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Correlation Between Body Mass Index (BMI) And Blood Pressure Among Undergraduate Students

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ABSTRACT

Body mass index (BMI) is a common, inexpensive and simple method to categorize individuals as underweight, normal, overweight and obese. BMI does not differentiate components in the body such as organ mass, skeletal weight, fat, water and muscle. However associations between BMI and blood pressure (BP) have been consistently observed but remain poorly understood. The purpose of this study was to detect the correlation between BMI and blood pressures (systolic and diastolic) of undergraduate medical students at SEGi University, Kota Damansara that were grouped according to gender, based on their races. The participants were randomly selected to participate in this research. The weight, height, systolic and diastolic blood pressure of 155 undergraduate students, 80 females (32 Malays, 21 Chinese and 27 Indians) and 75 males (27 Malays, 28 Chinese and 20 Indians) studying at SEGi University, Kota Damansara, were measured and used to calculate BMI using the standard formula (kg/m^2). The statistical analysis was conducted using statistical package for the social sciences software (version 22.0). Our results showed a statistically significant correlation between BMI and systolic blood pressure among the overall participants (r value = 0.471), males participants (r value = 0.558) and female participants (r value = 0.394). Similarly, our data also showed a statistically significant correlation between BMI and diastolic blood pressure among the overall participants (r value = 0.510), males participants (r value = 0.559) and female participants (r value = 0.439). In conclusion, there was statistically significant correlation between BMI and blood pressures (systolic and diastolic) in overall participants, male participants and female participants. Hence, this study may be used as a guidance for Malaysian undergraduate university medical students to be aware of their diet, physical activities and lifestyles, since they are the main risk factors of obesity. This would help to reduce the risks of getting diseases like diabetes, heart diseases, stroke and hypertension.

Keywords: Body mass index (BMI), Blood pressure, Obesity

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INTRODUCTION

The body mass index (BMI) is currently used for defining anthropometric height/weight characteristics in adults and for categorizing them into certain groups. It also represents the index of an individual's fatness. The BMI values obtained from individuals is globally accepted in defining specific categories of body mass as a particular health issue. These BMI values are used for clinical screening and surveillance purposes by the government, to determine public health policies and risk factors for several health issues. Accurate data collection and management are required to calculate BMI which is calculated by dividing the mass (kg) of an individual by their height in square (m^2). The results are categorized as underweight ($<18.5\text{kg}/m^2$), healthy weight ($18.5\text{-}24.9\text{kg}/m^2$), overweight ($25\text{-}29.9\text{kg}/m^2$) and obesity ($\geq 30\text{kg}/m^2$) [1]. A critical aspects in using BMI, is to choose appropriate equipment and measurement protocols, providing regular training and standardization of data as it will apply to all settings in which BMI will be measured and used. This method of BMI is commonly used as it is inexpensive and simple, since there is a standardized cut-off value provided to determine overweight and obesity in the general population [2-3]. However, BMI cannot be used to calculate the percentage of body fat and it has no specificity on location of the body fat. Other limitations include: gender, age, ethnicity, bone structures and the fat distribution or muscle mass which are not taken into consideration in calculating BMI. Due to these reasons, BMI can misrepresent the quantity it is used to measure [1, 4].

Obesity is an exceptionally common disorder worldwide, posing a lot of health risks and psychosocial issues among the people of all age groups in the society [5-7]. The major causes of obesity are associated with individual's daily diet and activities. Obesity is defined as the excessive accumulation of body fats which is caused by increase in the energy intake and a decrease in the energy expenditure. This accumulation of excess body fat will in turn have numerous untoward effects on the individual's health, like the shortening of life expectancy and an increase in the person's adverse health problems [5]. In 2010, WHO ranked Malaysia as the sixth country in Asia with the highest prevalence of obesity with an astonishing 60% of Malaysians being overweight [7]. Based on the Malaysian National Health and Morbidity Survey (NHMS), the number of overweight and obese adult males has increased from 1996 to 2006. Obesity prevalence was found to be higher among adult females than in males. However, there was no difference in obesity incidence between individuals in the rural and urban area. Considering ethnicity, the highest prevalence of obesity was detected in Indians followed by Malays and Chinese respectively [7]. Another study done by the national survey in Singapore in 1992 reported that Indians had the highest BMI value with a proportion of obese persons (10%) followed by Malays (6%) and Chinese (3%) [8]. However other reports also showed a difference in the pattern of BMI within the different races, where the BMI value was highest among Malays, followed by Indians and Chinese respectively [9-10].

Obesity opens up a risk to a broad spectrum of diseases such as: various cardiovascular diseases, type 2 diabetes mellitus, cancer, osteoarthritis, hypertension and dyslipidemias. A blood pressure of 140/90 mmHg or more is considered as hypertension. People with levels in between 120/80 and 140/90 have a condition called pre-hypertension. This means that they are at a high risk for high blood pressure [11]. In comparison, low blood pressure occurs in patients when their blood pressure is lower than the normal 120/80 mmHg [12-13]. The major difference in these values is due to different lifestyle habits and dietary practices between groups of individuals. Overall, there is a marked increase of hypertension trends in Malaysia since 1996, where the risk of hypertension is seen increasing with age. The highest percentage of about 70% of these cases are seen in the age groups 55-60 plus [14].

Obesity is thought to be an important contributing factor to the development of elevated blood pressure (BP) in children and youth. A number of studies have demonstrated that there is a positive relationship between BMI and systolic blood pressure (SBP) in school-aged children as well as in preschool-aged children and young adults. It has also been shown that moderate physical activity is associated with lower SBP and that exercise training can reduce BP in adolescents with hypertension [15]. Weight gain was associated with an increased risk of developing hypertension [16]. On the other hand, weight-loss can lead to a significant drop in blood pressure [17]. In another studies, it was reported that males had a higher prevalence of hypertension compared to the females (38.9% versus 34.0%) [18]. Obese individuals have more fatty tissue that increases their vascular resistance which increases the heart workload to pump blood throughout the body. Furthermore fat distribution in the abdominal trunk or abdominal obesity has the greatest influence on whether someone will develop hypertension [19].

There are not much studies being conducted in Malaysia in recent years regarding the correlation between BMI and blood pressures (systolic and diastolic). Therefore, we believe that this research is beneficial in giving a measure of both BMI and blood pressures among university students. Hence, this study was designed to determine the correlation between the BMI and blood pressures among undergraduate medical students in SEGi University Kota Damansara and to help them in acknowledging the importance of health care awareness.

MATERIALS AND METHODS

The ethical approval to perform our research was obtained by the ethical committee of SEGi University. We used two parameters in our research: BMI and blood pressures (systolic and diastolic). Our target populations were the undergraduate medical students of SEGi University, Kota Damansara with total of 155 students: 80 females (32 Malays, 21 Chinese and 27 Indians) and 75 males (27 Malays, 28 Chinese and 20 Indians). We briefly explained to them the purpose of our research and the methods in which we would obtain the necessary data from them. Finally, we obtained the measurements from the participants in the Physiology Lab at the Faculty of Medicine of SEGi University.

The students were asked to take off their shoes when the respective measurements for weight and height were taken. The students stood on the weighing scale so we could measure their weight. For obtaining the height, we used a stadiometer. The students were requested to stand straight and measurements were taken from the tip of their head to the tip of their toes. After obtaining data for height and weight, we put these values into the standard equation [weight (kg) / height (m²)] and obtained the respective participants BMI value [20].

The blood pressures (systolic and diastolic) were obtained using a sphygmomanometer. Before the measurements were taken, the students were required to rest for 5 minutes. We ensured that the cuff size fit around the respondent's upper arm in order to give more accurate results. The width of the cuff covered two-thirds of the upper arm and was long enough to encircle the whole arm [21]. After we obtained all the necessary values for BMI and blood pressures, we performed a statistical analysis of the data collected by using the statistical package for the social sciences software version 22.0 [22].

RESULTS

Data interpretation for mean BMI based on gender and races

Table 1 shows the demographic data. Out of the 155 participants, 75 were males (27 Malays, 28 Chinese and 20 Indians) and 80 were females (32 Malays, 21 Chinese and 27 Indians). It is evident from Fig. 1 that amongst males, Indians had the highest BMI value, followed by Malays and Chinese. BMI value for Indians was greater than that of Malays by 1.66% while the BMI value for Indians was greater than that of Chinese by 2.02%. The BMI value of Malays was greater than that of Chinese by 0.36%.

Table 1: Demographic Data (155 Participants)

	Mean	SD	Frequency	Percentage (%)
Gender				
Male			75	48.4
Female			80	51.6
Total			155	100
Race				
Malay			59	38.1
Chinese			49	31.6
Indian			47	30.3
Total			155	100
Weight (kg)	62.68	15.98		

Height (m)	1.63	0.094		
BMI (kg/m ²)	23.41	4.96		
Underweight			12	7.7
Normal weight			96	61.9
Overweight			35	22.6
Obese			12	7.7
Total			155	100
Systolic blood pressure (mmHg)	121.06	13.93		
Diastolic blood pressure (mmHg)	75.82	11.46		
Overall blood pressure status				
Hypotension			2	1.3
Normal blood pressure			138	89.0
Hypertension			15	9.7
Total			155	100

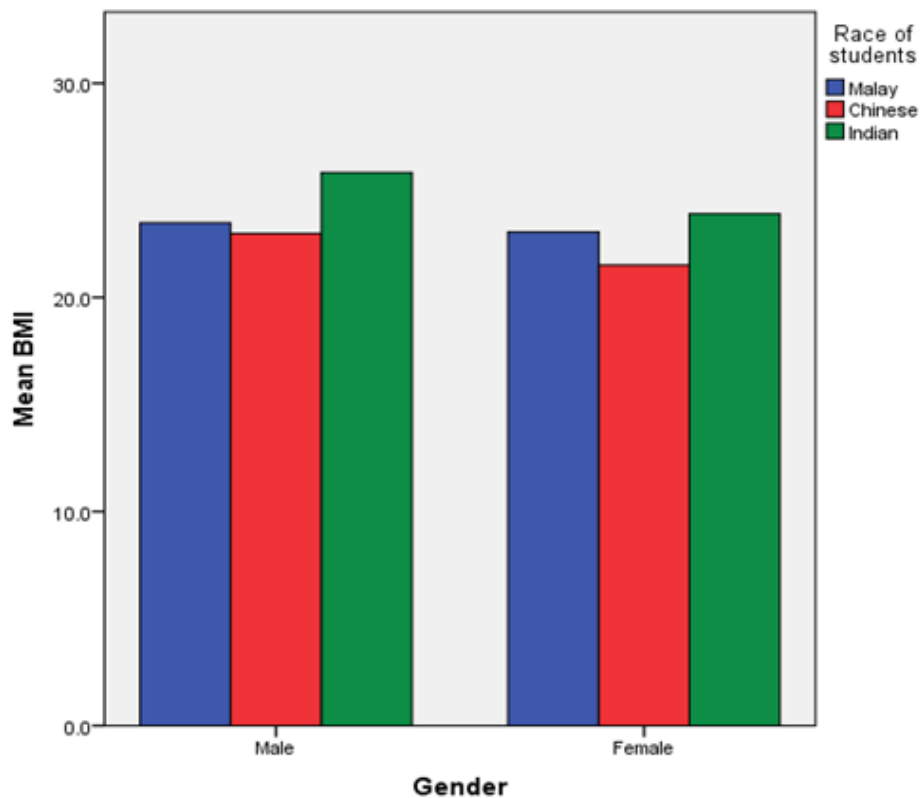


Fig. 1: Showing Data Interpretation for Mean BMI Based on Gender and Races

With respect to females, Indians also had the highest BMI value, followed by Malays and Chinese. BMI value for Indians was greater than that of Malays by 0.62% while the BMI value for Indians was greater than that of Chinese by 1.72%. The BMI value of Malays was greater than that of Chinese by 1.1%.

Data interpretation for mean systolic blood pressure based on gender and races:

It is clear from Fig. 2 that amongst males, Indians had the highest mean value of systolic blood pressure, followed by Chinese and Malays. Mean value of systolic blood pressure for Indians was greater than that of Chinese by 0.7% while the mean value of systolic blood pressure for Indians was greater than that of

Malays by 0.78%. The mean value of systolic blood pressure of Chinese was greater than that of Malays by 0.08%.

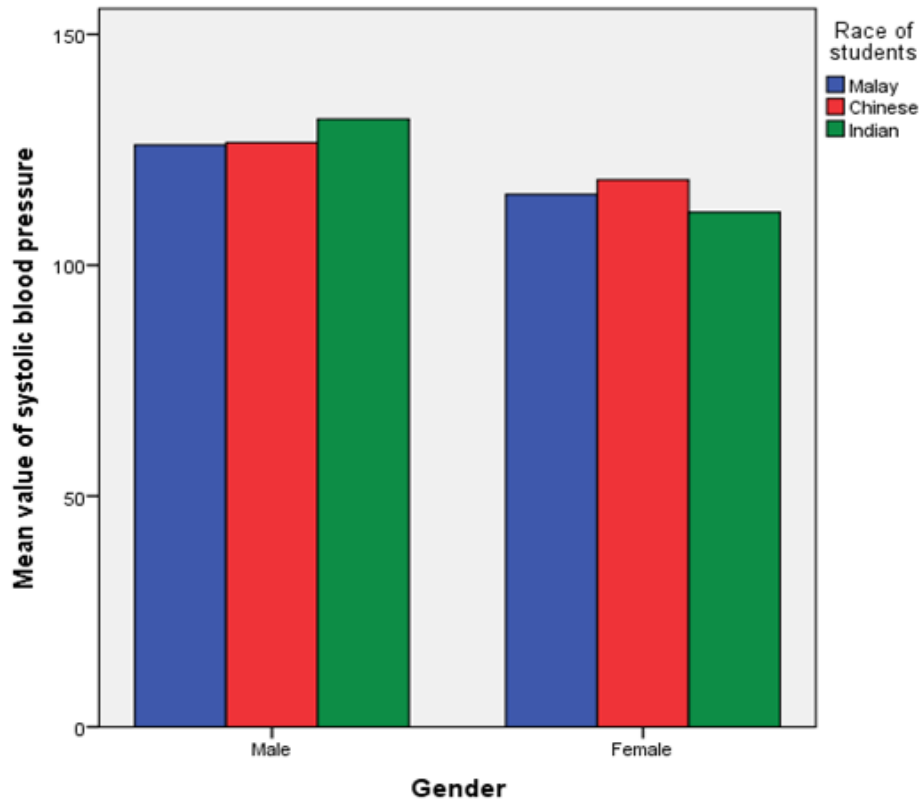


Fig. 2: Showing Data Interpretation for Mean Systolic Blood Pressure Based on Gender and Races

With respect to females, Chinese had the highest mean value of systolic blood pressure, followed by Malays and Indians. Mean value of systolic blood pressure for Chinese was greater than that of Malays by 0.43% while the mean value of systolic blood pressure for Chinese was greater than that of Indians by 0.96%. The mean value of systolic blood pressure of Malays was greater than that of Indians by 0.53%.

Data interpretation for mean diastolic blood pressure based on gender and races

It is clear from Fig. 3 that amongst males, Indians had the highest mean value of diastolic blood pressure, followed by Malays and Chinese. Mean value of diastolic blood pressure for Indians was greater than that of Malays by 0.7% while the mean value of diastolic blood pressure for Indians was greater than that of Chinese by 1.41%. The mean value of diastolic blood pressure of Malays was greater than that of Chinese by 0.71%.

With respect to females, Malays had the highest mean value of diastolic blood pressure, followed by Chinese and Indians. Mean value of diastolic blood pressure for Malays was greater than that of Chinese by 0.3% while the mean value of diastolic blood pressure for Malays was greater than that of Indians by 0.95%. The mean value of diastolic blood pressure of Chinese was greater than that of Indians by 0.65%.

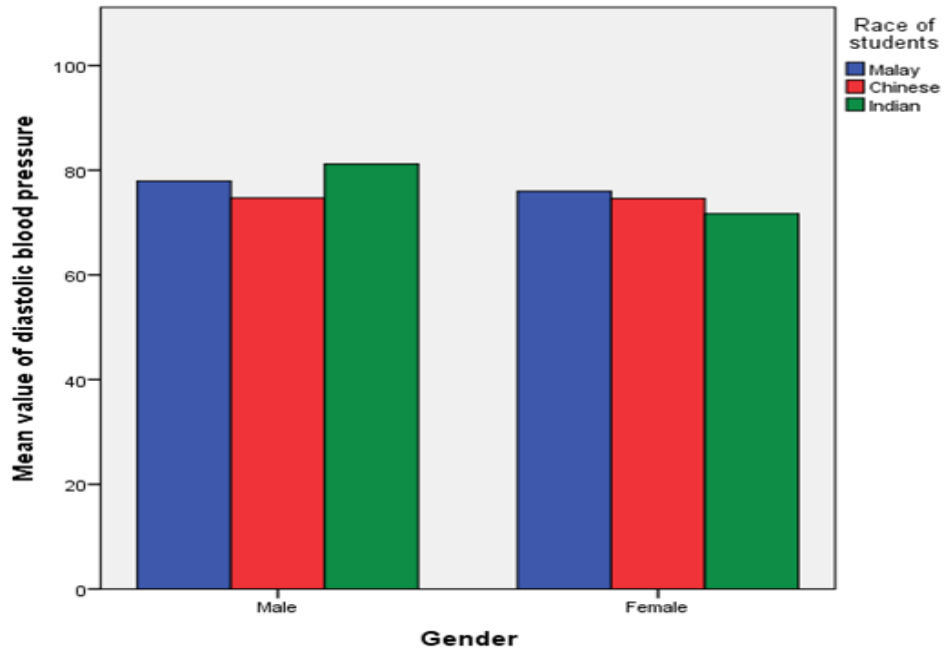


Fig. 3: Showing Data Interpretation for Mean Diastolic Blood Pressure Based on Gender and Races

Data interpretation of correlation between BMI and systolic blood pressure based on gender and races

The scatter plots in Fig. 4a, 4b and 4c show that there was a statistically significant correlation between BMI and the systolic pressure among the overall participants (N=155, p-value=0.000 for $p \leq 0.05$ and r value=0.471), male participants (N=75, p-value=0.000 for $p \leq 0.05$ and r value = 0.558) and female participants (N=80 and p-value=0.000 for $p \leq 0.05$ and r value = 0.394).

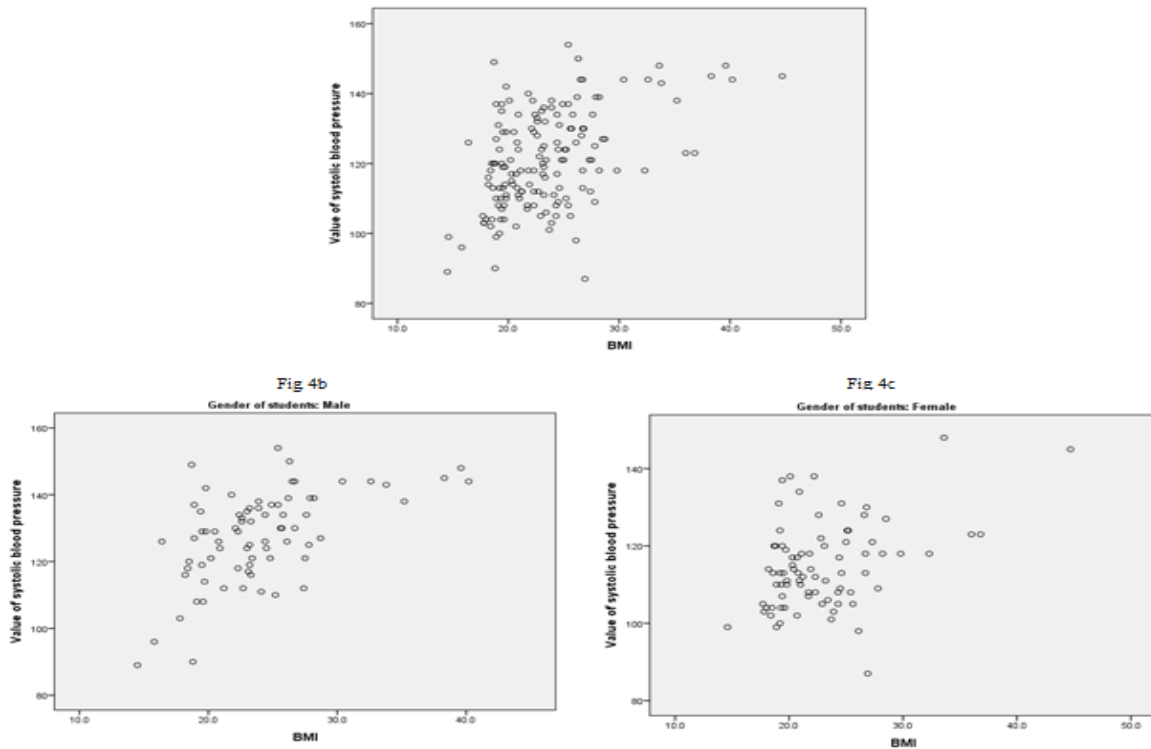


Fig. 4a, 4b and 4c: Showing Data Interpretation of Correlation between BMI and Systolic Blood Pressure Based on Gender and Races Fig. 4a Gender of students: Overall (Male & Female)

Data interpretation of correlation between BMI and diastolic blood pressure based on gender and race:

The scatter plots in Fig. 5a, 5b and 5c show that there was a statistically significant correlation between BMI and the diastolic pressure among the overall participants (N=155 and p-value=0.000 for $p \leq 0.05$ and r value= 0.510), male participants (where n=75 and p-value=0.000 for $p \leq 0.05$ and r value = 0.559) and female participants (N=80 and p-value=0.000 for $p \leq 0.05$ with and r value=0.439).

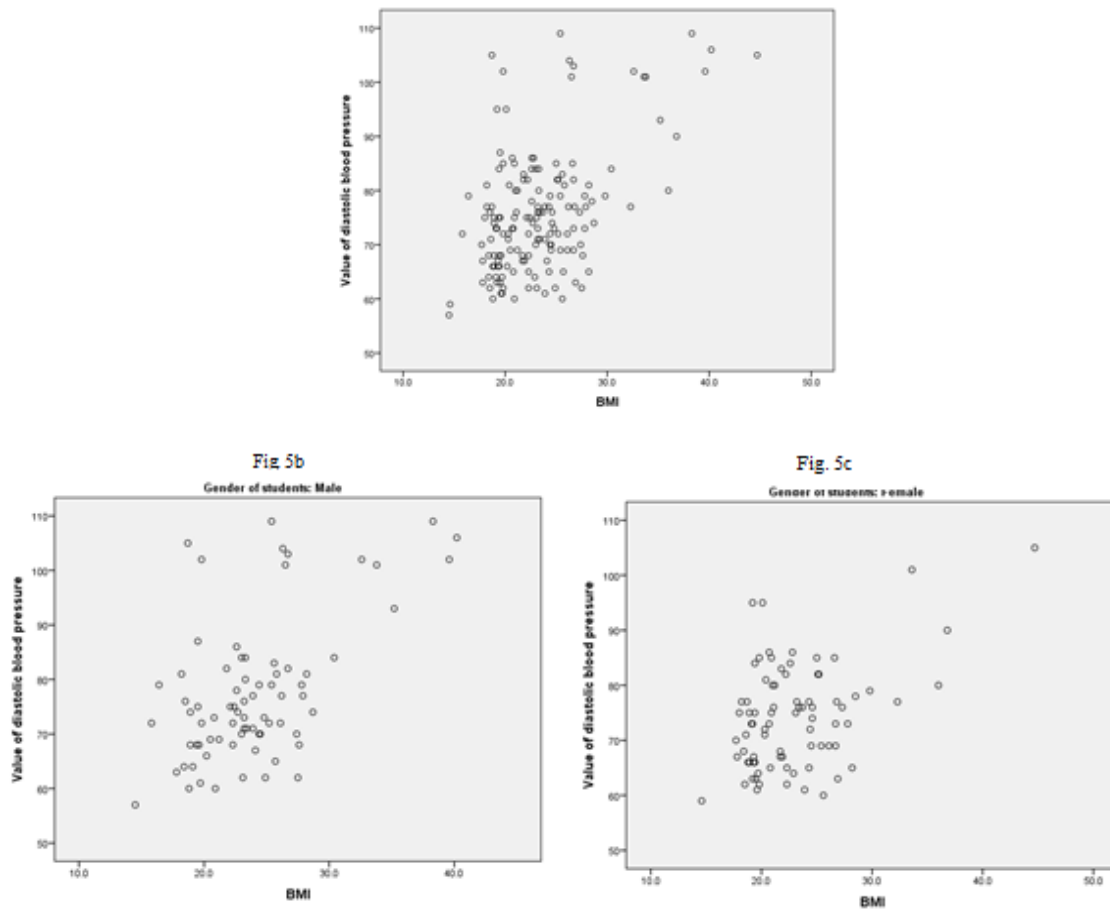


Fig. 5a, 5b and 5c: Showing Data Interpretation of Correlation between BMI and Diastolic Blood Pressure Based on Gender and Races Fig. 5a Gender of students: Overall (Male &Female)

DISCUSSION

The results obtained from our study conducted on undergraduate medical students of SEGi University, Kota Damansara showed that, in both males and females, the mean BMI value was highest among Indian students, followed closely by Malays and finally Chinese students. These results were in line with the findings from a previous study carried out among the individuals across selected regions in peninsular Malaysia and east Malaysia involving 4428 subjects. They reported that the prevalence of obesity was highest amongst Indians, followed by Malays and then the Chinese [7]. Our results were also found to be similar to a study done by the national survey in Singapore in 1992, which reported that Indians had the highest BMI value with a proportion of obese persons (10%) followed by Malays (6%) and Chinese (3%) [8]. However other reports contradicting with our results showed a difference in the pattern of BMI within the different races, in which the BMI value was highest among Malays, followed by Indians and Chinese respectively [9-10]. We had also previously reported that amongst males, Indians had the highest BMI value followed by Malays and Chinese. However with respect to females, Malays had the highest BMI value followed by Indians and Chinese [23-24]. The main difference in results obtained for these different studies maybe largely due to time, size and area of samples which will influence the outcomes of data due to the different ethnicities in Malaysia.

Our study also showed that the mean systolic blood pressure value was highest among the Indian males, followed by Chinese, and then Malays. However, in the case of females, we found that Chinese had the highest mean value of systolic blood pressure, followed by Malays, and then Indians. On the other hand the highest mean value of diastolic blood pressure was recorded in Indian males, followed by Malays, and then Chinese. But in case of females, the Malays had the highest mean diastolic blood pressure values, followed by Chinese and then Indians. In the past, no studies had been conducted in Malaysia on blood pressures among individuals based on their races.

Our results also showed a statistically significant correlation between BMI and systolic blood pressure among the overall participants (r value = 0.471), males participants (r value = 0.558) and female participants (r value = 0.394). Similarly, our data also showed a statistically significant correlation between BMI and diastolic blood pressure among the overall participants (r value = 0.510), males participants (r value = 0.559) and female participants (r value = 0.439). These findings were in line with previously conducted studies that reported that the prevalence of hypertension increased with increasing weight [16]. Our finding is also supported by another study which mentioned that obese individuals that have a higher BMI value have more fatty tissue that increases their vascular resistance and in turn increases the heart workload to pump blood throughout the body. This increase in vascular resistance results in a higher blood pressure in the individual [19].

CONCLUSION

In conclusion, there was statistically significant correlation between BMI and blood pressures (systolic and diastolic) in overall participants, male participants and female participants. Hence, this study may be used as a guidance for Malaysian undergraduate university medical students to be aware of their diet, physical activities and lifestyles, since they are the main risk factors of obesity. This would help to reduce the risks of getting diseases like diabetes, heart diseases, stroke and hypertension.

AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: NSS SRD Performed the experiments: KSYY SA GA MRM. Analyzed the data: KSYY SA GA MRM MB SAM. Wrote the paper: NSS SRD KTZ HTD. Revised the paper: NSS SRD KTZ HTD KSYY SA GA MRM KAJ MAE MI VA SYAK JZ RM WAC AY RSYW NMHM ATK SAY MB KTO SWWL KHA DM VK SAM MM. All authors read and approved the final manuscript to be published.

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