ORIGINAL ARTICLE

Correlation between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) Level among Malaysian Adults Age 40-60

SAEID REZA DOUSTJALALI[1*], NEGAR SHAFIEI SABET[1*], MUHAMMADEFS[1], ALY-AHMED AMM[1], SANIYAB[1], SREEMATHI K[1], ABDULAZIZAZ[1], NYANHTAIN LINN[1], KHIN THANT ZIN[1], S. SARAVANA KUMAR[1], HLAING THAW DAR[1], KHIN THANE OO[1], REBECCA SY WONG[1], SU WWL[1], NORAASYIKIN RAMLI[1], SHUSHAN LOW[1], MUFTAHABDUSALAM ELBAHLOUL[1], AHMAD YUSUF[1], MOHD NASIR MOHD DESA[2], NAZMUL MHM[3], KARIM AL-JASHAMY[4], AHMAD TAHA KHALAF[5], JAMAL HUSSAINI[6,7]

[1]*Faculty of Medicine, SEGi University, Kota Damansara, Selangor, Malaysia*
[2]*Department of Biomedical Science, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia*
[3]*Graduate School of Medicine Perdana University, Jalan MAEPS Perdana, Selangor 43400, Malaysia*
[4]*Bilad Alrafidain University College, Iraq*
[5]*College of Medicine (College of Nursing), Chengdu University, Sichuan, China*
[6]*Institute for Pathology, Laboratory and Forensic Medicine (I-PPerForM). UniversitiTeknologi MARA (UiTM), Sungai Buloh, Selangor, Malaysia*
[7]*Faculty of Medicine, UniversitiTeknologi MARA (UiTM), Sungai Buloh, Selangor, Malaysia*
Correspondence to Dr. Saeid Reza Doustjalali and Negar ShafieiSabet, Faculty of Medicine, SEGi University, Malaysia, Tel: +60 3-6145 1777; Email:saeidrezad@gmail.com, negar_4@yahoo.com

ABSTRACT

Background : Body mass index (BMI) is known as a measure of the body fat based on height and weight. It is used to raise the awareness of several diseases such as obesity which is one of the world's major epidemic affecting a massive range of the population. It is calculated by dividing the body mass by the square of the body height, and it is universally expressed in the unit of kg/m^2. Fasting blood glucose (FBG) level is a test which is used to know how much glucose is present in a blood sample after 10 hours (Purgatory) fasting.
Aim: To find the correlation between BMI and FBG level among Malaysian adults of age 40-60 years old based on the gender and race.
Methods: The population sample of this study was 147 adults age 40-60 years old, 63 of them were male (41 Malay, 12 Chinese, 10 Indian) and 84 of them were female (55 Malay, 18 Chinese, 11 Indian). Participants were randomly selected in this cross-sectional study. Their weight was measured by using a weighing scale and height was measured by using a stadiometer. BMI was calculated by using formula weight over height squared (kg/m^2). For FBG level, participants were tested by using the *'easy touch*' blood glucose monitor after 10 hours overnight fasting.
Results: Our results showed that the mean BMI level in males were highest among Malay followed by Chinese and Indian respectively, similarly in females the mean BMI level were highest in Malay but it was then followed by Indian and then Chinese respectively. Our study on FBG level showed that among males Malay had the highest mean FBG level followed by Indian and Chinese respectively. Concurrently, in females the mean FBG level were highest in Chinese followed by Indian and Malay respectively.A statistically significant correlation was obtained between BMI and FBG level in overall participants (N=147, p-value = 0.040 for $p \leq 0.05$ and r value = 0.145) and male participants (N=63, p-value = 0.023 for $p \leq 0.05$ and r value = 0.286), but not in female participants (N=84, p-value = 0.711 for $p \leq 0.05$ and r value = 0.041).
Conclusion: The significant positive correlation that was found in this research between BMI and FBG level in overall (male and female) participants and male participants could therefore be used as a fundamental guideline for spreading awareness among Malaysian adults between 40 and 60 years of age about their lifestyle, diet and daily physical activity with regard to obesity. This could considerably reduce the likelihood of developing non-communicable diseases such as diabetes, hypertension, stroke and heart disease in this age group over time.
Keywords: BMI, FBG

INTRODUCTION

Body Mass Index (BMI) is a commonly used value that is derived from the mass and height of an individual, which is mainly for identifying an individuals' fatness. The BMI is defined as the body mass divided by the square of the body height and is universally expressed in units of kg/m², resulting from mass in kilograms and height in metres. The best quality and useful data collection are very vital for the calculation of BMI. The BMI categorizes the individual based on the following values: underweight 18.5 kg/m^2, normal weight: 18.5 to 25 kg/m^2, overweight: 25 to 30 kg/m^2, obese: over 30 kg/m^2. This value is independent of age[1].

BMI also has a significant role in monitoring the spectrum of nutritional status, for surveillance and report of the health population by the government and WHO, also in taking the awareness to several diseases and severe health issues in a population, for instance, Obesity. BMI has many advantages, mainly it being a simple method and by being low in cost. According to a few researchers, BMI appears as a good proxy for problems related to adiposity and Obesity. As everything is said to have two sides, BMI has disadvantages too. BMI is not developed as an

indicator of the specific area and the percentage of body fat. Also, BMI is not designed to differentiate between fat mass and lean body mass. Other cons include that, BMI can be affected by age, gender, ethnicity, bone structure, fat distribution or the muscle mass while calculating[2].

A research group conducted a study from the Clinical Research Centre of Hospital Kuala Lumpur, where the distribution of BMI, body weight and height by age, sex and ethnicity in Malaysian adults had been reported. They had shown the percentage distribution of BMI among Malaysian adults according to the WHO. They had found that 26.5% of the adults population were overweight; however, only about 6% had grade 2 or higher overweight, 61% had normal BMI, and 13% had grade 1 or higher thinness. Both overweight and thinness were more common among women than men. Indian had the highest prevalence of overweight, followed by Malay, Chinese and other indigenous groups had the lowest prevalence[3].

Glucose is the primary source of energy for the cells of the body, and it is carried to each cell through the bloodstream. A fasting blood sugar level with less than 100 mg/dL (5.6 mmol/L) is normal (80 - 90 mg/dL), and it should be less than 140 mg/dL two hours after eating. A fasting blood sugar level from 100 to 125 mg/dL (5.6 to 6.9 mmol/L) is considered under the category of prediabetes. If it is 126 mg/dL (7 mmol/L) or higher on two separate tests, it will be under the category of diabetes[4].

Being overweight or obese increases the chances of developing the common type of diabetes, type 2 diabetes, especially it is reported higher in people among the age 40 to 60. Type 1 diabetes is a condition where the pancreas does not produce enough insulin hormones. Type 2 diabetes is a condition where the body cells are not capable of reacting to insulin hormone. The principal function of this insulin hormone is to maintain blood glucose level by storing glucose as energy fuel in body cells when this glucose cannot enter the cells, the sugar accumulation in the blood tremendously increases which renders the body incapable of using the energy to meet its needs. This condition is called hyperglycaemia[5]. As reported in Malaysia, diabetes varies according to the ethnics, age and gender; Indians have more cases reported than Malays and Chinese among the age 40 to 60[6].

Other research group conducted a study on the association between FBG level and mortality according to sex and age. The study was conducted in the Korean population of age 18-99 in the year 2001-2004 and was followed up till 2013. They concluded that both high and low glucose level was associated with increased mortality rates regardless of sex and age. And optimum glucose level for fasting individuals should be between (80–94mg/dL)[7]. However, ithas not been much reported about the pattern of FBG level in Malaysian based on ethnicity among age group 40-60 years old.

A correlation was reported between the BMI and FBG level in India. They mentioned that a person having BMI more than 30 kg/m2, most likely to have higher blood glucose level. As a result, their excess weight makes their inner cells more resistant to the significant action of insulin[8].A group of researchers in Korea had reported positive correlations between BMI and FBG level in the year 2011 among the age group 40 to 50 years old[9]. Another group also found a similar result in Nigeria in the year 2013 among the age group 22 to 28 years old[10]. Also in another study conducted by another group of researchers in Jharkhand (India) showed that Indians were highly susceptible to cardiovascular diabetes risk even with only modest overweight, central obesity and decrease in physical activity[11]. In Malaysia, there are not many research reported regarding the correlation between BMI and FBG level based on gender and race for age group 40-60 years old. Therefore, we designed this study to determine the correlation between BMI and FBG level in Malaysian adults aged 40-60 years old based on the gender and race. Hence, this finding can help to improve the Malaysian adults' health care awareness via controlling their body weight and maintaining suitable blood glucose level at the normal range, which may reduce obesity related diseases.

MATERIALS AND METHODS

In this cross-sectional study, our sample size consisted of 147 adult participants with the age of 40 – 60 years old, with different race groups; 63 of them were male (41 Malay, 12 Chinese, 10 Indian) and 84 of them were female (55 Malay, 18 Chinese, 11 Indian). Random sampling was used during the data collection. Before we proceeded with our study, the Ethical Committee of SEGi University approved our consent form for this research and the ethical clearance was obtained from the Ethical Committee of SEGi University. Each of the participants were required to fill the consent form and the information sheet, and they were briefed on the procedures. In the information sheet, we were able to investigate the socio-demographic characteristics of the participants, such as; age, sex and race. We were also able to tabulate the data of body mass index (BMI) and fasting blood glucose (FBG) level.

In this research, two measurements were taken; the BMI and FBG level. Body weight of each participant was measured in kilograms using the weighing scale with minimal clothing and no shoes. For height, each of the participants had to stand straight on the stadiometer while looking forward with no shoes to minimize measurement errors, only then we could start to measure their heights from their toes to their heads, in meters. The data obtained was recorded in the information sheet, then it was tabulated. BMI was calculated by using the BMI formula ($BMI=kg/m^2$)[9,12].

For measuring the FBG level, our participants were advised to fast for at least 10 hours to ensure an accurate reading of FBG level[13]. The instrument that was used to measure FBG level was glucometer, which reads the amount of sugar in a small sample of blood, usually from the fingertip. A disposable blood glucose test strip that was compatible with the blood glucose meter was inserted in the device. Before the procedure was conducted, the participant's index finger was sterilized by using alcohol swab. Once dry, a lancing device was used to prick the participant's sterilized finger, which expelled a drop of blood that was placed on thedisposable test strip[14]. The readings obtained were recorded in the information sheet and were tabulated systematically.

Finally the statistical analysis of the data obtained from all of the participants was done by using the Statistical Package for the Social Science software (SPSS) version 22.0[15].

RESULTS

Data interpretation for mean body mass index (BMI) based on gender and race: Among the 147 participants, 63 of them were male(41 Malay,12 Chinese,10 Indian) and 84 of them were female (55 Malay,18 Chinese, 11 Indian).Table 1 shows the demographic data. Figure 1 shows that among the males, Malay participants had the highest mean BMIvalue followed by Chinese and Indian respectively. The mean BMI value for Malay was greater than that of Chinese by 0.9%; and it was greater than that of Indian by 1.78%, the mean BMI of Chinese was greater than that of Indian by 0.88%.

In regards to females, Malay participants also had the highest mean BMI value, followed by Indian and Chinese respectively. The mean BMI value for Malaywas greater than that of Indian by 1.49% while the mean BMI value for Malay was greater than that of Chinese by 1.62%. The mean BMI value for Indian was greater than that of Chinese by 0.13%.

Data interpretation for mean fasting blood glucose (FBG) level based on gender and race: Figure 2 shows that the mean FBG level for the male participants was highest in Malay, followed by Indian and Chinese respectively. The mean FBG level for Malaywas greater than that of Indianby 0.31%; and greater than Chinese by 2.16%. The mean FBG level of Indian was greater than that of Chinese by 1.85%.

In case of female participants, Chinese had the highest mean FBG level followed by Indian and Malay respectively. The mean FBG level for Chinese was greater than that of Indianby 0.36%; and greater than that of Malay by 1.95%. The mean FBG level for Indian was greater than that of Malay by 1.59%.

Data interpretation of correlation between body mass index (BMI) and fasting blood glucose (FBG) level in overall, male and female participants: The scatter plot in figures 3a and 3b showed a statistically significant correlation between BMI and FBG level in overall participants (N=147, p-value = 0.040 for $p \leq 0.05$ andr value = 0.145) and male participants (N=63, p-value = 0.023 for $p \leq 0.05$ and r value = 0.286). However there was not statistically significant correlation between BMI and FBG level in female participants (N=84, p-value = 0.711 for $p \leq 0.05$ and r value = 0.041) as shown in figure 3c.

Table 1:Demographic characteristics of the total participants

Participants	**No.**
Total	147
Gender	
Male	63
Female	84
Race	
Malay	96
Chinese	30
Indian	21
Gender and Race	
Male	
Malay	41
Chinese	12
Indian	10
Female	
Malay	55
Chinese	18
Indian	11

Figure 1: Showing data interpretation for mean BMI based on gender and race

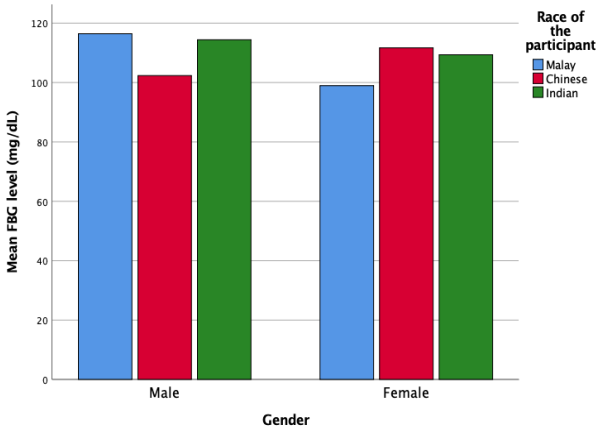


Figure 2: Data interpretation of mean FBG level based on gender and race

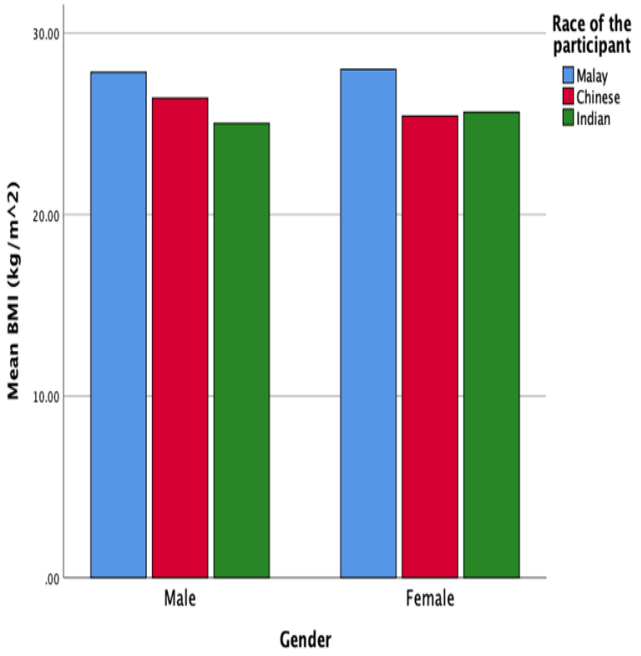


Figure 3a, 3b and 3c: Showing data interpretation of correlation between body mass index (BMI) and fasting blood glucose (FBG) level in overall, male and female participants

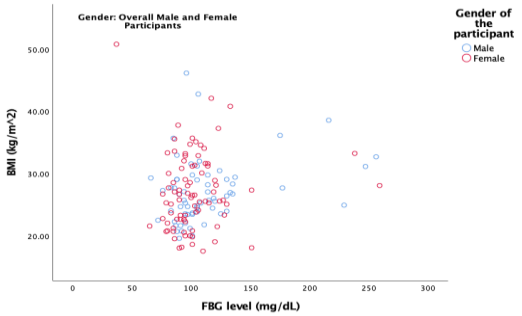
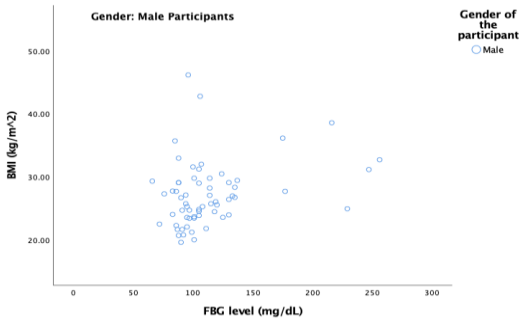
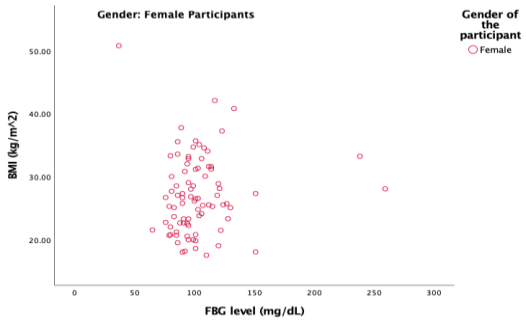


Figure 3a



Figure



Figure

DISCUSSION

The results obtained from our study on Malaysia adults (40-60 years old) showed that the mean body mass index (BMI) value was the highest among Malay for both male and female participants. Among males, the mean BMI value was followed by Chinese and then by Indian respectively. While among females, the mean BMI value was followed by Indian and then by Chinese respectively. These results contradict the findings of an earlier research on Malaysian adults,in which the researcher identified the Indian as the highest prevalence of obesity, followed by Malay and Chinese respectively[3]. Overall, our findings showed consistency with the three prior results acquired by the Medical Faculty of SEGi University, Kota Damansara, where the largest mean BMI in both genders tends to fluctuate between Malay and Indian races, whereas the smallest mean BMI was among Chinese[16].

Our results also showed that the mean fasting blood glucose (FBG) level was highest in Malay males, followed by Indian, and then by Chinese. While among females, Chinese had the highest mean FBG level followed by Indian and then by Malay.Based on our understanding, there were not many studies reported on FBG level based on gender and race among Malaysian adults of the age 40-60.

Our results also showed a statistically significant correlation between the BMI and FBG level among overall participants (N=147, p-value = 0.040 for $p \leq 0.05$ and r value = 0.145) and male participants (N=63, p-value = 0.023 for $p \leq 0.05$ and r value = 0.286), but not in female participants (N=84, p-value = 0.711 for $p \leq 0.05$ and r value = 0.041).Based on our understanding, there were not many studies reported on the correlation between the BMI and FBG level among Malaysian adults for the age 40-60 years old. However, similar results to our studywere obtained in Koreaand Nigeria. They reporteda positive correlation between the BMI and FBG level[9,10].Alsoa positive correlation between the BMI and FBG level were reported for the study conducted on Malaysian undergraduate students by Medical Faculty of SEGi University, Kota Damansara[16].

CONCLUSION

A statistically significant correlation was observed between the BMI and FBG level for the overall (male and female) participants and male participants but was not statistically significant in female participants. Hence, the significant positive correlation that was found in this research between BMI and FBG level in overall (male and female) participants and male participants could therefore be used as a fundamental guideline for spreading awareness among Malaysian adults between 40 and 60 years of age about their lifestyle, diet and daily physical activity with regard to obesity. This could considerably reduce the likelihood of developing non-communicable diseases such as diabetes, hypertension, stroke and heart disease in this age group over time.

Competing interests: The authors declare they have no competing interests.

Acknowledgements: This study was supported by SEGi University, Faculty of Medicine internal grant.

REFERENCES

1. Nuttall FQ. Body Mass Index: Obesity, BMI and Health: A Critical Review. Nutrition Today. 2015; 50(3):117-128.
2. Doustjalali SR, Hlaing TD, Khin TZ, Kumar RG, Sharma R, Nabil NJ, et al. Correlation between Body Mass Index (BMI) and Fasting Total Blood Cholesterol Level among Undergraduate Students. Pakistan Journal of Nutrition. 2016; 15(9):873-877.
3. Lim TO, Ding LM, Zaki M, Suleiman AB, Fatimah S, Siti S, Tahir A, Maimunah AH. Distribution of Body Weight, Height and Body Mass Index in a National Sample of Malaysian Adults. Med J Malaysia. 2000; 55:108-128.
4. Estela C. Blood Glucose Levels. Undergraduate Journal of Mathematical Modeling: One + Two. 2011; 3(2):12.
5. Abdullah SG, Mohammed AA, Muhamma ZK. Mechanism Linking Diabetes Mellitus and Obesity. Diabetes MetabSyndrObes. 2014; 7:587-591.
6. Tan A, Dunn R, Yen S. Ethnic Disparities in Metabolic Syndrome in Malaysia: An Analysis by Risk Factors. Metabolic Syndrome and Related Disorders. 2011; 9(6):441-451.
7. Sang-Wook Y, Sangkyu P, Yong-ho L, Hyang-Jeong P, Beverly B, Jee-Jeon Y. Association between Fasting Blood Glucose and All-cause Mortality According to Sex and Age: A Prospective Cohort Study. Scientific Reports. 2017; 7(1):8194.
8. Vittal BG, Praveen G, Deepak P. A Study of Body Mass Index in Healthy Individuals and Its Relationship with Fasting Blood Sugar. Journal of Clinical and Diagnostic Research. 2010; 4:3421-3424.
9. Silmane M, Abdeslam H, Khalid EK, Asmaa EH, Amina B, Mohammed EM, Najat M, Hassan A. Body Mass Index, Waist Circumference, Body Fat, Fasting Blood Glucose in a Sample of Moroccan Adolescents Aged 11-17 Years. Journal of Nutrition and Metabolism. 2012; 510458.
10. Nwafor A, Mmom FC, Obia O, Obiando C, Hart VO, Chinko BC. Relationship between Blood Pressure, Blood Glucose and Body Mass Index and Coexisting Prehypertension and Prediabetes among Rural Adults in Niger Delta Region, Nigeria. Journal of Advances in Medicine and Medical Research. 2015; 9(7):1-12.
11. Neelam A, Mukesh KA, Tannu K, Sunil K. Correlation between Body Mass Index and Blood Glucose Levels in Jharkhand Population. International Journal of Contemporary Medical Research. 2017; 4(8):1633–1636.
12. Rothman KJ. BMI-Related Errors in the Measurement of Obesity. International Journal of Obesity. 2008; 32:56-59.
13. Gholamreza V, Mehdi S, Hamidreza J, Samieh B, Pooneh M, Abdolhamid A, Ebrahim T, Abbas M, Karimollah HT, Yedolla ZP. The Association of Fasting Blood Glucose (FBG) and Waist Circumference in Northern Adults in Iran: A Population Based Study. Journal of Diabetes and Metabolic Disorders. 2014; 13:2.
14. Surya P, Soumavo MS, Luis HG, Peter TCS, Ramachandra RD, Zubair KU, Kannan R, Upendran A, Woong KJ. Evaluation of Accuracy Dependence of Raman Spectroscopic Models on the Ratio of Calibration and Validation Points for Non-invasive Glucose Sensing. Analytical and Bioanalytical Chemistry. 2018; 410(25): 6469-6475.
15. IBM Corp. IBM SPSS Statistics for Windows, Version 22.0. 2013. Armonk, NY: IBM Corp.
16. Sabet NS, Doustjalali SR, Khalaf AT, Zin KT, Hlaing TD, Chong MS, et al. Correlation between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) Level among Undergraduate Students. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2018; 9(3):609-617.