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Original article

The impact of age, gender, and fasting blood glucose on the serum lipid profile at a tertiary care hospital: A retrospective study

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Abstract. *Background and aim:* This relatively large retrospective study explores the impact of age, gender, and fasting blood glucose levels on the lipid profile that can be influenced. It is crucial to investigate these relationships, as dyslipidemia is linked to many critical diseases, including cardiovascular disease. *Methods:* Data of 3,115 individuals were collected including age, gender, total serum cholesterol, high-density lipoprotein (HDL), low-density lipoproteins (LDL), triglyceride (TGL), and fasting glucose levels at King Fahad Military Medical Complex's Clinical Chemistry Laboratory, Dhahran, from January to July 2019. *Results:* The results shows that people 65 years or older had a significant association with total cholesterol (p<0.001), LDL (p-value= 0.001), and triglycerides (p-value= 0.001). Regarding gender, women in general are 1.2 times more likely to have hypercholesterolemia than men. Diabetes was significantly associated with all lipid profile parameters. *Conclusions:* There is a variable association between the lipid profile with age, gender, and fasting glucose. (www.actabiomedica.it)

Key words: Age, gender, fasting blood glucose, and lipid profile

Introduction

The lipid profile is a laboratory test that measures lipids and lipoprotein after patient fasting for more than eight hours, including total cholesterol (TC), triglycerides (TGLs), low-density lipoprotein (LDL), and high-density lipoprotein (HDL) (1,2). Dyslipidemia is a metabolic disorder which involves serum lipid abnormalities, such as an increase in TC, TGL, and LDL, and a decrease in HDL. Dyslipidemia is considered a risk factor for cardiovascular disease (CVD), as it is considered one of the major causes of mortality worldwide. Several factors affect lipid levels in the body. Among these are environmental risk factors such as diet, physical inactivity, smoking, and obesity, as well as diseases like biliary obstruction, chronic kidney disease, type 2 diabetes mellitus, high blood pressure, hypothyroidism, and CVD (3). Lipid abnormalities are known to be a classical risk factor for CVD, due to the elevation of LDL (4). Several studies evaluated lipid level variation among males and females, finding higher HDL levels in females. LDL and triglycerides were higher in males, which is consistent with a higher prevalence of CVD in males (5–7). In addition, an increased glucose level is related to lipid profile abnormalities as a function of insulin resistance, affecting the metabolism of most biomolecules in the body. Insulin dysfunction increases secretion of very-low-density lipoprotein (VLDL), which plays a role in elevating TGL and reducing HDL levels (8). The impact of age

on changing lipid profiles was studied, which found that TC, TGL, LDL, and HDL increase as age increases (9–11). Some studies assessing the correlation between a healthy population's age group, gender, and glucose, and lipid profiles are limited due to patient selection, especially those from the Middle East. This is the first study to find an association between age, gender, and glucose in the serum samples of healthy Saudis, based on a large population sample.

Material and methods

This retrospective study was conducted at King Fahad Military Medical Complex's Clinical Chemistry Laboratory, Dhahran, from January to July 2019. Approval was obtained from the Ethics Committee at Prince Sultan Military College of Health Sciences. The data was collected from a record of 3,115 individuals, which included: TC, HDL, LDL, TGL, and fasting blood glucose levels (FBGs).

Data were random and covered different ages as well as both genders. Age groups ranged from 18 to 96 years, in healthy male and female patients. The American Diabetes Association established criteria for FBG in 2020 (12): FBG < (6.9 mmol/L) as normal and FBG ≥ 7 mmol/L as high. Dyslipidemia was defined by the National Cholesterol Education Program – Adult Treatment Panel III (NCEP – ATP III) (13) – along with TC > 5.3 mmol/L, LDL > 3.30 mmol/L, HDL< 1.0 mmol/L, and TGL> 1.78 mmol/L. Dimension RXL Max Integrated Chemistry System (Siemens, Munich, GY) took blood specimens after an overnight fast (10-12 hours) to measure FBG, TC, TGL, LDL, and HDL.

Statistical analysis

The raw data was collected and organized with Excel (Microsoft, Redmond, WA, USA), and analyzed with the statistical software IBM-SPSS, version 26 (Armonk, NY, USA). Descriptive statistics, such as frequencies and percentages, were used to measure sample characteristics. An association of serum lipid profiles with age, gender, and glucose levels used binary logistic regression and odds ratios (OR) with a 95% CI. A value of $p < 0.05$ was considered significant. The correlation between the serum lipid profile, age, gender, and FBG was examined with Pearson's bivariate test.

Results

Characteristics of study participants

The study included 3,115 participants, classified according to age and gender shown in (Table 1). Age was divided into three groups, with most participants belonging to the age group 18-44 (n=1350, 43.3%), with a close percentage from those in group 45-64 (n=1289, 41.4%) and the rest were older than 64 years. Male gender was relatively large among participants in this study sample, as 55.8% of subjects were males. Furthermore, FBG levels were determined in the study

Table 1. Characteristics of study sample.

Variable		Frequency	Percentage
Age group	18-44	1350	43.3%
	45-64	1289	41.4%
	≥65	476	15.3
Gender	Female	1378	44.2%
	Male	1737	55.8%
Fasting blood glucose level	<6.9 mmol/L (normal)	2191	70.3%
	≥7 mmol/L (diabetic)	924	29.7%

sample: 70.3% had FBG level < 6.9 mmol/L, and 924 participants had FBG level > 7 mmol/L.

Association of age, gender, and fasting blood glucose (FBG) in lipid profile parameters

There was no association between ages 45-64 and lipid profile parameters, compared to the reference group at less than 45. Yet, people 65 years or older had a significant association with total cholesterol (p < 0.001), LDL (p=0.001), and TGL (p=0.001). Moreover, this age group had an OR of less than 1 with a 95% CI for all lipid parameters. Results show that people over 65 were less likely to have abnormal lipid profiles vs. the reference age group (18-44), with the OR at 95% CI of this age group (18-44) for total cholesterol (OR=1.9); LDL (OR= 2.08); and TGL (OR= 1.8).

Gender was significantly associated with all lipid profile parameters as well as a p-value: TC (p=0.02), HDL (p=0.001), LDL (p=0.046), and TGL (p=0.001). The OR at 95% CI for men compared to women was found to be 0.841, 4.933, 1.167, and 2.077 for TC, HDL, LDL, and TGL, respectively. Results show that women are 1.2 times more likely to have hypercholesterolemia than men, as men are 4.9 times lower in HDL than women; they are also 1.1 and 2 times at greater risk for high LDL and TGL than women, respectively.

Diabetes was significantly linked to all lipid profile parameters, with a p-value in Table 2. ORs of diabetic patients had 1.98 times lower HDL than non-diabetics (< 6.9 mmol/L). The OR of TGL (OR=2.550) found that those with diabetes had a 2.55 times higher risk for hypertriglyceridemia.

The correlation between age, gender, and glucose levels for lipid profiles

Pearson's correlation coefficient (r) investigated the association between age, gender, and glucose levels with lipid profiles (Table 3). Age was statistically significant and negatively correlated with TC, HDL, LDL with correlation coefficients (r) = (-0.153, p < 0.01), (-0.038, p < 0.05), (-0.183, p < 0.01), respectively. Gender was statistically significant and negatively correlated with TC and HDL while having a positive and significant correlation with TGLs found the correlation coefficient as (r) = (-0.067, p < 0.01), (-0.380, p < 0.01), (0.167, p < 0.01), respectively. FBG was negatively correlated with HDL and LDL, while the positive significant correlation was with TGL.

Discussion

Lipids, such as TGLs and cholesterol, are prognostic for metabolites in different conditions. Dyslipidemia is a metabolic disease with a multifactorial pathological condition, including CVDs. The lipid profile tends to be affected by different environmental, genetic, and physiological conditions. In this study, we aimed to investigate the association between selected factors relevant to lipids as well as the lipid profile of healthy Saudis. The current results revealed three main findings: people 65 years or older had a significant association with TC, LDL and TGL. Second, women were 1.2 times more likely to have hypercholesterolemia than men. In addition, diabetic patients had 1.98 times lower HDL and 2.55 times higher risk for hypertriglyceridemia than non-diabetics.

The present study shows that diabetic people 65 years or over had a higher chance of a disturbed lipid profile than non-diabetics. Other studies demonstrate that dyslipidemia increases with age in both genders (14,15). In this study, the OR at age 65 or more for HDL (OR 0.831, 95% CI) revealed that older subjects had lower HDL than the reference group (18-44). Another study reported similar findings with a higher OR, which correlated low HDL (OR = 2.27 CI = 1.10-4.68) with an age greater than 50 in a logistic regression analysis (16). Meanwhile, Kolovou et al. showed an inverse association between high TGL and low HDL (17). In comparison with the Devroey et al. study, including groups up to 65 years, our study increased the age range to above 65 years. Conversely, our group (45-64) had a higher OR of 1.09, in agreement with their results (16), including the male gender (16), but their OR was lower (OR = 1.94 CI = 1.14-3.30) than in our work (OR 2.077, 95% CI). Men had a 2.07 times higher risk of hypertriglyceridemia than

Table 2. Association of age, gender, and fasting blood glucose (FBG) on lipid profile parameters.

S	Study variables	OR	95% CI	p-value
Total Cholesterol	Age 18-44 (reference group) 45-64 ≥65	 0.986 0.514	 0.840-1.158 0.405-0.651	 0.866 <0.001*
	Gender (female reference group)	0.841	0.727-0.973	0.02*
	FBG (normal refers to reference group)	0.832	0.703-0.985	0.03*
HDL-Cholesterol	Age 18-44 (reference group) 45-64 ≥65	 1.096 0.831	 0.919-1.308 0.654-1.057	 0.307 0.132
	Gender (female reference group)	4.933	4.217-5.770	<0.001*
	FBG (normal refers to reference group)	1.988	1.651-2.395	<0.001*
LDL-Cholesterol	Age 18-44 (reference group) 45-64 ≥65	 0.992 0.479	 0.841-1.169 0.371-0.618	 0.992 <0.001*
	Gender (female reference group)	1.167	1.003-1.357	0.046*
	FBG (normal refers to reference group)	0.739	0.619-0.882	0.001*
Triglycerides	Age 18-44 (reference group) 45-64 ≥65	 1.092 0.559	 0.907-1.314 0.424-0.737	 0.355 <0.001*
	Gender (female reference group)	2.077	1.747-2.469	<0.001*
	FBG (normal refers to reference group)	2.550	2.125-3.061	<0.001*

Table 3. The correlation between ages, gender, and glucose levels with lipid profiles.

	Total Cholesterol	HDL-Cholesterol	LDL-Cholesterol	Triglycerides
Age	-0.153**	-0.038*	-0.182**	0.27
Gender	-0.067**	-0.380**	0.002	0.167**
FBG	-0.023	-0.161**	-0.070**	0.258**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

women. The OR for LDL (OR 1.167, 95% CI) shows that men and women were almost at the same risk of having high LDL. The association of LDL and cardiovascular events is well-established, demonstrating that high LDL increases clinical events in both men and women (18,19).

The association of diabetes (diabetes or glucose level) with age, gender, and an abnormal lipid profile

was reported by others (20–22). Those with diabetes had significantly raised cholesterol levels, LDL, and TGL, with significantly lower HDL levels than controls, and males having higher values than females (21,23–25). Similar results were obtained for high TC, high TGL, as well as low HDL and high LDL in this study. Another study reported all types of dyslipidemias as significantly more prevalent in diabetic women (26). The link between lipid profiles and diabetes is controversial: it has been well-observed that one of the metabolic disorders associated with diabetes is dyslipidemia.

On the other hand, dyslipidemia may indicate a higher risk to develop diabetes. For example, in poorly controlled type 1 diabetes, elevated TGL and lower HDL commonly occur. In contrast, patients with type 2 diabetes tend to have high TGL, lower HDL, and higher small dense LDL, regardless of diabetes control (27–29). Lipid abnormality in diabetes involves more than one parameter, as seen in our study (30). Several studies assessed underlying physiological mechanisms around these relationships, linked to insulin regulation of apolipoprotein B (apoB) production (31).

Conclusion

Dyslipidemia is a disorder associated with lipid profiles, thus it is critical to monitor them, as they play a significant role in many pathological conditions. This study revealed there is a significant association between age and TC, LDL and TGL in those 65 and above. In addition, it was noted that women were more likely to have hypercholesterolemia than men. Those with diabetes were likely to have an abnormal lipid profile along with more than one affected parameter.

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Conflicts of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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