Research Article

Relationship of Serum Cholesterol and Triglycerides Levels with the Body Mass Index in a Group of Healthy Undergraduates

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Abstract

Introduction: Knowledge about the relationship between Body Mass Index (BMI) and serum lipid levels is important in detecting the risk of cardiovascular diseases. The present study assessed the correlations of serum total cholesterol and triglyceride levels with BMI in a group of healthy undergraduates. Methods: A cross-sectional study was conducted among 104 students of the Faculty of Allied Health Sciences, University of Ruhuna. Serum total cholesterol and triglyceride levels of fasting blood samples were measured using enzymatic kits. Students' heights and weights were measured, and BMI values were calculated. Information regarding students' dietary habits, lifestyle and family history of diseases related to dyslipidemia was collected using a pre-tested and self-administered questionnaire. Data were analyzed using SPSS-20.0. Results: Mean (±SD) serum total cholesterol and triglyceride levels of the samples were 191.34±36.13 mg/dL and 116.25±59.9 mg/dL, respectively. The mean BMI was 22.48±3.59kg/m^2. The total population had significant positive correlations between; BMI and total cholesterol level ($r=0.23$, $p=0.017$), and BMI and triglyceride level ($r=0.42$, $p<0.001$). There was no significant correlation between BMI and cholesterol levels in male students ($p=0.800$) but, a significant positive correlation was found between triglyceride levels and BMI of them ($p=0.017$). Among female students, significant positive correlations with BMI were observed for both cholesterol ($p=0.005$) and triglyceride ($p=0.002$) levels. Family history of dyslipidemia related disease conditions showed a significant effect on the elevation of serum cholesterol and triglyceride levels of the students. Although there was no significant difference, the highest serum lipid levels were detected among students who consumed eggs more than once a day. Conclusions: Significant positive correlations were found between BMI and both serum total cholesterol and triglycerides levels in female students. Among the male students, there was a significant positive correlation between BMI and triglycerides, and no correlation between BMI and cholesterol levels.

Keywords: Body mass index, Cholesterol, Correlation, Triglyceride, Undergraduates

Introduction

Cholesterol and triglycerides are the two main lipid types found in human blood. They are transported throughout the body incorporated into lipoproteins; High-Density Lipoproteins (HDL), Low-Density Lipoproteins (LDL), Very-Low-Density Lipoproteins (VLDL), and chylomicrons. Obesity occurs due to the accumulation of excessive fat in the body. This leads to severe

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health threats by harmfully affecting blood pressure, glucose tolerance and plasma lipid metabolism [1].

Body Mass Index (BMI) is an anthropometric measurement of body weight adjusted for height. It is 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 measure of the risk for cardiovascular diseases [2]. According to BMI, the National Institute of Health (NIH) classifies people as underweight, normal weight, overweight, and obese [3-4]. BMI is generally used in estimating body fat because it is a simple, convenient, inexpensive, and non-invasive method [2]. Even though BMI does not directly measure body fat, it is more accurate at approximating body fat than weight alone [2]. Another advantage is that a person does not need to be of an exact weight or height to be considered normal weight or not, as it is classified according to a range of BMI. Further, these classifications are adjusted according to gender and age groups [2].

Several studies have been conducted to assess the relationship between BMI, serum lipid levels, and obesity in foreign populations. The relationships among the above parameters are well reported for foreign ethnic groups and populations. Studies have also been carried out in selected Sri Lankan communities on the same aspect [5-7]. The age category of 20-30 years is vital to predicting cardiovascular risk factors in later years of life [8-10]. Since university students are within this age group and they are going to contribute to the workforce of the country to a substantial extent, estimation of their serum total cholesterol, triglycerides, and BMI values is very important. This study was carried out to investigate the correlation of total serum cholesterol level and triglycerides level with BMI of undergraduates and to assess the cardiovascular risk factors (genetic factors, diet, and lifestyle) affecting the above parameters. According to our knowledge, a similar study has not been previously done with a similar study group in Sri Lanka.

Methods

Study setting and study sample

A purposive, convenient sampling technique was adopted to recruit undergraduates for the study (n=104) without calculating the sample size. The study was conducted at the Faculty of Allied Health Sciences, University of Ruhuna, by recruiting an equal number of students from both genders and similar numbers from first, second, third, and fourth-year students (26 students from each batch, representing all the departments). The study was conducted from January 2020 to May 2020.

Subject recruitment

All undergraduates were invited to participate in the study. The inclusion criteria to recruit participants for the study included, Allied Health Science undergraduates of the University of Ruhuna in the year 2020 and undergraduates who were willing to participate.

Undergraduates who were suffering from diseases associated with abnormal lipid metabolism were excluded from the study. This information was gathered by inquiring about their medical histories. Informed written consent was obtained from the eligible candidates after explaining the study procedure and objectives. Subject recruitment was done entirely on a voluntary basis.

Data collection

Participants were prepared as follows. They were advised; to be on a stable and regular diet for one week, not to take alcohol or smoke before three days of testing, not to have strenuous exercises before testing, and to stay fasting without any food/food containing juices except water for 12 hours before the test. Venous blood samples of 3 mL were drawn from each participant who fulfilled the above requirements under sterile conditions by a qualified nurse. Immediately after receiving blood samples, they were centrifuged, and serum was separated and frozen at -20˚C until analysis. Blood samples were analyzed for serum total cholesterol and triglyceride levels using enzymatic kits by spectrophotometric methods using a double-beam spectrophotometer (SHIMADZU-UV 1800). Multi quality control (QC) materials were used for internal quality control. QC samples were run at the beginning of testing each batch of samples (1 batch=20 samples) daily. External quality control was also done by sending the samples to the Teaching Hospital Karapitiya and comparing the results obtained by the automated analyzer.

On the same day, the weight and height of the participants were measured in duplicates using a standard digital weighing scale (SALTER-9069) and a measuring tape. Mean values of weight and height were calculated and recorded. The BMI value of each participant was calculated.

A pre-tested, self-administered questionnaire was used to collect data on their dietary habits and lifestyle. The questionnaire comprised four main sections. Part A consisted of eight structured questions to obtain demographic data, Part B consisted of 15 questions regarding dietary habits, Part C consisted of five structured questions regarding the lifestyle of the participant, and Part D consisted of three structured questions regarding the family histories related to non-communicable diseases.

The levels of physical exercises (moderate) were assessed by recording about 18 physical activities/sports, and quantifying by the frequency and amount of time spent on those activities/sports. The study sample was divided into three groups depending on the amount of time spent on exercise: less than 5 hours/week, 5-10 hours/week and greater than 10 hours/week. Information regarding the family history of ten (dyslipidemia related) disease conditions, including diabetes mellitus, hypertension, cardiovascular diseases, hyperlipidemia, hyperthyroidism, hypothyroidism, fatty liver, acute kidney disease, chronic kidney disease, and systemic lupus erythematosus was collected using the Part D of the questionnaire.

Data analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Group comparison was done using paired student t-test and ANOVA. Pearson correlation was used to find the correlation. The p-value <0.05 was considered statistically significant.

Ethical consideration

Ethical approval for the study was obtained from the Ethics Review Committee, Faculty of Allied Health Sciences, University of Ruhuna (03.2019:3.18). Institutional approvals were obtained from the Vice Chancellor, Dean and Heads of the relevant departments of the Faculty of Allied Health Sciences, University of Ruhuna.

Results

Demographic characteristics of the study population

A total of 104 students participated voluntarily in the study, with an equal representation of male (n=52) and female (n=52) students. The age of the students ranged from 21 to 27 years. The demographic data of the study population is indicated in Table 1.

Body mass index, cholesterol and triglyceride levels of the participants

The BMI values of the study population ranged between 14.1 to 30.8 kg/m^2. The mean (±SD) BMI of the sample was 22.48 (±3.59) kg/m^2. The BMI of the male participants (23.35 kg/m^2) was significantly higher (p=0.008) compared to female (21.61 kg/m^2) participants. Serum total cholesterol levels of the participants ranged between 110.8 to 307.1 mg/dL. The mean (±SD) cholesterol level of the study participants was 191.34 (±36.13) mg/dL. The mean cholesterol level of the male participants (200.66 mg/dL) was significantly higher compared to the female students (182.0 mg/dL) with a p value of 0.008. Serum triglyceride levels of the study population ranged between 35.5 to 348.9 mg/dL. The mean (±SD) serum triglyceride level of the study participants was 116.25 (±59.9) mg/dL. The mean triglycerides level of the male students (137.13 mg/dL) was significantly higher ($p<0.001$) compared to the female students (95.38 mg/dL). Levels of BMI, serum total cholesterol and triglycerides levels among the study participants are indicated in Table 2.

Table 1: Demographic data of the study population (n=104)

Characteristics		Number (n)	Frequency (%)
Gender	Male	52	50.0
	Female	52	50.0
Academic programme	B.Sc. MLS	24	23.1
	B. Pharm.	23	22.1
	B.Sc. Nursing	57	54.8
Age (Years)	21-23	35	33.6
	24-26	66	63.5
	Above 26	03	2.9
Ethnicity	Sinhala	103	99.1
	Muslim	01	0.9
Residence	Hostel	60	57.7
	Boarding place	33	31.7
	Home	11	10.6
Monthly income of the family (LKR)	< 25,000	35	33.6
	25,000-75,000	55	52.9
	Above 75,000	14	13.5
Funds	Mahapola	37	35.6
	Bursary	24	23.1
	No funds	43	41.3

B.Sc- Bachelor of Science, MLS- Medical Laboratory Sciences

Table 2: Body mass index, serum total cholesterol and triglycerides levels among the study population

Gender	BMI Mean (±SD) (kg/m^2)	Serum total cholesterol level Mean (±SD) (mg/dL)	Serum triglyceride level Mean (±SD) (mg/dL)
Male (n=52)	23.35 (3.49)*	200.66 (39.96)**	137.13 (64.58)***
Female (n=52)	21.61 (3.50)	182.00 (29.37)	95.38 (46.81)
All (n=104)	22.48 (3.59)	191.34 (36.13)	116.25 (59.90)

*p=0.008, **p=0.008,***p<0.001

BMI- Body Mass Index

Multiple group comparisons with one-way ANOVA revealed that there were no statistically significant differences in BMI or cholesterol levels between the academic years of the students. However, there were statistically significant differences in the mean triglyceride levels between the first and third-year students (p=0.041) and first and fourth-year students (p=0.034).

Of the study sample, there were 24 students with BMI values higher than 25 kg/m^2 (overweight). Among them, there were 15 male students and nine female students. Among the first-year students, only three were identified with BMI values higher than 25 kg/m^2. High BMI values were reported from the male students than the female students. Twelve students of the sample were under-weight (BMI<18.5 kgm^2).

Correlation between body mass index and serum lipid levels

According to the Pearson correlation analysis, a significant positive correlation was found between the cholesterol level and BMI of the study population (r=0.23, p=0.017) (Figure 1), and a significant positive relationship was found between the triglyceride levels and BMI of the study population (r=0.42, p<0.001) (Figure 2).

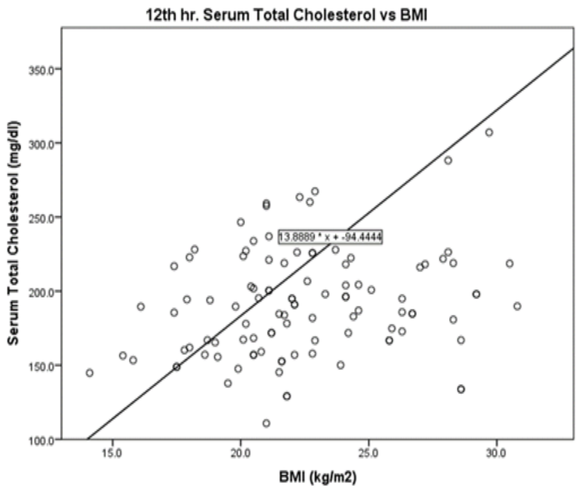

Figure 1: Correlation between body mass index and cholesterol levels

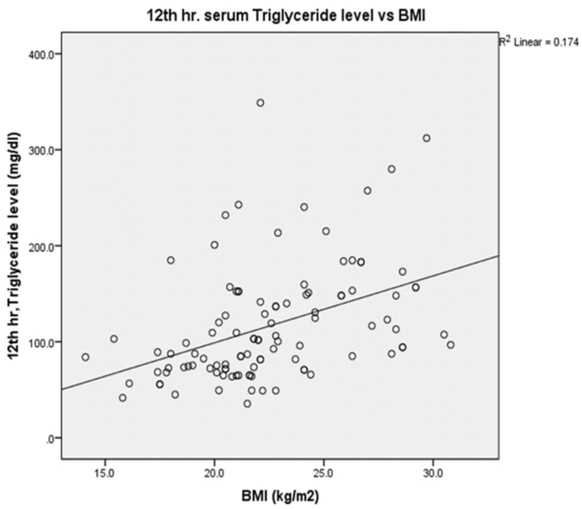

Figure 2: Correlation between body mass index and triglyceride levels

A significant correlation was not found between cholesterol levels and BMI among male students (r=0.036, p=0.800). However, a significant positive correlation was found between triglyceride levels and BMI among male students (r=0.330, p=0.017). Among female students, significant positive correlations were found between BMI and cholesterol levels (r=0.387, p=0.005) as well as between BMI and triglyceride levels (r=0.424, p=0.002).

Effect of physical exercise level, family history of diseases, dietary patterns, and socio-demographic factors on serum lipid levels and body mass index

There were no significant differences in BMI (p=0.097), total cholesterol (p=0.533) and triglyceride (p=0.818) levels with respect to the levels of physical exercise.

There was a significant difference among the mean BMI values between the group without no family history of dyslipidemia and those who had four or more than four family members with dyslipidemia (21.19±3.57 kg/m^2) vs (25.36±3.36 kg/m^2), (p=0.019)]. Similar results were reported with respect to serum cholesterol and triglyceride levels as well. The obtained BMI, serum total cholesterol,

Table 3: Body mass index, serum total cholesterol and triglycerides levels with respect to family history of dyslipidemia

No. of family members with dyslipidemia	BMI Mean (±SD) (kg/m^2)	Cholesterol levels at 12 hour Mean (±SD) (mg/dL)	Triglyceride levels at 12 hour Mean (±SD) (mg/dL)
0 cases (n=36)	21.19 (3.57)	172.87 (33.80)	102.55 (45.29)
1 case (n=19)	22.50 (2.68)	201.53 (29.79)	116.76 (40.50)
2 cases (n=20)	23.49 (3.66)	188.81 (26.40)	113.23 (63.96)
3 cases (n=21)	22.60 (3.65)	201.06 (27.29)	103.25 (44.06)
4 or more cases (n=8)	25.36 (3.36)*	231.06 (55.26)**	218.38 (91.02)***

*p=0.019, **p=0.004,***p<0.024

BMI- Body Mass Index

and triglycerides with respect to the family history of dyslipidemia are indicated in Table 3.

There was no significant effect of meat consumption in the study population on BMI (p=0.347), serum total cholesterol (p=0.696), and triglyceride (p=0.982) levels between the different meat consumption groups (no consumption, rarely, once a week, once in three days, once in two days, once a day, and more than once a day).

Results revealed that egg consumption has no significant effect on BMI (p=0.101), cholesterol (p=0.136), and triglyceride (p=0.077) levels of the total population. However, higher serum lipid levels were observed in the students who consumed eggs more than once a day. Also, it was found that there was no significant effect of fish consumption on BMI (p=0.245), cholesterol (p=0.634), and triglyceride (p=0.085) levels of the study population. Further, results revealed that there was no significant effect of powder milk consumption on BMI (p=0.482), cholesterol (p=0.686), and triglyceride (p=0.227) levels of the study population. Almost all the students of the study population were non-vegetarian. Oil consumption was very similar throughout the entire study sample. Dietary patterns were very much similar except for the frequency of egg consumption.

A significant relationship was observed between the students' residence and their serum lipid levels. Cholesterol (p=0.012) and triglyceride levels (p=0.015) were significantly different among the students who resided in their own houses compared to those who lived at hostels or boarding houses. The mean cholesterol levels were higher among the students who lived at home (209.17 mg/dL) when compared to those who lived in hostels (195.81 mg/dL), or boarding houses (177.27 mg/dL). Mean triglyceride levels were higher among the students who resided at home (165.21 mg/dL) when compared to those who lived in hostels (111.03 mg/dL), or boarding houses (109.43 mg/dL). However, the residence had no significant effect on the BMI (p=0.309) of the students.

Discussion

The BMI is commonly used as an indirect measure of body fat deposition, and it is reported to be closely associated with the risk of the development of cardiovascular diseases [11]. Therefore, estimation of serum total cholesterol, triglycerides, and BMI values, and identification of the factors affecting unfavorable serum lipid levels are very important and timely needs.

The BMI is reported to be directly proportional to the serum total cholesterol, serum triglyceride level, LDL cholesterol, and VLDL cholesterol levels and is inversely proportional to the HDL cholesterol levels in non-smoking men and women [2]. The present study showed a significant positive correlation between serum total cholesterol and BMI. Also, there was a significant positive correlation between triglyceride levels with BMI. The obtained p-values and Pearson correlation coefficients suggest that the correlation between BMI and triglyceride levels is stronger than the correlation between BMI and cholesterol levels of the students.

Previous research conducted to assess the correlation between BMI and fasting serum total cholesterol levels among 82 undergraduate medical students at SEGi University, Malaysia, revealed a significant correlation between BMI and total cholesterol levels in male subjects but not in female participants [2]. A previous study had suggested that an increase in serum total cholesterol with age differs in the female population compared to the male population [12]. BMI could be misleading due to factors like fitness (muscle mass) and puberty [2]. A muscular person can have a high BMI even though they have a little body fat because muscles and bones have a higher density than fat [13]. In the present study, when analysing the correlation between BMI and lipid types concerning gender, there was no significant correlation between cholesterol level and BMI among male students [$r=0.036$, $p=0.800$]. However, there was a significant positive correlation between triglyceride level with BMI among male students [$r=0.330$, $p=0.017$]. Among the female students, there was a significant positive correlation between BMI and cholesterol level [$r=0.387$, $p=0.005$]; and between BMI and triglyceride level [$r=0.424$, $p=0.002$].

A study has shown that familial factors are also contributed to the development of obesity [14]. The results of the present study revealed that there is a significant positive relationship between the number of dyslipidemia conditions related to family history and fasting 12 hours serum total cholesterol levels [$r(102)=0.39$, $p<0.001$]; and the 12th hour serum triglyceride levels [$r(102)=0.28$, $p=0.004$] of the students. Correlation coefficients and the p-values' suggested that a family history of dyslipidemia has a higher effect on the students' serum cholesterol levels than serum triglyceride levels.

Hyperlipidemia due to unhealthy dietary habits and inadequate physical activities are now considered as important factors for developing ischemic heart diseases [14-16]. As there was no defined parameter to quantify the intensity of the physical activity precisely, only the amount of time and frequency engaged per week were considered in this study. The results revealed no significant relationship between the time duration spent on physical exercise and the students' serum lipid levels. A cross-sectional study has been carried out to study the lipid profile in a population of students in a public university in Fortaleza, Brazil, in 2013. This research has recruited 702 students with equal male and female representation and revealed high levels of serum triglyceride, total cholesterol, LDL-cholesterol and low levels of HDL-cholesterol among the students with less physical activity [14].

Scientific evidence and experimental data have not validated the hypothesis that dietary cholesterol increases blood cholesterol. Investigators have reported that increased intake of dietary cholesterol (exogenous) is associated with the decreased synthesis of endogenous *de novo* cholesterol, possibly as a compensatory mechanism that keeps cholesterol homeostasis constant [17]. Similar findings were observed in the present study as well. The present study revealed that a considerable number of the study participants have a higher risk of developing hyperlipidemia and obesity. Familial history was found to be the main causative factor.

It is recommended to screen the university undergraduates for serum lipid abnormalities and direct them for treatments and counseling. It is also recommended to conduct some inspiring and effective awareness and educational programmes to stimulate the student to develop an interest to have in attention to their health conditions throughout their life. Further, BMI could be recommended as a screening tool for detecting cardiovascular risk in settings where serum lipid levels cannot be routinely estimated.

Conclusions

Significant positive correlations were found between serum total cholesterol and BMI, and triglyceride levels with the BMI in female students. Among the male students, there was a significant positive correlation between BMI and triglycerides level, and no correlation was reported between BMI and cholesterol level. Both serum total cholesterol and triglyceride levels were higher among male students compared to female students. BMI, serum total cholesterol, and triglyceride levels were significantly higher in the students with a family history of dyslipidemia related disease conditions compared to those without a family history of it.

Limitations

As a purposive and convenient sampling technique was adopted for subject recruitment, generalization of the results to Sri Lankan undergraduates is inappropriate. Recall bias could affect the data collected regarding dietary and lifestyle patterns through the self-administered questionnaire. A relatively larger sample would have represented the relationships among the parameters more clearly and precisely.

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