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Correlation Between Body Mass Index (BMI) and Fasting Total Blood Cholesterol Level among Undergraduate Students

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Abstract: A cross sectional study to observe the relation between body mass index (BMI) and the fasting total blood cholesterol level was carried out among 82 undergraduate medical students from SEGi University, Kota Damansara. The participants were randomly selected to participate in this research. The BMI was then calculated by using the standard formula (kg/m^2). The fasting total blood cholesterol level was measured by using home cholesterol kit. The obtained data was then analyzed by using statistical package for the social sciences software (version 22.0). For males, the highest mean BMI value and highest mean fasting total blood cholesterol level were recorded for Indian students followed by Malays and Chinese. There was significant correlation between BMI and the fasting total blood cholesterol level in male participants (0.001, r-value = 0.525). As for females, Malays had the highest mean BMI value followed by Indians and Chinese and the highest mean fasting total blood cholesterol level was found in Chinese followed by Malays and Indians. No significant correlation was found between BMI and fasting total blood cholesterol levels in female participants (0.922, r-value = 0.015). However, there was a significant correlation between BMI and fasting total blood cholesterol level in overall male and female participants (0.015, r-value = 0.267). In conclusion, our study suggests that the students should be advised to exercise more; reduce intake of food with high cholesterol, avoid fast food and have an active and healthy lifestyle. This may overall improve their health status and prevent them from getting diseases which are associated with obesity and high cholesterol level.

Key words: Body mass index (BMI), Fasting total blood cholesterol level, obesity

INTRODUCTION

Body Mass Index (BMI) is a measure of weight adjusted for height, calculated as weight in kilograms divided by the square of height in meters (kg/m^2). BMI is an estimate of body fat and a good gauge of your risk for diseases that can occur with more body fat. The National Institutes of Health (NIH) defines normal weight, overweight and obesity according to BMI (Sobal and Marquart, 1994; Gahagan *et al*., 2011). BMI is usually chosen as a measure of body fat because it is simple, inexpensive and non-invasive. The method of measurement is safe and conducted in clinical and research settings. It is also a useful tool for a quick assessment of weight classification. Although it does not directly measure body fat, it is more accurate at approximating the degree of body fat rather than weight alone. In addition, a person does not have to be of an exact weight or measurement, to be considered 'normal.' There is a range within each classification to allow for different body types and shapes. The guideline for BMI classification is shown in Table 1 (Eisenberg *et al*., 1993; Sobal and Marquart, 1994; Gahagan *et al*., 2011). Despite being popular and simple to use, BMI has some limitations. It is an indirect and imperfect measure for body fat because it does not differentiate between fat mass and lean body mass components. BMI also varies with age and sex. The calculation for adults is different from that for children, but then compared to typical values for other children of the same age (Sobal and Marquart, 1994;

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Gahagan *et al*., 2011). Besides, BMI is only a proxy indicator of body fat mass. Factors such as fitness (muscle mass), ethnic origin and puberty can alter the relationship between BMI and body fat mass. Muscle and bone are denser than fat, so an athlete or muscular person may have a high BMI, yet not have too much fat (Deurenberg *et al*., 2000). Thereby BMI can be misleading in such cases. BMI does not provide any indication of the distribution of body fat and does not fully adjust for the effects of height or body shape, which may be particularly important when comparing figures across ethnic groups (Moore, 2000).

Obesity is a condition of excessive fat deposition in the body, an uncommon fat stacking up in the adipose tissues of the body causing health threats in severe cases. Basically, the underlying cause is a positive energy balance gain leading to increase in weight in sedimentary lifestyle whereby the ingested calories overreach the calories conserved (Sobal and Marquart, 1994; Lamon-Fava *et al*., 1996; Moore, 2000; Gahagan *et al*., 2011). Obesity is part of raising the risk of health problems, given by an increased body weight to its effects on blood pressure, glucose tolerance and plasma lipid metabolism (Rosenbaum *et al*., 1997). Although the etiology of an excessive body weight is still obscure, energy metabolism and dietary intake strongly contribute in its development (Dietschy *et al*., 1993). However, the most important cause of overweight and obesity is the accumulation of cholesterol and fat in our body (Khoo *et al*., 1991). A general consensus ensures that the total cholesterol level rises as the body mass index rises (Wenger, 1999). The guideline for blood lipids profile is shown in Table 2 (Lamon-Fava *et al*., 1996). BMI is often used as an indirect index of adiposity and has been closely related with risk of cardiovascular disease (Brown *et al*., 2000). BMI was significantly and linearly associated with systolic blood pressure, fasting glucose levels, plasma total cholesterol, VLDL cholesterol and LDL cholesterol levels and was inversely and linearly associated with HDL cholesterol levels ($p<0.001$) in nonsmoking men and women. The association between BMI and apolipoprotein B and A-I was similar to that of LDL and HDL cholesterol, respectively (Lamon-Fava *et al*., 1996). Normally BMI is directly linked with total and LDL-cholesterol concentrations, whereas an inverse relationship has been reported between HDL-cholesterol and BMI (Ferrannini, 1995).

It had been previously reported that with regards to ethnicity, obesity cases in Malaysia were highest among Malays, followed by Indians and Chinese, respectively (Azmi *et al*., 2009; Nurul and Ruzita, 2010). The report also showed that 60% of Malaysians aged 18 and above have BMI of over 23, classifying them as overweight. An exploratory study by Wenger (1999) suggested that the increase in total cholesterol with age is different for men and women. High BMI value is known to cause hypertension, diabetes mellitus and hyper-cholesterolaemia. The prime BMI cut-off value for predicting the presence of diabetes mellitus, hypertension, hypercholesterolaemia or at least one of these health risk factors varied from 23.3 to 24.1 kg/m^2 for men and from 24.0 to 25.4 kg/m^2 for women (Ferrannini, 1995; Lamon-Fava *et al*., 1996; Brown *et al*., 2000).

Therefore, we believe that this research is beneficial to give a measure of both BMI and fasting total blood cholesterol level among university students. Hence, this study was designed to determine the correlation between the BMI and fasting total blood cholesterol level among undergraduate medical students of SEGi University Kota Damansara and help them in acknowledging health care awareness.

MATERIALS AND METHODS

Ethical approval was obtained from the ethical review board of SEGi University. A cross sectional study was carried out in SEGi University, Kota Damansara among 82 undergraduate medical students [Male: 37 (15 Malays, 12 Chinese, 10 Indians), Females: 45 (20 Malays, 10 Chinese, 15 Indians)]. Two parameters were used in this research: BMI and fasting total blood cholesterol level. Randomly selected participants of the same age, gender and race were requested to sign a letter of consent to participate in this study.

After obtaining the consent, their measurements were obtained in the Physiology laboratory at the Faculty of Medicine of SEGi University. Participants were asked to remove their shoes and step on the weighing scale for weight measurement. For measuring the height, they were asked to stand upright with their back against the stadiometer with eyes looking straight forward. The BMI was computed by using the standard formula which is weight in kilograms divided by the square of the height in metres (kg/m^2) (Sobal and Marquart, 1994; Gahagan *et al*., 2011). The results obtained were tabulated.

Having informed all participants to have 12 h fasting before taking the blood, the fingertip of the participants was pricked with a lancet to draw the blood. Then the blood was placed on a digital strip which was inserted into the cholesterol home test kit to measure the fasting total blood cholesterol level. The results obtained were tabulated.

Finally, the statistical analyses were done using statistical package for the social sciences software. (IBM Corp, version 22.0).

RESULTS

Data interpretation for mean BMI based on gender and races: It is evident from Fig.1 that amongst males, Indians had the highest BMI value followed by Malays and Chinese. The BMI value for Indians were greater than that for Malays by 4.93% whereas the BMI value for Indians

Table 1: Guideline for body mass index (BMI) classification

Classification	BMI (kg/m^2)
Underweight	<18.5
Normal range	18.5-22.9
Overweight	23-24.9
Obese I	25-29.9
Obese II	≥30

Table 2: Guideline for blood lipids profile

Total cholesterol, mg/dL	
Less than 200	Desirable
200 to 239	Borderline high
240 or more	High
LDL cholesterol, mg/dL	
Less than 100	Optimal
100 to 129	Near
optimal/above optimal	
130 to 159	Borderline high
160 to 189	High
190 or more	Very high
HDL cholesterol, mg/dL	
Men, less than 40	Low
Women, less than 50	Low
60 or more	High
Triglycerides, mg/dL	
Less than 150	Normal
150 to 199	Borderline high
200 to 499	High
500 or more	Very high

were greater than that for Chinese by 9.17% and that for Malays were greater than that for Chinese by 4.46%.

In females, Malays had the highest BMI value followed by Indians and Chinese. The BMI value for Malays were greater than that for Indians by 6.61% whereas the BMI value for Malays were greater than that for Chinese by 7.62% and that for Indians were greater than that for Chinese by 1.08%.

Data interpretation for mean fasting total blood cholesterol level based on gender and races: Figure 2 shows that amongst males, Indians had the highest fasting total blood cholesterol level followed by Malays and Chinese. The fasting total blood cholesterol level for Indians were greater than that for Malays by 11.03% whereas the fasting total blood cholesterol level for Indians were greater than that for Chinese by 14.6%. and that for Malays were greater than that for Chinese by 4.01%.

Amongst female participants, Chinese had the highest fasting total blood cholesterol level followed by Malays and Indians. The fasting total blood cholesterol level for Chinese were greater than that for Malays by 1.80% whereas the fasting total blood cholesterol level for Chinese were greater than that for Indians by 5.98%. and that for Malays were greater than that for Indians by 4.25%.

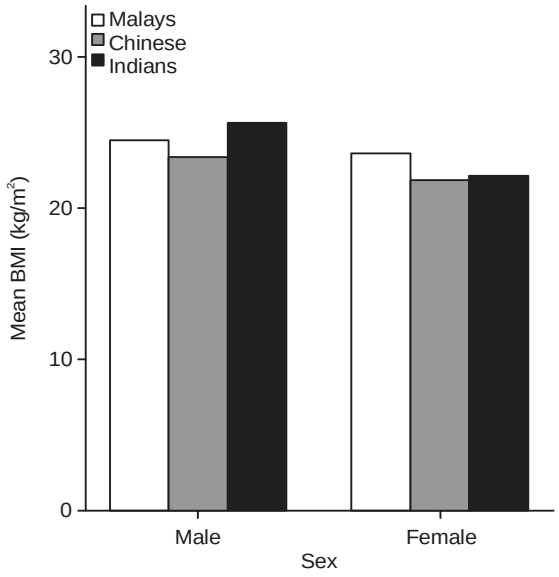

Fig. 1: Showing the data interpretation for mean BMI based on gender and races

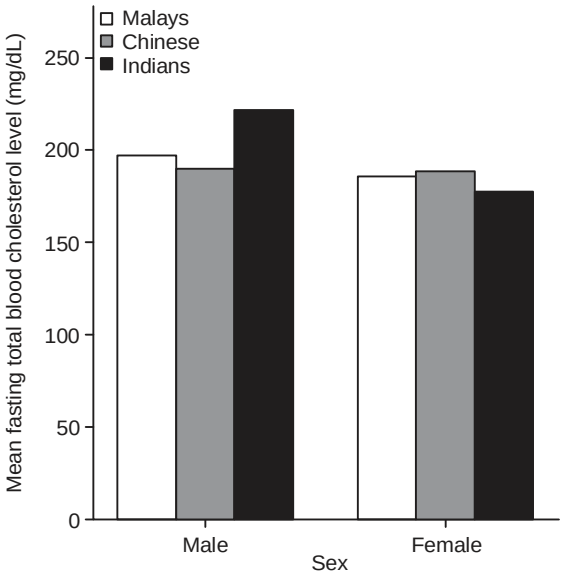

Fig. 2: Showing data interpretation for mean fasting total blood cholesterol level based on gender and races

Data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall male and female participants): It is evident from the scatter plot of Fig. 3 that there was correlation between BMI and fasting total blood cholesterol level among the overall male and female participants and the significant value was (0.015, r-value = 0.267).

Data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall male participants): The scatter plot of Fig. 4 shows that there

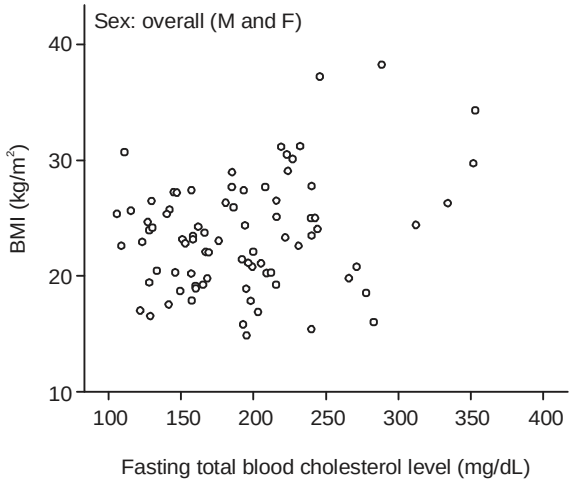

Fig. 3: Showing data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall male and female participants)

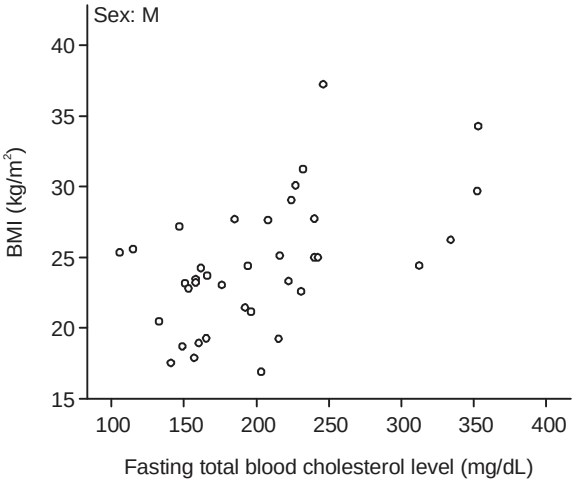

Fig. 4: Showing data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall male participants)

was correlation between BMI and fasting total blood cholesterol level among the overall male participants and the significant value was (0.001, r-value = 0.525).

Data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall female participants): There was no significant correlation between BMI and fasting total blood cholesterol level among the overall female participants as shown in the scatter plot of Fig. 5 and the value was (0.922, r-value = 0.015).

DISCUSSION

In the present study, it was found that in males, the Indians had the highest BMI value readings followed by

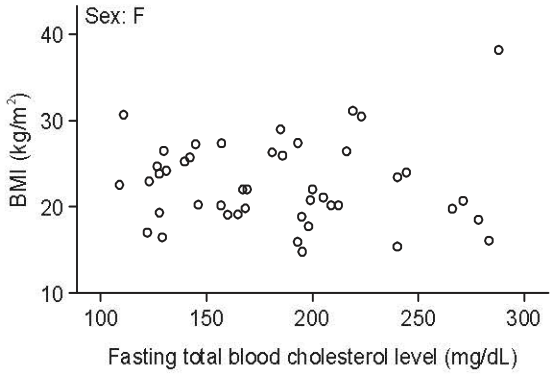

Fig. 5: Showing data interpretation of correlation between the BMI and the fasting total blood cholesterol level (overall female participants)

Malays and Chinese, respectively. This finding was confluent with the study done by the national survey in Singapore in 1992 which observed that Indians had the highest BMI value and proportion of obese persons (10%) followed by Malays (6%) and Chinese (3%) (MOH Singapore, 1993). Other studies in Malaysia had reported differently from the results of the present study with regards to ethnicity, where the BMI value was highest among the Malays, followed by the Indians and the Chinese, respectively (Azmi *et al*., 2009; Nurul and Ruzita, 2010). The latter sequence was also observed in our study in case of females, where we found the BMI value was highest in the Malays, followed by the Indians and Chinese, respectively.

Our study also showed that in males, the Indians had the highest fasting total blood cholesterol level followed by the Malays and the Chinese. This present finding was similar to previous report that the total cholesterol level was statistically highest in the Indians followed by the Malays and the Chinese, respectively (Zaraihan *et al*., 1994). However in the females, the fasting total blood cholesterol level in Chinese was found to be the highest in our study followed by the Malays and the Indians.

In our study there was significant correlation between BMI and the fasting total blood cholesterol level in male participants (0.001, r-value = 0.525). We also found that there was a significant correlation between BMI and fasting total blood cholesterol level in overall male and female participants (0.015, r-value = 0.267). These findings were in accordance with previous reports by other researchers who stated that the most important cause of overweight and obesity is the accumulation of cholesterol and fat in the body and the total cholesterol in the body rises as the BMI rises (Khoo *et al*., 1991; Dietschy *et al*., 1993; Ferrannini, 1995; Lamon-Fava *et al*., 1996; Wenger, 1999; Brown *et al*., 2000). It was also previously reported that the number of individuals with obesity, high BMI and high cholesterol level had increased rapidly in the past decades (Management of Obesity, 2013). However in our

study no significant correlation was found between BMI and fasting total blood cholesterol levels in female participants (0.922, r-value = 0.015).

Conclusion: In conclusion, for BMI in males, the Indians had the highest mean BMI value followed by Malays and Chinese. In females, Malays had the highest mean BMI value followed by Indians and Chinese. With respect to fasting total blood cholesterol level, Indians showed the highest mean fasting total blood cholesterol level readings followed by Malays and Chinese in males and in the females, Chinese had the highest mean fasting total blood cholesterol level follow by Malays and Indians. There was no significance correlation between BMI and fasting total blood cholesterol level in female participants (0.922, r-value = 0.015). However, there was a significant positive correlation between BMI and fasting total blood cholesterol level in overall male and female participants (0.015, r-value = 0.267) and in male participants (0.001, r-value = 0.525). Therefore it is necessary to advise students that they should exercise more and reduce their intake of food with high cholesterol content and to have an active and healthy lifestyle. This may overall improve their health status for the future and prevent them from getting diseases that are associated with obesity and high cholesterol level.

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

Author contributions: Conceived and designed the experiments: SRD NSS Performed the experiments: NNJ WB FLS LSJ IYH YKL. Analyzed the data: NNJ WB FLS LSJ IYH YKL MB SAM. Wrote the paper: SRD HTD KTZ NSS. Revised the paper: SRD HTD KTZ KRG RS KAJ MI MES NHL WML VA SYAK RM WAC AY RSYW VK JN NSFS CPWT MNH ATK HH SAY MB SARA FF MAE SAM MM NSS. All authors read and approved the final manuscript to be published.

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