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Serum Lipid Profile and Its Association with Hypertension among Mongolian Adults

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Objective: The purpose of this study was to investigate the relationship between serum lipid profile and hypertension among Mongolian adults. **Methods:** This population-based cross-sectional study was conducted between January and June 2018 in Mongolia. According to current European Society of Cardiology guidelines, hypertension was defined as an average systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg. Lipid profile (total cholesterol (TC), triglycerides (TG), high-density lipid [HDL], cholesterol and low-density lipid [LDL]-cholesterol) and fasting plasma glucose as well as Apolipoprotein B (ApoB), Apolipoprotein A (ApoA) and a ratio of apoB/apoA1 were estimated. **Results:** This study included 998 participants with a mean age ± SD of 49.4±14.8 years. Serum levels of TC, TG, and LDL were 4.8±0.93, 1.58±1.19 and 3.23±0.9 mmol/L, respectively among males, and 4.5±0.96, 1.22±0.48 and 2.95±1, respectively in females, which were significantly lower ($p<0.05$). The serum HDL was significantly lower ($p<0.01$) in males (1.67±0.22mmol/L) than in females (1.85±0.21). **Conclusion:** The results of this study demonstrate that people with hypertension are more likely have higher dyslipidemia, including elevated TC, TG, LDL and reduced HDL cholesterol level compared to a normotensive group. However, according to the binary logistic regression analysis, the most significant elevations of BP were attributed to age and reduced HDL.

Keywords: Dyslipidemia, Blood Pressure, Cardiovascular Disease, Gender Difference

Introduction

Data provided by the World Health Organization shows that during the last decade, cardiovascular disease (CVD) became the main cause of death worldwide, accounting for 17.3 million deaths per year [1]. During 1990-2001, cardiovascular mortality increased from 26%-28% in developed and developing countries [1]. The highest rates of mortality due to CVDs, representing approximately 58%, are recorded in Eastern European countries, whereas the lowest (10%) are to be found in the African countries [1]. Dyslipidemia and hypertension are major risk factors for CVD and account for more than 80% of deaths and disability in low- and middle-income countries [2, 3]. Atherosclerosis is more extensive and severe in hypertensive patients than in normotensive; this was the conclusion after the autopsy studies conducted on human coronary arteries and aortas collected from various parts of the world [4-6]. Worldwide, there is broad variation in serum lipid profile levels among different population groups and a great majority of CVDs are associated with dyslipidemia [7-9]. Increased serum levels of total cholesterol (TC), triglycerides (TG), high-density lipid [HDL]-cholesterol and decreased low-density lipid [LDL]-cholesterol are known to be associated with major risk factors for CVD [10-12]. Low HDL is increasingly recognized as an independent risk factor for adverse CVD outcomes, irrespective of levels of LDL [11]. In recent years, rapid urbanization, unhealthy diet, increased life expectancy and lifestyle changes have led to an increased rate of CVD around the world [13].

In Mongolia, non-communicable disease (NCD) -related death rates are increasing annually, and during the three decades, mortality and morbidity attributable to CVDs are continuously taking first place among the leading causes of morbidity and deaths [14]. Consumptions of saturated fat and salt are known risk factors for CVD, and especially of hypertension in the Mongolian population. The Third Mongolian National Survey on the Prevalence of Non-communicable Disease (STEPS) and Injury Risk Factors, conducted in 2013 estimated the prevalence of hypertension among adults to be 27.5%, with a 95% confidence interval (CI) ranging from 25.6% to 29.4% [14]. However, data about the relationship between hypertension and lipid profiles in Mongolian adults are rarely published. The purpose of this study was therefore to determine the association between hypertension and lipid profile in this population.

Materials and Methods

Study design and sampling

This population-based cross-sectional study was conducted in two districts of Ulaanbaatar city (Bayanzurkh and Songinokhairkhan districts) and two aimags or provinces (Tuv and Dundgobi). Participants were recruited from these areas and comprised Mongolian adults aged 25 and over. The study error of 5% was assumed with a confidence interval 1.96%. A sample size of 950 was considered adequate for this study.

Data collection

Data were collected between January and July 2018. Four data collection teams were established, each with 6-7 members including a team leader, interviewer, anthropometric measurer and laboratory technician. Local assistants recruited by the teams were asked to inform randomly selected individuals about the collection procedures two weeks in advance of the actual field survey. Eligible participants were asked to provide written consent prior to completing a comprehensive questionnaire which recorded demographic data, behavioral risk factors such as smoking, alcohol consumption, and past medical history.

Anthropometric measurements and laboratory methods

Anthropometric measurements or physiological factors, such as body weight and height, were measured for each participant from a standing position. Weight was measured adjusting by 0.1 kg for subjects not wearing shoes. Height was measured adjusting by 0.1 cm for subjects in light clothes. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Participants were classified according to their BMI as normal (BMI ≤ 25 kg/m^2), over-weight (BMI between 25 kg/m^2 and 29.9 kg/m^2) and obese (BMI between > 30 kg/m^2). Waist circumference (WC) was measured with an accuracy of 0.1 cm from midway between the lowest rib and iliac crest using a Gullick II tape in standing position. Blood pressure (BP) was measured at least three times in the sitting position after a 5 min rest and estimated as the average of three readings of systolic and diastolic blood pressure.

European Society of Cardiology guidelines, define hypertension as an average of systolic blood pressure (SBP) ≥ 140 mmHg and diastolic blood pressure (DBP) ≥ 90 mmHg [15]. A volume of 5 mL of venous blood was collected from participants in the morning after an overnight fast, and serum was used for biochemical tests. All tests were analyzed at the Med-Analytic laboratory in Ulaanbaatar, Mongolia. Lipid profile (total cholesterol (TC), triglycerides (TG), high-density lipid [HDL]-cholesterol and low-density lipid [LDL]-cholesterol) and fasting plasma glucose as well as ApoB and ApoAwere estimated by the enzymatic colorimetric methods. Furthermore, we estimated a ratio of ApoB/ApoA (ApoB divided by Apo A).

Statistical Analysis

Statistical analysis was performed using STATA 12 (STATA Corp, College station, TX, USA). Descriptive statistics were created to describe the characteristics of the participants including age, gender, education, ethnic group, marital status, employment status, alcohol consumption and smoking status. Chi-Square test was used to compare categorical variables for 95% confidence intervals (CI) and p-value. Normal distribution of variables was confirmed via STATA by observing skewness and kurtosis values between -1 and +1 before further proceeding. The non-normally distributed data (TC, TG, LDL, HDL and glucose) were log transformed.

After checking for normal distribution, the independent t-test was used for evaluating differences between groups in continuous variables. Pearson's correlation analysis was used to test the positive and negative correlation between variables. Binary logistic regression analysis was performed to measure the relationship of lipid profile among the hypertensive and normotensive patients after adjusting for age, gender, BMI, WC and smoking status. All p-values were two-sided, and less than 0.05 were considered statistically significant.

Ethical statements

The research methodology, recruitment procedure and consent forms were reviewed and approved by the Scientific Committee at the Institute of Medical Sciences in May 03, 2016. The Medical Ethical Committee at the Ministry of Health reviewed the survey methodology and issued an approval #02/2016 in August 26, 2018. To protect participants' confidentially, they were assigned a participant ID number and all paperwork included only the participant ID number and age. Participants provided written consent prior to having their blood and anthropometric measurements taken and to completing the questionnaire.

Results

Demographic data are presented in Table 1, while anthropometric and biochemical data are presented in Table 2. This study recruited 998 participants with a mean age ± standard deviation (SD) of 49.4±14.8 years. The mean SBP and DBP were 127.5±21.1 mmHg and 82.6±12.3 mmHg, respectively. The mean TC, TG, LDL, SBP, DBP, BMI and glucose were higher for males than for females, which was statistically significant ($P<0.01$). The mean WC was higher in males, but this was not statistically significant ($P=0.19$) (Table 2).

According to Table 2, the mean age ± SD of males and females were 49.3±15.3 and 49.4±14.3 years, respectively. Serum levels of TC, TG, and LDL were 4.8±0.93, 1.58±1.19 and 3.23±0.9 mmol/L, respectively among males while in females, there were 4.5±0.96, 1.22±0.48 and 2.95±1, respectively, which were significantly higher among males ($p<0.05$). The serum HDL was significantly lower ($p<0.01$) in males (1.67±0.22 mmol/L) than in females (1.85±0.21). The mean SBP of male and female participants were 131.4±19.5 mmHg versus 123.9±21.9 mmHg, respectively, and mean DBP were 84.2±11.7 mmHg versus 81.8±12.7 mmHg ($p<0.01$), respectively. However, there was not statistically significant difference in lipid profile, SBP and DBP between urban and rural areas among the study population. Serum lipid values with or without hypertension status (with mean ± SD; 95% CI and p-values) is represented in Table 3. Serum lipid values were higher among hypertensive participants. However, HDL was lower in hypertensive participants ($p<0.01$). The mean of ApoB was statistically significant different between hypertensive and normotensive groups, whereas there were no significant difference in ApoA and a ratio of ApoB/ApoA among the groups.

Tables 4 and 5, present the correlation between serum lipids and blood pressure (systolic and diastolic, respectively). It is evident from the tables that correlation and p-values were positively significant in serum lipids (TC, TG, and LDL). However, HDL was found to be negatively significant with systolic and diastolic blood pressures. Binary logistic regression analysis for the serum lipids and other risk factors comparing two groups (hypertensive and normotensive) are presented in Table 6. The crude odds ratio (OR) demonstrated that age, sex, BMI, WC, smoking and glucose were risk factors for hypertension compared to normotensive groups ($p<0.05$). However, the adjusted OR showed that low HDL values was a major risk factor for increased blood pressure and the OR was 2.06, 95% CI: 2.03-2.12, $p<0.05$, whereas TC, TG and LDL were not associated with hypertensive groups after adjusting for age, gender, BMI, WC and smoking status. These results clearly indicate that age and low HDL are strongly associated with hypertension.

The results in Figure 1 indicate that older people had higher dyslipidemia, including elevated TC, TG, LDL, but a reduced HDL cholesterol level compared to young people.

Discussion

We investigated the association between serum lipid profile and hypertension among Mongolian adults. Results of this study revealed that the mean values of serum TC, TG and LDL

Table 1. Demographic characteristics

Variables	Total% (n)	Men% (n)	Women% (n)
Gender	100 (998)	47.1 (470)	52.9 (528)
Urban	49.9 (498)	51.1 (240)	48.9 (258)
Rural	50.1 (500)	48.8 (229)	51.2 (271)
Age group (years)			
25-34	20.6 (205)	20.9 (98)	20.2 (107)
35-44	20.6 (205)	20.9 (98)	20.2 (107)
45-54	21.4 (214)	21.1 (99)	21.7 (115)
55-64	20.3 (203)	19.4 (91)	21.2 (112)
65+	17.1 (171)	17.7 (83)	16.7 (88)
Education level			
Incomplete primary education	8.6 (85)	9.3 (43)	7.9 (42)
Primary school complete	19.1 (190)	23.3 (108)	15.5 (82)
Incomplete secondary education	25.1 (249)	25.4 (118)	24.8 (131)
Complete secondary education or technical education	13.2 (131)	10.1 (47)	15.9 (84)
Higher education	33.6 (334)	31.7 (147)	35.4 (186)
Postgraduate degree completed	0.4 (4)	0.2 (1)	0.5 (3)
Marital status			
Never Married	6 (60)	5.8 (27)	6.2 (33)
Married certified	78 (777)	85.4 (399)	71.4 (378)
Diversed	1.9 (19)	1.7 (8)	2.1 (11)
Widowed	13.1 (130)	5.6 (26)	19.7 (104)
Intimate relationship	0.6 (6)	0.9 (4)	0.4 (2)
Separated	0.4 (4)	0.6 (3)	0.2 (1)
Ethnicity			
Khalkha	90.6 (896)	90.5 (421)	90.6 (475)
Kazak	0.5 (5)	0.4 (2)	0.6 (3)
Others	8.9 (88)	9.1 (42)	8.8 (46)
Employment status			
Government organization	22.3 (221)	17.3 (81)	26.6 (140)
Non-government organization	8.3 (82)	9. 9 (46)	6.8 (36)
Self-employed	24.7 (245)	32.8 (153)	17.5 (92)
Occasional work with no regular income	1.3 (13)	1.9 (9)	0.8 (4)
Student	0.7 (7)	1.1 (5)	0.4 (2)
Home-maker	4.1 (41)	1.5 (7)	6.5 (34)
Retired	29.1 (289)	24.4 (114)	33.3 (175)
Unemployed (able to work)	5.7 (57)	6.2 (29)	5.3 (28)
Unemployed (disabled)	3.8 (38)	4.9 (23)	2.8 (15)
Tobacco use			
Percentage who currently smoke tobacco	29.5 (294)	54.3 (254)	7.6 (40)
Mean duration of smoking (in years) (95% CI)	22.7 (21.1-24.4)	23.5 (21.6-25.5)	18.1 (13.7-22.3)
Alcohol consumption			
Proportion who consumed alcohol in the preceding 12 months	61.2 (599)	77.7 (359)	46.4 (240)

Table 2. Anthropometric and biochemical characteristics by gender

Indicators	Total	Male		Female		p-value*
	Mean±SD	Mean±SD	95% CI	Mean±SD	95% CI	
Age (in years)	49.4±14.8	49.3±15.3	47.9-50.7	49.4±14.3	48.2-50.6	0.67
Height (meter)	1.59±0.19	1.65±0.21	1.64-1.67	1.55±0.16	1.53-1.56	<0.01
Weight (kg)	73.6±15.8	77.8±14.4	76.5-79.2	69.9±15.9	68.5-71.2	<0.01
BMI	28.1±5.3	27.5±4.5	27.1-27.9	28.6±5.9	28.1-29.1	<0.05
WC (cm)	96±13.9	96.7±13.5	95.4-97.9	95.5±14.2	94.2-96.7	0.19
SBP (mmHg)	127.5±21.1	131.4±19.5	122.1-125.8	123.9±21.9	122.1-125.8	<0.01
DBP (mmHg)	82.6±12.3	84.2±11.7	83.2-85.3	81.8±12.7	80-82.2	<0.01
Total cholesterol (mmol/L)	4.7±0.96	4.8±0.93	4.73-4.96	4.5±0.96	4.35-4.59	<0.01
Triglyceride (mmol/L)	1.4±0.92	1.58±1.19	1.43-1.73	1.22±0.48	1.16-1.28	<0.01
HDL (mmol/L)	1.76±0.24	1.67±0.22	1.64-1.7	1.85±0.21	1.82-1.88	<0.01
LDL (mmol/L)	3.09±1	3.23±0.9	3.1-3.35	2.95±1	2.8-3.08	<0.05
Glucose (mmol/L)	5.37±1.2	5.5±1.28	5.36-5.68	5.2±1.13	5.08-5.36	<0.01
Apo A (mg/dL)	134.3±25.7	136.2± 6.5	132.8-139.5	132.5±24.8	129.4-135.6	0.3
ApoB (mg/dL)	94.2± 38.5	94.2±19.9	91.7-96.8	94.1±50.6	87.8-100.4	0.1
Ratio (ApoB/ApoA)	0.73±0.35	0.72±0.21	0.69-0.74	0.74±0.45	0.68-0.79	0.6

* p-value is compared between groups by Student T-test. Log transform is used for non-normally distributed data.

Table 3. Hypertension status with serum lipids

Indicators	Total	Hypertension		Normal		p-value*
	Mean±SD	Mean±SD	95% CI	Mean±SD	95% CI	
Age (in years)	49.4±14.8	56.8±12.6	54.9-58.7	46.2±14.5	45.2-47.3	<0.01
BMI	28.1±5.3	30.7±5.6	29.9-31.6	27.1±4.9	26.7-27.5	<0.01
WC (cm)	96±13.9	96.7±13.5	95.4-97.9	95.5±14.2	94.2-96.7	<0.01
Total cholesterol (mmol/L)	4.7±0.96	4.67±0.87	4.48-4.85	4.63±0.96	4.52-4.73	0.63
Triglyceride (mmol/L)	1.4±0.92	1.47±1.03	1.25-1.68	1.31±0.61	1.24-1.37	0.06
HDL (mmol/L)	1.76±0.24	1.68±0.25	1.63-1.74	1.79±0.23	1.76-1.81	<0.01
LDL (mmol/L)	3.09±1	3.28±1.04	3.05-3.49	3.0±0.9	2.89-3.1	<0.05
Glucose (mmol/L)	5.37±1.2	5.64±1.85	5.25-6.03	5.25±1.13	5.15-5.35	<0.01
Apo A (mg/dL)	134.3±25.7	132.9±25.9	127.5-138.4	133.7±24.9	131.1-136.4	0.6
ApoB (mg/dL)	94.2± 38.5	95.5±19.3	91.4-99.6	93.8±44.8	88.9-98.6	<0.05
Ratio (ApoB/ApoA)	0.73±0.35	0.74±0.21	0.7-0.79	0.72±0.4	0.68-0.77	0.08

* p-value is compared between groups by Student T-test. Log transform is used for non-normally distributed data.

Table 4. Correlation of lipids and Systolic BP

Variables tested for correlations	Pearson's correlation coefficient	p-value
Systolic BP and TC	0.006	0.8
Systolic BP and TG	0.047	0.3
Systolic BP and LDL	0.104	<0.05
Systolic BP and HDL	-0.158	<0.01

Table 5. Correlation of lipids and diastolic BP

Variables tested for correlations	Pearson's correlation coefficient	p-value
Diastolic BP and TC	0.046	0.3
Diastolic BP and TG	0.138	<0.01
Diastolic BP and HDL	-0.139	<0.01
Diastolic BP and LDL	0.105	<0.01

Table 6. Crude and adjusted logistic regression analysis for normal and hypertension groups

Indicators	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Total cholesterol (mmol/L)	1.3	0.45-3.79	0.6			
Triglyceride (mmol/L)	1.6	0.89- 3.03	0.1			
HDL (mmol/L)	0.03	0.004-0.18	<0.01	0.2	0.05-0.35	<0.05
LDL (mmol/L)	1.9	0.99-3.69	<0.05	1.1	-0.59-0.5	0.9
Glucose	1.3	1.04-1.5	<0.05	1.4	0.87-2.08	0.8
Age	2.7	2.5-2.9	<0.01	2.06	2.03-2.12	<0.05
Sex (female)	0.7	0.47-0.92	<0.05	0.7	0.11-4.67	0.7
BMI	2.2	1.77-2.83	<0.01	1.2	0.38- 3.64	0.8
WC	1.05	1.04-1.06	<0.01	1.04	0.97-1.12	0.3
Tobacco use	1.04	1.02-1.06	<0.01	0.9	0.95-1.04	0.8
Alcohol consumption	0.8	0.60-1.1	0.2			

were significantly higher among hypertensive participants compared to normotensive. The mean HDL level was lower in the hypertensive groups compared to normotensive and was statistically significant. Participants demonstrated significant gender differences in rates of smoking, dyslipidemia, glucose and hypertension. Hypertension is one of the major risk factors for CVD found in Mongolia, with a constantly growing incidence. Our study indicated that in elderly subjects, all lipid fraction levels were higher in men, irrespective of the assessment. TC, TG, and LDL-cholesterol were generally lower in women, whereas HDL-cholesterol was higher in men. These results are similar to those of Nahar S. Yusuf' study [11, 16].

Hypertension or elevated blood pressure is recognized globally as a major risk factor for CVD, stroke, diabetes, and renal diseases [17]. A study in the northern region of Bangladesh comparing lipid profile status in hypertensive patients with that of healthy normotensive controls found high serum TC, TG, and LDL in the former group, replicating our findings [18]. Several studies have found that treatment for hypertensive patients was inconsistent and there was significant instability of serum TC, TG, HDL, and LDL in hypertensive patients [19–22]. A large-scale study conducted in Mexico again echoed our findings and indicated that the most frequent abnormality in urban adults, aged between 20 and 69 was HDL cholesterol below 0.9 mmol/L (46.2% for men and 28.7% for women).

Hypertensive patients should have their BP and lipid profile measured regularly to prevent CVD, stroke, diabetes, and renal diseases. Multi-centered research throughout Mongolia would be recommended to assess the relationship between serum lipid profile and cardiovascular diseases among the population.

Our study has several limitations. First, the sample was obtained from just two provinces (Dundgobi and Tuv) and two districts within the capital city of Ulaanbaatar. Participants therefore might not be representative of the wider Mongolian population. In addition, we could not investigate lipid profile variation due to diet, physical activity, medications and other potentially linked factors. These components should be included in future studies.

Conflict of Interest

The authors declare that there were no competing interests related to this study.

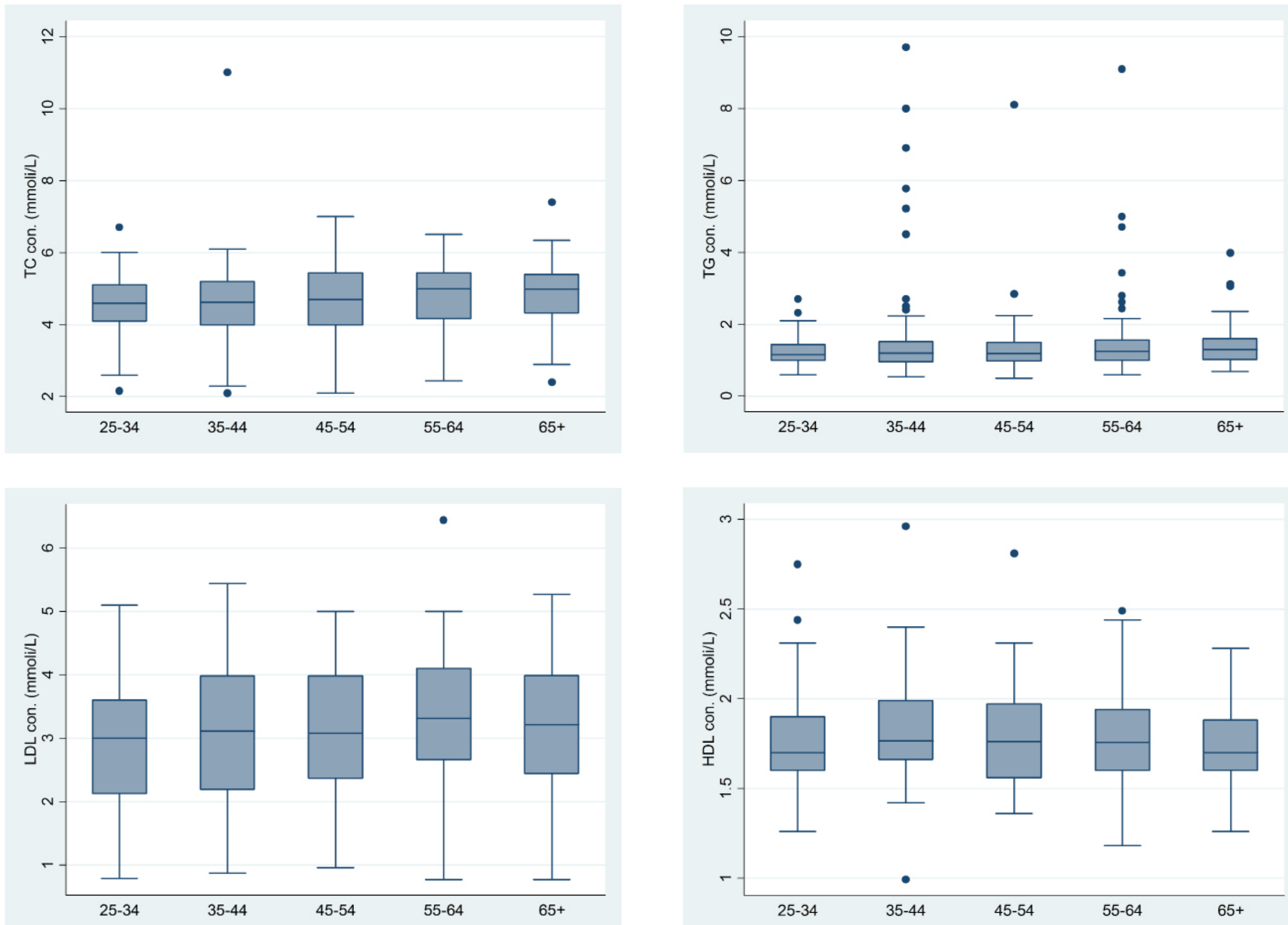

Figure 1. Lipid profiles of participants in various age group

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