



Evaluating and comparing changes in lipid profile of women across age groups 22-65 years

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Abstract

Background

Disturbances in lipid profile parameters are significant indicators of cardiovascular disease. While age is a factor influencing lipid metabolism, the response of specific lipid profile components to this factor varies; consequently, the relationship between age and the lipid profile requires further study to elucidate the nature of this association.

Objectives

The study aimed to evaluate the levels of lipid profile components—specifically TC, TG, HDL-C and LDL-C—across four progressive age groups, and to determine the relationship between age and changes in the levels of these components.

Methods

This cross-sectional study was conducted at Imam Al-Hussein Medical City, involving blood samples from 92 apparently healthy women. The samples were divided into four age groups. Lipid profiles were measured using laboratory methods, and Statistical analysis was performed using appropriate tests at $P < 0.05$.

Results

The study results indicated no significant differences in TC and LDL-C levels among the four age groups studied, however significant differences were observed in TG and HDL-C levels. The (35–44) age group exhibited the highest TG levels and the lowest HDL-C levels compared to the other age groups.

Conclusion

The study results indicate a selective relationship between age and components of the lipid profile in women—specifically TG and HDL-C as these were the most affected by age compared to TC and LDL-C. Consequently, these findings underscore the necessity of continuously monitoring the levels of these components, particularly during middle age, as a preventive measure to avoid metabolic disorders and the potential future diseases associated with them.

Keywords Lipid profile, total cholesterol, triglycerides, HDL-C and LDL-C, age group, women.

Introduction

Lipids are biological molecules that play an important role in energy storage, cell building, hormone synthesis, and regulation of metabolic processes in the body. Lipid profile tests, which include Total Cholesterol (TC), High-Density Lipoprotein Cholesterol (HDL-C), Low-Density Lipoprotein Cholesterol (LDL-C) and Triglycerides (TG), help to understand the state of cardiovascular health and the body's metabolic status. Abnormal levels of these types are risk indicators for atherosclerosis, coronary artery disease, and other cardiovascular diseases (Mach *et al.*, 2020; Nordestgaard *et al.*, 2014). Fats are essential components of the body and have many important physiological functions. In addition to being the body's primary source of energy, they are important for the integrity of cell membranes and are a fundamental building block for steroid hormones, bile acids, and vitamin D. Furthermore, lipoproteins contribute to the transport of lipids through the bloodstream to various tissues and organs of the body. Maintaining normal levels of fats in the body is crucial for cell health and function, as well as overall health. Alterations or disturbances in fat metabolism can lead to metabolic and vascular diseases (Pirillo *et al.*, 2021; Musunuru, 2010).

One of the important factors in determining lipid metabolism is age. Aging causes gradual changes in lipid balance due to hormonal, metabolic, and lifestyle changes. According to many studies TC, TG and LDL-C levels in the blood begin to gradually increase as a person ages, while HDL-C levels take on different patterns depending on gender, hormonal changes, and environmental factors (Arnett *et al.*, 2019; Gopal & Mehta, 2010).

Aging in women has an effect on fat metabolism, and this effect comes as a result of changes in reproductive hormones. For example, in the reproductive years of a woman's life, estrogen has a positive effect on fat metabolism by increasing the level of HDL-C and decreasing the level of LDL-C. As a woman gets older, the level of this hormone decreases, and its decrease causes undesirable changes in fat levels, thus increasing the risk of cardiovascular diseases (El Khoudary *et al.*, 2020; Kolovou & Bilianou, 2008).

Numerous studies have shown significant changes in lipid levels across different age groups. TC and LDL-C levels tend to rise during middle age, while TG levels may increase due to physiological changes, insulin sensitivity, and metabolism. These changes contribute to an increased risk of cardiovascular disease in older adults (Grundy *et al.*, 2019; Ambikairajah *et al.*, 2019).

Assessing blood lipid levels is important for providing crucial information about age-related metabolic changes. These assessments help identify age groups most susceptible to cardiovascular complications. Understanding the relationship between age and lipid metabolism allows for the development of preventative plans and programs to support individual health, reduce the incidence of cardiovascular diseases, and consequently lower mortality rates from these diseases (Lloyd-Jones *et al.*, 2022; Yusuf *et al.*, 2020; Morris *et al.*, 2014).

Although there are many international studies that have been interested in knowing the relationship between age and fat metabolism (Pirillo *et al.*, 2021; Liu *et al.*, 2022), there are few local studies that show this relationship. Therefore, this study aimed to evaluate body fat levels according to different age groups and to evaluate the relationship between them.

Materials and Methods

Study Design

This study adopted a comparative cross-sectional study design to determine the relationship between changes in an individual's lipid profile and age, with the ages under study ranging from 22 to 65 years.

Study Setting and Duration

The samples for this study were collected from the laboratories of Imam Hussein Medical City in Karbala, Iraq, during the sample collection period from 1/4/2026 to 1/6/2026.

Study Population

The study involved collecting 92 blood samples from apparently healthy women visiting the laboratories of Imam Hussein Medical City. The samples were selected from women aged 22-65 years.

The samples were then categorized according to age groups:

- Group 1: 22-34 years (23 women)
- Group 2 : 35-44 years (23 women)
- Group 3 : 45-54 years (22 women)
- Group 4 : 55-65 years (24 women)

Inclusion Criteria

Women aged 22-65 years, who appeared healthy and who gave their consent to participate in the study and provide a blood sample, were selected.

Exclusion Criteria

Women with diabetes, heart disease, those taking cholesterol-lowering drugs, pregnant women, and those with liver disease or chronic kidney disease were excluded.

Sample Collection

Five ml of blood were drawn from each woman participating in the study using sterile medical syringes. The samples were transferred to ordinary tubes and left to clot. They were then centrifuged at a rate of 3000 rpm for 10 minutes to extract the serum. The serum was then analysed or frozen at -20°C if the analysis was not done immediately.

Laboratory Analysis

Serum lipid levels were determined using a range of commercially available diagnostic tests, following the manufacturer's instructions. The following parameters were measured: TC , TG , HDL-C and LDL-C . TC and TG levels were measured using enzymatic colorimetric methods . HDL-C was measured using direct enzyme assays, while LDL-C was measured either directly or according to a laboratory protocol (Burtis and Bruns, 2018).

Statistical Analysis

The study results were statistically analysed using GraphPad Prism software (version 9.0; GraphPad Software Inc., San Diego, CA, USA). Lipid profile variables were expressed as mean $\pm$ standard deviation (SD), standard error of the mean (SEM), median, and range. Comparisons of lipid profile parameters among the four study groups were performed using the Kruskal–Wallis test; where significant differences were observed, Dunn's test for multiple comparisons was applied, incorporating the Bonferroni adjustment for pairwise comparisons between groups. A p-value of less than 0.05 was considered statistically significant.

Ethical approval

Formal approval was obtained from Imam Hussein Medical City to collect blood samples from women visiting the hospital laboratory. Verbal consent was obtained from the participants after they were informed of the research objectives and assured of the confidentiality of their information. Prior to this, ethical approval was secured from the scientific research ethics committee at the college of nursing, university of Kerbala.

Ethical approval code: UOK.CON.25.0105

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Results

As shown in Table 1 for the four age groups of women studied, the results indicated that the lowest mean TC level was observed in the (22–34) age group (118.66 ± 34.84 mg/dL). Mean levels subsequently rose to (133.21 ± 37.71 mg/dL) and (134.44 ± 38.68 mg/dL) in the (35–44 and 45–55) age groups, respectively, before decreasing slightly to (119.67 ± 37.60 mg/dL) in the (55–64) age group. Regarding mean TG levels,

the value for the (35–44) age group was (127.09 ± 59.41 mg/dL). Finally, the mean of (HDL-C) level was highest in the (22–34) age group (44.45 ± 7.28 mg/dL) and decreased as age increased. As for (LDL-C), the lowest average level was observed in the (22–34) age group; it rose gradually with advancing age, then decreased in the (55–64 age) group.

Table 1 : Descriptive statistics for lipid levels in women aged 22–65 years

Parameter	Group (year)	n	Mean $\pm$ SD	SEM	Median	Min – Max
Total Cholesterol (TC) (mg/dL)	G1 (22–34)	23	118.66 ± 34.84	± 7.26	117.00	46.90 – 187.00
Total Cholesterol (TC) (mg/dL)	G2 (35–44)	23	133.21 ± 37.71	± 7.86	116.00	85.00 – 203.00
Total Cholesterol (TC) (mg/dL)	G3 (45–54)	22	134.44 ± 38.68	± 8.25	127.45	85.30 – 236.00
Total Cholesterol (TC) (mg/dL)	G4 (55–65)	24	119.67 ± 37.60	± 7.67	117.50	59.00 – 233.00
Triglycerides (TG) (mg/dL)	G1 (22–34)	23	96.03 ± 82.24	17.15	86.00	13.00 – 437.00
Triglycerides (TG) (mg/dL)	G2 (35–44)	23	127.09 ± 59.41	± 12.39	117.00	60.00 – 347.00
Triglycerides (TG) (mg/dL)	G3 (45–54)	22	101.04 ± 42.81	± 9.13	100.50	38.00 – 189.00
Triglycerides (TG) (mg/dL)	G4 (55–65)	24	97.46 ± 33.61	6.86	107.50	36.00 – 164.00
HDL-Cholesterol (HDL-C) (mg/dL)	G1 (22–34)	23	44.45 ± 7.28	1.52	47.12	18.10 – 52.10
HDL-Cholesterol (HDL-C) (mg/dL)	G2 (35–44)	23	40.00 ± 5.58	1.16	40.00	31.00 – 55.00
HDL-Cholesterol (HDL-C) (mg/dL)	G3 (45–54)	22	42.13 ± 5.22	1.11	41.50	33.00 – 51.00
HDL-Cholesterol (HDL-C) (mg/dL)	G4 (55–65)	24	40.71 ± 7.35	1.50	39.00	28.00 – 53.00
LDL-Cholesterol (LDL-C) (mg/dL)	G1 (22–34)	23	55.00 ± 23.27	4.85	52.30	25.16 – 109.32
LDL-Cholesterol (LDL-C) (mg/dL)	G2 (35–44)	23	67.79 ± 34.23	7.14	58.40	20.80 – 144.60
LDL-Cholesterol (LDL-C) (mg/dL)	G3 (45–54)	22	72.10 ± 35.49	7.57	64.65	18.90 – 154.20

Parameter	Group (year)	n	Mean $\pm$ SD	SEM	Median	Min – Max
LDL-Cholesterol (LDL-C) (mg/dL)	G4 (55–65)	24	59.47 $\pm$ 33.56	6.85	53.40	23.80 – 176.40

Table 2: Comparison of overall lipid levels of each parameter for age groups by using the Kruskal–Wallis statistical test.

Parameter	H statistic	df	p-value	Result
Total Cholesterol (TC)	2.561	3	0.4643	Not significant
Triglycerides (TG)	8.382	3	0.0387	Significant (p < 0.05)
HDL-Cholesterol (HDL-C)	10.548	3	0.0144	Significant (p < 0.05)
LDL-Cholesterol (LDL-C)	3.360	3	0.3393	Not significant

As shown in Table 2, the results indicate significant differences among age groups, particularly regarding HDL-C and TG levels; a clear, significant difference was observed for HDL-C ($H = 10.548$, $p = 0.0144$) and for TG ($H = 8.382$, $p = 0.0387$). In contrast, no clear significant differences were found for TC ($H = 2.561$, $p = 0.4643$) or LDL-C ($H = 3.360$, $p = 0.3393$). Thus, the study results demonstrate that age-related variation in lipid levels is manifested in HDL-C and TG levels.

Table 3. Dunn's test (Bonferroni-adjusted p-values) for lipid parameters with a significant Kruskal–Walli's result.

Parameter	Comparison	Adjusted p-value	Result
Triglycerides (TG)	G1 vs G2	0.0256	Significant
Triglycerides (TG)	G1 vs G3	1.0000	Not significant
Triglycerides (TG)	G1 vs G4	1.0000	Not significant
Triglycerides (TG)	G2 vs G3	0.6366	Not significant
Triglycerides (TG)	G2 vs G4	0.3974	Not significant
Triglycerides (TG)	G3 vs G4	1.0000	Not significant
HDL-Cholesterol (HDL-C)	G1 vs G2	0.0124	Significant
HDL-Cholesterol (HDL-C)	G1 vs G3	0.5071	Not significant
HDL-Cholesterol (HDL-C)	G1 vs G4	0.0885	Not significant
HDL-Cholesterol (HDL-C)	G2 vs G3	1.0000	Not significant
HDL-Cholesterol (HDL-C)	G2 vs G4	1.0000	Not significant
HDL-Cholesterol (HDL-C)	G3 vs G4	1.0000	Not significant

Table 3 presents pairwise comparisons between the study groups using Dunn's post-hoc test. The results showed that women in the 35–44 age group had significantly higher TG levels compared to those in the 22–34 age group (adjusted p-value = 0.0256), whereas HDL-C levels were significantly lower in the 35–44 age group compared to the younger age groups (adjusted p-value = 0.0124). No significant differences were observed in TG and HDL-C levels among the remaining groups following the Bonferroni correction.

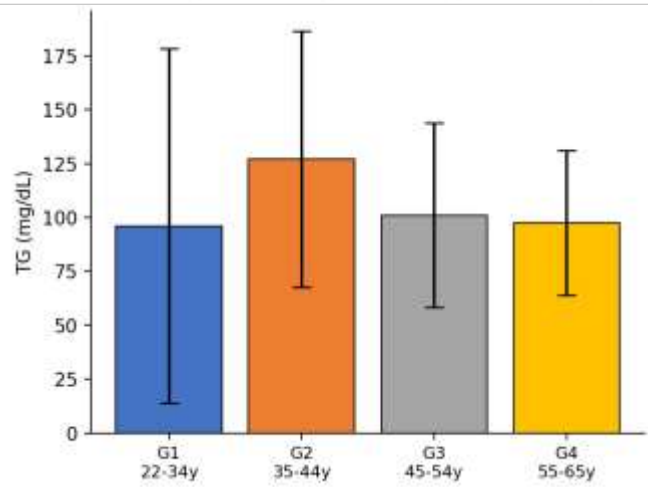
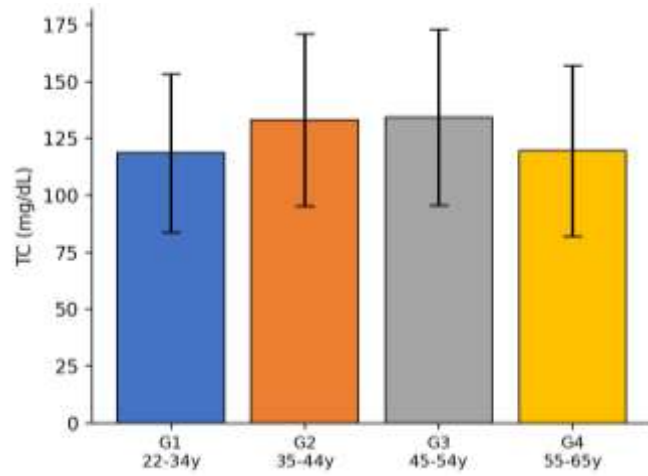


Figure 1. Serum TC (mg/dL) by age group (mean $\pm$ SD).
 Figure 2. Serum TG (mg/dL) by age group (mean $\pm$ SD).

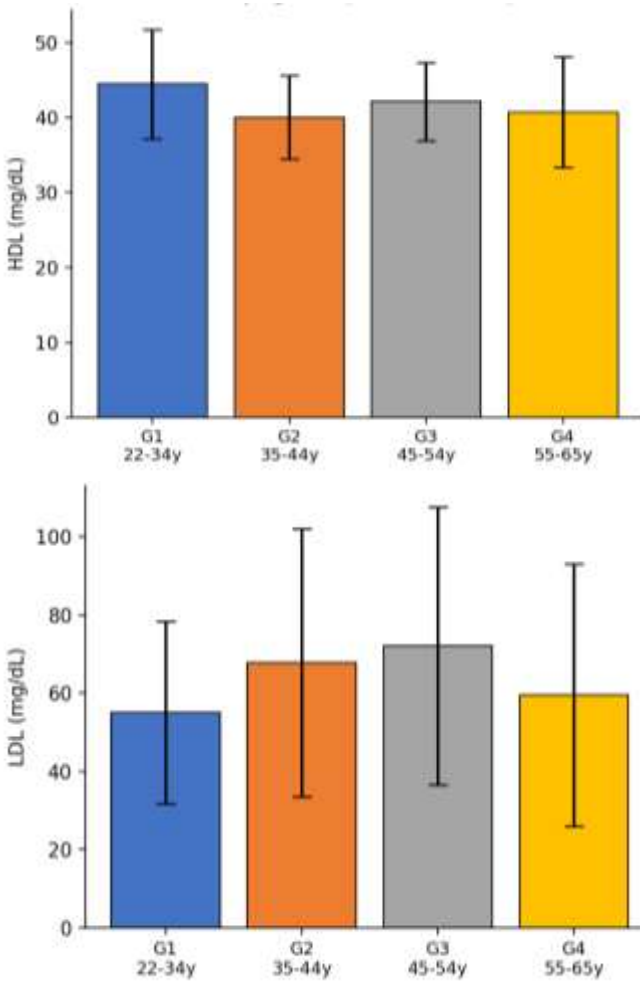


Figure 3. Serum HDL-C (mg/dL) by age group (mean $\pm$ SD).

Figure 4. Serum LDL-C (mg/dL) by age group (mean $\pm$ SD).

Discussion

The results of the current study revealed significant differences in TG and HDL-C levels across the age groups of the four study cohorts, whereas no significant differences were observed in TC or LDL-C levels. These findings indicate that the impact of aging on lipid profile components is not uniform; TG and HDL-C appear to be more sensitive to age-related metabolic changes than TC and LDL-C (Pirillo *et al.*, 2021; Lloyd-Jones *et al.*, 2022). No significant differences in total cholesterol levels were observed across the age groups of the study population, although a slight increase in mean levels was noted among women in the 35–54 age group compared to the younger 22–34 age group. This suggests that total cholesterol levels are not determined solely by age; rather, a complex interplay of factors—such as physical activity, diet, and general health status, alongside genetic influences—regulates these levels. Furthermore, the study was limited to apparently healthy women, a factor that may have contributed to minimizing the differences observed between the groups (Grundy *et al.*, 2019; Klop *et al.*, 2013).

Regarding LDL-C, the results showed a gradual increase in levels from the youngest age group studied (22–34 years) up to the 45–54 age group; this was followed by slight decreases among women in the oldest age group studied (54–65 years), although these variations were not statistically significant. Numerous studies have indicated that the rise in LDL-C levels in women following menopause is attributable to declining estrogen levels and the consequent reduction in hepatic LDL receptor activity. However, numerous studies have indicated that, in addition to this effect, there are many other influencing

factors—such as an individual's body mass index, dietary habits, and genetic factors—which may explain the absence of significant differences in lipid profile levels among the age groups under study (El Khoudary, *et al.*, 2020 ; Mach, *et al.*, 2020).

Regarding TG, the results revealed significant differences among the groups under study; women in the 35–44 age group exhibited the highest mean TG levels compared to the other age groups. Furthermore, the Dunn test—used for statistical analysis—indicated a significant difference between this age group and the younger group (22–34 years). This may be attributed to the onset of metabolic changes associated with middle age, such as increased visceral fat accumulation and reduced insulin sensitivity, alongside age-related hormonal shifts that drive increased hepatic triglyceride synthesis and impair the body's clearance rate (Pirillo *et al.*, 2021; Lloyd-Jones *et al.*, 2022; Musunuru, 2010).

The study results also indicated a significant decrease in HDL-C levels among women in the 35–44 age group compared to those in the younger age group. HDL-C is a crucial factor in preventing atherosclerosis, given its effective role in transporting cholesterol from body tissues to the liver, as well as its antioxidant and anti-inflammatory properties. Consequently, a decline in HDL-C levels during middle age may serve as an early indicator of metabolic changes preceding more pronounced lipid disorders (Lloyd-Jones *et al.*, 2022; Mach *et al.*, 2020).

Some studies indicate that changes in the lipid profile are not determined solely by age; rather, numerous other factors influence lipid levels—such as physical activity, diet, body mass, genetic factors, and hormonal status. These factors vary across different populations and studies, and such variations likely account for the discrepancies observed in the results of different studies (Torosyan *et al.*, 2022; Anagnostis *et al.*, 2020)

Some studies have yielded results partially consistent with those of the present study, indicating that TG and HDL-C levels are more significantly affected by advancing age than other lipid profile components. Conversely, these findings differ from other studies showing a significant rise in TC and LDL-C levels among postmenopausal women. This discrepancy may be attributed to variations in demographic characteristics, dietary habits, and ethnic backgrounds, as well as differences in sample size criteria and participant selection—specifically, the fact that participants in the current study were apparently healthy (El Khoudary, *et al.*, 2020; Liu, *et al.*, 2022) .

This study is distinguished by its categorization of participants into four distinct age groups, which allowed for the observation of gradual changes across the studied stages and the identification of the specific age at which significant changes in the lipid profile begin to manifest. Despite this strength, the study was limited by the relatively small number of women participating across the four age groups. Furthermore, data on certain factors that could influence lipid levels—such as physical activity, dietary habits, body mass, and smoking status—were unavailable. These limitations highlight the need for future research incorporating these variables to provide a more comprehensive and precise understanding of the relationship between age and an individual's lipid profile (Arnett, *et al.*, 2019) .

Overall, the study results indicated that triglyceride and HDL-C levels are the primary indicators of an individual's lipid profile as they age, particularly among the apparently healthy women included in the study sample. Conversely, total cholesterol and LDL-C levels remained relatively unchanged across the four groups studied. These findings underscore the importance of ongoing monitoring of an individual's lipid profile; such monitoring facilitates the early detection of potential metabolic disorders and enables appropriate preventive measures to avert future cardiovascular diseases (Visseren *et al.*, 2021).

Recommendations

Conduct future studies with larger sample sizes across diverse regions to validate these findings; incorporate additional parameters—such as diet, body mass, and physical activity—to examine their relationship with the lipid profile; and encourage women to undergo periodic screening to detect potential lipid abnormalities, particularly regarding TG and HDL-C levels.

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