platform located in pedobarography laboratory



Figure 2: The sensor area at the middle of the platform

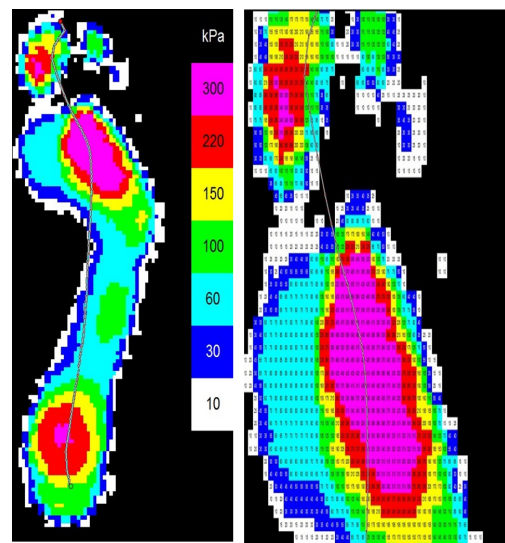


Figure 3: Example of plantar foot pressure measurement result. The highest pressure value (pink area at 2nd metatarsal head region, with value of 580kPa) are identified.

STATISTICAL ANALYSIS

Descriptive analysis was used to determine the mean values for each demographic data, such as age, gender, weight, height, peak pressure values, and body mass index (BMI). As for comparison between two variables (continuous and categorical variables), the independent t-test analysis was used to determine whether there are significant differences in the peak foot pressure by the independent variable (gender). For comparing more than three groups (BMI), One Way ANOVA was used. The data collected was analysed using the SPSS version 24 and the significant level was defined as p-value less than 0.05.

RESULTS

The demographic characteristics of age, gender, weight, height, BMI, and plantar foot pressure averages is

presented in Table 1. The average age was 27 years old (SD±8), 56.5% were females, and mostly (44.5%) are having normal BMI. The average plantar foot pressure was 509.38kPa with standard deviation ±167.24.

Comparison of the mean of peak pressure area by BMI are presented below in Table 2. There was significant statistical difference between different BMI groups.

Comparison of the mean of peak pressure area by gender are presented below in Table 3. There was no significant statistical difference among male and female subjects.

Comparison of the MPP value by gender and BMI are presented below in Table 4. There was no significant statistical difference among these groups.

Table 1: Demographic Data (N = 400)

	Frequency	%
Age (years)	Mean (±SD)	27(±8)
Gender	Male	174 43.5
	Female	226 56.5
Weight	Mean (±SD)	65.08 (±15.46)
Height	Mean (±SD)	162.96 (±9.45)
Body Mass Index	Normal	178 44.5
	Overweight	126 31.5
	Obese	96 24.0
Peak Pressure Area	1MH & 1T	154 38.5
	2MH	137 34.3
	3MH	64 16.0
	4MH & 5MH	27 6.8
	HF	18 4.5
Peak Foot Pressure	Mean (±SD)	509 (±167)

Table 2: Comparison between BMI and Peak Pressure Area (N=400)

		Peak Pressure Area					Total	P-value*
		1MH&1T	2MH	3MH	4MH&4MH	HF		
BMI	Normal	86 (48.3)	42 (23.6)	24 (13.5)	10 (5.6)	16 (9.0)	178	0.000
	Over-weight	36(28.6)	53 (42.1)	24 (19.0)	12 (9.5)	1 (0.8)	126	
	Obese	32 (33.3)	42 (43.8)	16 (16.7)	5 (5.2)	1 (1.0)	96	
Total		154	137	64	27	18	400	

*Chi-Square test

Table 3: Comparison between Gender and Peak Pressure Area (N=400)

		Peak Pressure Area					Total	P-value*
		1MH&1T	2MH	3MH	4MH&4MH	HF		
Gender	Male	63 (36.2)	63 (36.2)	32 (18.4%)	9 (5.2%)	7 (4.0%)	174	0.532
	Female	91 (40.3)	74 (32.7)	32 (14.2)	18 (8.0)	11 (4.9)	226	
Total		154	137	64	27	18	400	

*Chi-Square test

Table 4: Comparison of the Mean of Peak Pressure Score by Gender (Male/Female) (N=400)

	Gender/BMI	Mean	Std. Deviation	t-stat / *F-stat	p-value*
Peak foot pressure	Male	509.2	153.3	-0.018	0.985
	Female	509.5	177.6		
Peak foot pressure	Normal	492.8	178.0	1.895	0.152
	Overweight	515.1	157.9		
	Obese	532.7	156.5		

Independent t-test, *One-Way ANOVA test

DISCUSSION

The mean score of FPP among participants in this study was found to be 509kPa, with a standard deviation of 167. This mean value of FPP was higher than those observed in other studies in the other reports.^{2,3,6} The difference between the normal values observed in this study and other studies globally, could be due to the varying demographic factors, such as age, ethnicity, geographical background, and other health-related factors.

There is currently lack of studies in the literature which provided FPP values among patients from different background in this country as well as the Southeast Asian region. Thus, the findings obtained in this study has contributed to the body of literature with regards to the standard normal values of FPP among the general population in Malaysia.

From the peak pressure area on the other hand, the above findings suggested that plantar foot pressure in normal foot among subjects in this study mostly occurred at the first ray (metatarsal head and toe), followed by second and third metatarsal head area, which is quite in agreement with other studies.^{7,8,9} The highest area of foot peak pressure in 23 healthy subjects was under the great toe

and second metatarsal head, with the mean of 435 kPa and 407 kPa respectively.⁸

In terms of BMI status, this study also reported the significance of BMI on the values and distribution of participants' plantar foot pressure. A statistically significant association was observed between the distribution of peak pressure and BMI status. The normal-BMI mostly experienced the pressure at the toe (1T) region, while those overweight and obesity mostly had it at the metatarsal head (2MH) region. Similar findings related to the differences in higher BMI level was also observed in a study by Tománková et al.¹⁰

CONCLUSIONS

The mean peak pressure value among Malays from this study is 509kPa (SD 167) and it is not affected by different genders and BMI. The peak pressure area on the other hand, are most commonly fall on 1MH&T. However, there is a shift in overweight and obese groups to the 2MHT, and the difference is significant. This finding can be used as initial reference for further studies, in Malaysia particularly.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest

ACKNOWLEDGEMENT

This study received the financial support from the International Islamic University Malaysia research initiative grant scheme (RIGS17-024-0599)

CONTRIBUTION

All authors have made contribution to this work.

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