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Serum Lipid Profile Alterations and Cardiovascular Risk in Post-Menopausal Women: A Cross-Sectional Study

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Abstract

Background

Menopause is a phase of woman's natural aging process and is marked by the cessation of ovarian function. The increased incidence of cardiovascular risk in the post-menopausal women may partly be due to hormonal changes leading to derangement of lipid metabolism.

Aim of the Study:

To study the serum lipid profile among post-menopausal women attending AMCH

Method

This was a hospital based descriptive cross-sectional study carried out among 156 post-menopausal women attending Out Patient Department of Medicine at AMCH. A structured questionnaire was administered and relevant sociodemographic information was obtained. Serum Lipid profile level was recorded for all the samples. Data were analyzed using SPSS version 20.

Results

The study showed there was mild increase in serum Triglycerides, Total cholesterol, and LDL in post-menopausal women while there was mild decrease in serum HDL level in post-menopausal women. In present study, out of 156 study subjects, the serum Triglycerides, Total cholesterol, and LDL level were found to be elevated in 48.7%, 23.7% and 14.7% study subject respectively while serum HDL level below normal was found in 10.9% of the study subjects. Serum HDL had statistically significant ($p < 0.05$) association with different age group while serum TG, TC, and LDL were not statistically significant ($p > 0.05$). The serum TG, TC, LDL had a weak negative correlation ($r = -0.13$, $p = 0.09$), ($r = -0.02$, $p = 0.78$), ($r = -0.06$, $p = 0.40$) with age respectively. The serum HDL had a weak positive correlation ($r = 0.17$, $p = 0.03$) with age.

Conclusion

Post-menopausal women are at increased risk of developing cardiovascular disease due to change in the lipid pattern and loss of cardio protective effect of estrogen. Predicting the factors affecting the lipid profile in post-menopausal women, adopting strategies to control these mechanisms by modifying the relative risk factors during menopausal transition may improve the cardiovascular risk profile in these women.

INTRODUCTION

General Background

Menopause is the time of a women's life when reproductive capacity ceases. According to WHO, the term menopause is defined as the permanent cessation of menstruation resulting from the loss of ovarian follicular activity. Natural menopause is recognized to have occurred after 12 consecutive months of amenorrhea, for which there is no other obvious pathological or physiological cause [1]. The average age of menopause is 51 years and less than 1% of women experience it before the age of 40 years, with some women undergoing premature menopause at a very early age, affecting their ability to have children [2]. The average age of menopause for Nepalese women is 48.7 years [3]. This age can be divided into two periods: Pre-menopause is the period before the last menstrual cycle which refers to the reproductive years in women and they have menstrual cycle which may be regular or irregular [4]. And post-menopause is the period of a woman's life that comes after the last menstrual cycle, i.e. when the ovaries completely stop working, regardless of the reasons for the drop naturally or because of disease [5]. The majority of women at this stage experience a variety of symptoms as a result of hormonal changes, and these symptoms can be severe and frequent; some women experience more severe symptoms, while others have no symptoms at all [6]. During the transition to menopause, women may experience vasomotor, urogenital, psychosomatic, and psychological symptoms, as well as sexual dysfunction, etc. [7].

During menopause, depletion of ovarian follicles occurs at the level of the ovary but the ovarian-hypothalamic-pituitary axis remains intact. After menopause, estrogen and progesterone level decreases with a corresponding increase in the level of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) due to absence of negative feedback mechanism [8]. Estrogens are sex hormones that are responsible for the development and maintenance of the female sex organs and female sex characteristics [9]. Estrone (E1), estradiol (E2), and estriol (E3) are major types of estrogens in females. E3 is primary and E2 is the predominant estrogen in pregnant and non-pregnant females respectively while E1 is produced during menopause [10]. Estrogen in conjugation with progesterone, participate in regulation of menstruation cycle, breast and uterine growth, and in the maintenance of pregnancy [9].

Lipid profile is a pattern of lipids in the blood which includes the levels of triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) as well as calculated very-low-density lipoprotein (VLDL). LDL delivers cholesterol from the liver to peripheral tissues while HDL returns it from peripheral tissue to the liver and prevents the deposition of cholesterol in the walls of the arteries. HDL concentration has an inverse relation with coronary heart disease. So, LDL/HDL ratio is used as a predictive parameter for coronary heart disease [11, 12]. Estrogen has a cardio protective effect as it helps to lower serum LDL and TG levels and maintains high serum HDL levels. The cardio protective effect is lost in postmenopausal women due to low estrogen level that causes derangement of plasma lipid and lipoprotein where TC, TG, LDL levels are usually increased while

HDL level is decreased which increases the chance of developing cardiovascular diseases (CVDs) in post-menopausal women [13, 14].

Excessive deposition of cholesterol from plasma lipoproteins into the arteries leads to atherosclerosis via lipid oxidation [11]. Women are prone to develop coronary artery disease after menopause. According to the American Heart Association report (2002), after menopause 70% of women develop cardiovascular disease in USA [13]. Cardiovascular disease continues to be the leading cause of death among women [15].

Dyslipidemia is a major distractor in post- menopausal women so timely monitoring of serum lipid profile should be recommended for all the post-menopausal women to prevent the associated co-morbidity. The outcome of this research work is expected to clarify the effects of menopause on serum lipid profile level to find out the probable risk for developing CVD in postmenopausal women [16].

Statement of problem

According to the national report of Central Bureau of Statistics of Nepal in 2011, total population of Nepal is 26,494,504 out of which 13,645,463 are women. About 1.9 million of women were 50 years of age or older. Most of these women had or shortly would have their last menstrual period, thus becoming postmenopausal [17]. Elevated total cholesterol, LDL-cholesterol and triglycerides are more common in post- than premenopausal women. The incidence of cardiovascular disease (CVD) increases after menopause [18, 19, 20]. According to the American Heart Association report (2002), after menopause 70% of women develop cardiovascular disease in USA. Dyslipidemia, especially hypercholesterolemia is a major cause of cardiovascular disease, which intern is the most common cause of female morbidity and mortality [13]. Hence, early detection and effective management of dyslipidemia helps in reducing rate of CVD mortality and morbidity in postmenopausal women.

Rationale of the study

There is an elevated level of serum LDL, atherogenic index, decreased level of HDL, hypertriglyceridemia, hypercholesterolemia in postmenopausal women. These are involved in atherogenic process and development of cardiovascular disease 2. Dyslipidemia is a major distractor in post- menopausal women so timely monitoring of serum lipid profile should be recommended for all the post-menopausal women to prevent the associated co-morbidity [16]. Hence, the probable risk for developing CVD in postmenopausal women can be minimized.

The objective of the study was to assess the serum lipid profile among post-menopausal women attending AMCH. The specific objectives were to determine the levels of serum lipid profile components (Total Cholesterol, Triglycerides, HDL, and LDL) among post-menopausal women and to compare the serum lipid profile according to different age groups among these women. The study's variables included dependent variables such as lipid profile components (Total Cholesterol, Triglycerides, HDL, LDL, VLDL) and the independent variable of age.

Operational definitions

Post-menopause: Post-menopause is the time after a woman's menstrual periods have ceased for 12 consecutive months.

Lipid Profile: A lipid profile, or lipid panel, is a blood test to check the lipid levels in blood which is comprised of Total Cholesterol (TC), Triglycerides (TG), High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL) and Very-Low Density Lipoprotein (VLDL).

Dyslipidemia: Dyslipidemia is a disorder of lipoprotein metabolism, including lipoprotein overproduction or deficiency. These disorders may be manifested by elevation of the serum total cholesterol, low-density lipoprotein (LDL) cholesterol and triglyceride concentrations, and a decrease in the high-density lipoprotein (HDL) cholesterol concentration.

MATERIALS AND METHOD

This hospital-based descriptive cross-sectional study was conducted in the Department of Biochemistry at Arogyam Medical College and Hospital (AMCH), Roorkee, Haridwar. The target population comprised post-menopausal women visiting the Out Patient Department of Medicine at AMCH. The sample size was determined using a 95% confidence interval level and an 8% allowable error, applying a simplified formula for sample size estimation.

$$n = \frac{Z^2 \times P \times Q}{d^2}$$ (**Cochran, 1967**)

Where p = prevalence from past study (for the purpose of this study we took hypothetical prevalence i.e. out of total patients attending AMCH, 50% is post-menopausal)

Then optimum sample size: n = 150.05 = 151

The entire research project was expected to be completed within 8 months, from October 2022 to May 2023. A consecutive sampling technique was employed in the study. The inclusion criteria were: women aged 55 years and above who had experienced at least one year of menopause and were willing to participate. The exclusion criteria included: women with a habit of chronic smoking and alcoholism; pregnant and lactating women; those who had undergone menopause due to hysterectomy or other non-natural causes; women on hormone replacement therapy (HRT) or with irregular menstruation; and women with comorbidities such as hypertension, thyroid disorders, diabetes mellitus, bone disease, arthritis, renal disease, and liver disease, as well as those on medications (e.g., serotonin, acitretin, antipsychotics, β-blocking agents, immunosuppressive agents, vitamin A, etc.) that could alter the serum lipid profile.

Methodology

After taking informed consent from the participants, about 5ml of venous blood sample was collected from patients using aseptic technique into a clot activator tube (Yellow capped vial). The non-haemolysed serum sample was separated and utilized for analysis of different selected biochemical parameters. Lipid profile test include Total Cholesterol (TC), Triglycerides (TG), High density lipoproteins (HDL), low density lipoprotein (LDL) and very low-density lipoprotein (VLDL), was measured by fully automated Biochemistry analyzer (Dimension ® clinical chemistry).

Lipid Profile:

Triglyceride, Total cholesterol, HDL cholesterol, LDL cholesterol, was measured by automated biochemistry analyzer on Dimension ® clinical chemistry [33–39].

Laboratory analysis test procedure

Lipid profile

Serum triglyceride (TG)

Principle

The triglyceride method is based on enzymatic procedure. The sample is incubated with lipoprotein lipase (LPL) enzyme reagent that converts triglycerides into free glycerol and fatty acids. Glycerol kinase (GK) catalyzes the phosphorylation of glycerol by adenosine-5-triphosphate (ATP) to glycerol-3-phosphate. Glycerol-3- phosphate oxidase oxidizes glycerol-3-phosphate to dihydroxyacetone phosphate and hydrogen peroxide (H2O2). The catalytic actions of peroxidase forms quinonimine fromH2O2, amino antipyrine and 4-chlorophenol. The change in absorbance is due to the formation of quinonimine is directly proportional to the total amount of glycerol and its precursors in the sample and is measured using a bichromatic (510,700nm) endpoint technique [33].

Reference range: 45-145mg/dl

Serum total cholesterol (TC)

Principle

Cholesterol esterase (CE) catalyzes the hydrolysis of cholesterol esters to produce free cholesterol and fatty acids. Cholesterol is oxidized in a reaction catalyzed by cholesterol oxidase (CO) to form cholest-4-ene-3-one and hydrogen peroxide. In the presence of horse radish peroxidase (HPO), the hydrogen peroxide thus formed is used to oxidize N, N Diethyl aniline-HCL/4-aminoantipyrine (DEA-HCL/AAP) to produce a chromophore that absorbs at 540nm. The absorbance due to oxidized DEA-HCL/AAP is

directly proportional to the total cholesterol concentration and is measured using a polychromatic (452,540,700nm) endpoint technique [34,35,36].

Reference range: 0-220mg/dl

Serum high density lipoprotein (HDL)

Principle

In the first reaction, chylomicrons, VLDL and HDL form water soluble complexes with dextran sulfate in the presence of magnesium sulfate. These complexes are resistant to the polyethylene glycol (PEG)-modified cholesterol esterase and cholesterol oxidase that react with HDL cholesterol. In the presence of oxygen, the HDL cholesterol is oxidized to 4-cholestenone and hydrogen peroxide. The generated hydrogen peroxides the reacts with 4-aminoantipyrine and sodium-N-3,5-dimethoxyaniline in the presence of peroxidase to form a colored dye that is measured using a bichromatic (600,700nm) endpoint technique. The color intensity of the dye is directly proportional to the serum HDL-C concentration [37,38].

Reference range: >40mg/dl

Serum low density lipoprotein (LDL)

Principle

Measurement of LDL is a two-reagent format and depends on the properties of detergent 1 which solubilizes only non-HDL particles. Cholesterol released is consumed by cholesterol esterase and cholesterol oxidase in a non-color forming reaction. Detergent 2 solubilizes the remaining LDL particles. The soluble LDL-C is then oxidized by the action of cholesterol esterase and cholesterol oxidase forming cholestenone and hydrogen peroxide. The enzymatic action of peroxidase on H2O2 produces color in the presence of N, N-bis (4-sulfobutyl)-m-toluidine, disodium salt (DsBmT) and 4-aminoantipyrine (4-AA) that is measured using bichromatic (540,700nm) endpoint technique. The color produced is directly proportional to the amount of LDL-C present in the sample [37, 39].

Reference range: 0-150mg/dl

Data Analysis

Each sample were encoded with identification number. Findings were entered manually into database. Analysis was done by using tools of SPSS20.

RESULTS

In this chapter, the data collected from 156 respondents, were analyzed and interpret. All the parameters, including demographic and laboratory investigations were recorded as per the guideline laid down in the

materials and methods. The data obtained were analyzed according to the research questions and objectives of the study. The results and observations were shown in the tables and figures.

Figure 1 shows the frequency of post-menopausal women with different age group. Post-menopausal subjects were highest in the age group 55–59 years and the lowest in the age group 70–74 years. Among the different age groups of 156 study subjects, 30.1% were in the age group of 55–59, 24.4% were in the age group of 60–64 years, 21.2% were in the age group of 65-69years, 10.3% were in the age group of 70–74 years and 14.1% were of 75years and above.

Table 1
Descriptive analysis on Serum lipid profile among post-menopausal women attending AMCH (n = 156)

Variables	Statistics	Min/Max	Normality test
TG	Median (IQR) = 140.5 (78.4)	53.43/466	Not-normal
TC	Mean ± SD = 185.62 ± 44.17	101/332	Normal
HDL	Median (IQR) = 49 (13)	20.47/81	Not-Normal
LDL	Median (IQR) = 104 (48.6)	46/203	Not-normal

Normality test was done through Shapiro wilk test at 5% level of significance, SD denotes standard deviation, IQR denotes inter quartile range

Table 1 shows the descriptive analysis on serum lipid profile among post-menopausal women. The serum TC has the Mean ± SD 185.62 ± 44.17 with 101/332 (min/max). The serum TG has the Median (IQR) 140 (78.4) with 53.43/466 (min/max). The serum HDL has Median (IQR) 49 (13) with 20.47/81 (min\max). The serum LDL has Median (IQR) 104 (48.6) with 46/203 (min/max).

All variables of lipid profile except serum TC do not follow normal distribution.

Table 2
Association between level of serum lipid profile and age group among post-menopausal women attending AMCH (n = 156)

Variables	Normal (%)	Age group		P-value
		55 to 65	Above 65	($\varvec{\chi}^2$ test)
TG	80 (51.3%)	43 (46.7%)	37 (57.8%)	0.17
TC	119 (73.6%)	68 (73.9%)	68 (73.9%)	0.40
HDL	139 (89%)	78 (84.8%)	61 (95.3%)	**0.03****
LDL	133 (85.3%)	78 (84.8%)	55 (85.9%)	0.84

*** denotes significant association (by applying Pearson chi-square test at 5% level of significance).*

The Table 2 shows the association between serum lipid profile level and age group. Serum HDL had statistically significant association with different age group while serum TG, TC, and LDL were not statistically significant. Out of 156 study subjects, 51.3% subjects had normal triglycerides level of which 46.7% were of 55–65 years while 57.8% were of above 65 years. The remaining 48.7% of study subjects had elevated serum triglycerides level. Among the study subjects, 73.6% had normal total cholesterol level of which 73.9% were of 55–65 years and 73.9% were of above 65 years. The remaining 23.7% of the study subjects had elevated total cholesterol level. Similarly, 89% had normal serum HDL level of which 84.8% were of 55–65 years and 95.3% were of above 65 years. The remaining 10.9% of the study subjects had lower HDL level. Likewise, 85.3% had normal LDL level of which 84.8% were of 55–65 years and 85.9% were of 65years and above. The remaining 14.7% subjects had elevated LDL level.

Table 3
Degree of linear relationship between serum lipid profile and age (n = 156)

Serum lipid profile	*Vs. Age*	
	Correlation	P-value
TG	-0.13	0.09
TC	-0.02	0.78
HDL	0.17	**0.03****
LDL	-0.06	0.40

*** denotes significant correlation (by applying spearman rank correlation coefficient).*

Table 3 shows the degree of linear relationship between serum lipid profile and age. All the parameters of serum lipid profile except HDL were statistically not significant ($p > 0.05$) with age. The serum TG had a weak negative correlation ($r = -0.13$, $p = 0.09$) with age. The serum TC had a weak negative correlation ($r = -0.02$, $p = 0.78$) with age. The serum HDL had a weak positive correlation ($r = 0.17$, $p = 0.03$) with age. The serum LDL had a weak negative correlation ($r = -0.06$, $p = 0.40$) with age.

DISCUSSION

Post-menopause is the period of a woman's life that comes after the last menstrual cycle, i.e. when the ovaries completely stop working, regardless of the reasons for the drop naturally or because of disease. Hormonal changes after menopause such as low plasma estrogen level and elevated Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH) level causes derangement of plasma lipid and lipoprotein where the serum Triglycerides, Total cholesterol, and LDL levels are usually increased while HDL level is decreased which increases the chances of developing cardiovascular diseases (CVDs) in

post-menopausal women [13, 14]. Results from this study on lipid profile in post-menopausal women also indicate that menopause alters the lipid profile in women.

In present study, the serum Triglycerides, Total cholesterol, and LDL levels were found to be elevated in 48.7%, 23.7% and 14.7% study subject respectively while serum HDL level below normal was found in 10.9% of the study subjects. The present study is similar to the study conducted by Jan Krakowiak *et al.*, Berg *et al.*, and, Usoro *et al.*, who showed the rise in serum TC, TG and LDL and decrease in serum HDL in post-menopausal women [22, 21, 2]. Similarly, a study conducted by Sapkota A *et al.* also showed the significant increase in serum TC, TG, and LDL-C and significantly decreased HDL-C in post-menopausal women [17]. Likewise, a study conducted by Pardhe BD *et al.*, showed that the Serum TC, TG, and LDL-C levels were increased in post-menopausal women [25].

The elevated serum TG, TC, and LDL-C in post-menopausal women has been attributed to hormonal changes and failure of follicular development, where the plasma estradiol level that reduces the risk of coronary heart disease falls below the normal level. Serum TC is an independent risk factor for CVD and every 1% rise in TC is associated with at least 2% increase in the incidence of CVD [40].

The present study showed that serum HDL was decrease in the post-menopausal women which is similar to the study conducted by (Usoro *et al.*,) [2] however, there is vast controversy in the level of HDL in post-menopausal women. Some studies revealed significant increase (Derby et al.,) [41] in level of serum HDL in post-menopausal women while some remain unaffected (Jenson *et al.*,) [42]. This discrepancy result may be due to variation in study population, life intervention, and duration of menopause.

CONCLUSION

From this study, it is concluded that the serum lipid profile was altered in post-menopausal women. This study showed that the serum Triglycerides, Total Cholesterol and LDL level were increased while serum HDL was decreased in post-menopausal women and elevated Triglycerides, Total cholesterol, and LDL with decreased HDL is associated with development of CVD in post-menopausal women. Therefore, it is important to consider each and every post-menopausal woman to undergo screening for abnormal lipid profile to prevent associated co-morbidity. So, in all post-menopausal women, specific health education strategies should be strongly recommended to prevent the emerging cardiovascular diseases

Declarations

Dissemination plan

The result of this work will be disseminated to Arogyam Medical College and Hospital (AMCH) Uttarakhand. Publication of the findings in the reputed national or international journals will be attempted.

Ethical Considerations

The study was conducted in accordance with existing ethical guidelines. Ethical approval was taken from AMCH-IEC (Institutional Ethical committee) and department of laboratory medicine, AMCH. The research was conducted based on the declaration of Helsinki. A verbal informed consent was taken from the patient prior to his/her inclusion in research. A complete description of the aims of the study and assurance of confidentiality for any information was given to all patients who were potential study participants. All required data for my research was taken from tests that were prescribed by clinician and patients were not be charged extra for research purpose.

References

1. World Health Organization. Research on the menopause in the 1990s: report of a WHO scientific group.
2. Usoro CA, Adikwuru CC, Usoro IN, Nsonwu AC. Lipid profile of postmenopausal women in Calabar, Nigeria. Pak J Nutr. 2006;5(1):79-82.
3. World Health Organization. Research on the menopause: report of a WHO scientific group [meeting held in Geneva from 8 to 12 December 1980]. World Health Organization; 1981. (670).
4. Shrividya S, Joy M. Brain Fog among Perimenopausal Women: A Comparative Study. Journal of International Women's Studies. 2021;22(6):11-21.
5. Mondul AM, Rodriguez C, Jacobs EJ, Calle EE. Age at natural menopause and cause-specific mortality. American journal of epidemiology. 2005 Dec 1;162(11):1089-97
6. Sizer F, Whitney E. Nutrition: concepts and controversies. Cengage Learning; edition13, 2013 Apr 5, page no. 596.
7. Malacara JM, de Cetina TC, Bassol S, González N, Cacique L, Vera-Ramírez ML, Nava LE. Symptoms at pre-and postmenopause in rural and urban women from three States of Mexico. Maturitas. 2002 Sep 30;43(1):11-9.
8. Dalal PK, Agarwal M. Postmenopausal syndrome. Indian journal of psychiatry. 2015 Jul;57(Suppl 2): S222.
9. Burtis CA, Ashwood ER, Burns DE SB. *Tietz Fundamntals of Clinical Chemistry*. 6th edition. Sunders Elsevier, 2008.page no:787
10. Godkar PB GD. *Textbook of Medical Laboratory Technology Clicical Laboratry and Molecular Diagnosis*. 3rd edition. Balani Publishing House, Mumbai, 2014.page no:579
11. Murray RK, Bender DA, Botham KM, Kennelly PJ, Roadwell VW WP et al. *Harper's Illustrated Biochemistry*. 28th edition. The McGrow Hill Companies, 2009 pageno. 230.
12. Colpo A. LDL Cholesterol:" Bad" Cholesterol or Bad Science? Journal of American Physicians and Surgeons. 2005;10(3):83.
13. Pardhe BD, Ghimire S, Shakya J, Pathak S, Shakya S, Bhetwal A, Khanal PR, Parajuli NP. Elevated cardiovascular risks among postmenopausal women: a community-based case control study from

Nepal. Biochemistry research international. 2017 May 2;2017.

14. Taleb-Belkadi O, Chaib H, Zemour L, Fatah A, Chafi B, Mekki K. Lipid profile, inflammation, and oxidative status in peri-and postmenopausal women. Gynecological Endocrinology. 2016 Dec 1;32(12):982-5.
15. Boudghène F, Gautier P, Delsart P, Claisse G, Letombe B, Fayolle P, Devos P. " Heart, arteries and women" an innovative care pathway for women at high risk: First evaluation at one year. InAnnales de Cardiologie et D'angeiologie 2015 Jun 1 (Vol. 64, No. 3, pp. 199-204).
16. Kilim SR, Chandala SR. A comparative study of lipid profile and oestradiol in pre-and post-menopausal women. Journal of clinical and diagnostic research: JCDR. 2013 Aug;7(8):1596.
17. Sapkota AS, Sapkota A, Acharya K, Raut M, Jha B. Study of metabolic syndrome in postmenopausal women. Annals of Clinical Chemistry and Laboratory Medicine. 2015 Mar 19;1(1):6-11.
18. Matthews KA, Meilahn E, Kuller LH, Kelsey SF, Caggiula AW, Wing RR. Menopause and risk factors for coronary heart disease. New England journal of medicine. 1989 Sep 7;321(10):641-6.
19. Stevenson JC, Crook D, Godsland IF. Influence of age and menopause on serum lipids and lipoproteins in healthy women. Atherosclerosis. 1993 Jan 4;98(1):83-90.
20. Kuller LH, Meilahn EN, Cauley JA, Gutai JP, Matthews KA. Epidemiologic studies of menopause: changes in risk factors and disease. Experimental gerontology. 1994 May 1;29(3-4):495-509.
21. Ko SH, Kim HS. Menopause-associated lipid metabolic disorders and foods beneficial for postmenopausal women. Nutrients. 2020 Jan;12(1):202.
22. Dobiášová M. Atherogenic impact of lecithin-cholesterol acyltransferase and its relation to cholesterol esterification rate in HDL (FER (HDL)) and AIP [log (TG/HDL-C)] biomarkers: the butterfly effect. Physiol Res. 2017 May 4;66(2):193-203.
23. Ambikairajah A, Walsh E, Cherbuin N. Lipid profile differences during menopause: a review with meta-analysis. Menopause. 2019 Nov 1;26(11):1327-33.
24. Inaraja V, Thuissard I, Andreu-Vazquez C, Jodar E. Lipid profile changes during the menopausal transition. Menopause. 2020 Jul 1;27(7):780-7.
25. Pardhe BD, Ghimire S, Shakya J, Pathak S, Shakya S, Bhetwal A, Khanal PR, Parajuli NP. Elevated cardiovascular risks among postmenopausal women: a community-based case control study from Nepal. Biochemistry research international. 2017 May 2;2017.
26. Krakowiak J, Raczkiewicz D, Wdowiak A, Cichońska D. Atherogenic lipid profile and health behaviours in women post-menopause working in agriculture. Annals of Agricultural and Environmental Medicine. 2019;26(4).
27. Shenoy R, Vernekar P. Fasting lipid profile in pre-and post-menopausal women: a prospective study. International Journal of Scientific Study. 2015;3(9):116-9.
28. Mohammad FM, Pambuk IA, Jalal NA. A Comparative Study to Evaluate the Serum Lipid Profile in Pre and Postmenopausal Woman in Sulaymaniyah City _ Iraq. Biomedical Journal of Scientific & Technical Research. 2017;1(3):820-5.

29. Wang N, Qin MZ, Cui J. Lipid profile comparison between pre-and post-menopausal women. Zhonghua xin xue guan bing za zhi. 2016 Sep 1;44(9):799-804.
30. Kumar S, Shah C, Oommen ER. Study of cardiovascular risk factors In pre and postmenopausal women. Int J Pharma Sci Res. 2012 Dec;3(12):560-70.
31. Al-Dahhan FH, Al-Naama LM, Disher A. Lipid profile and Menopausal status. Al-Kindy Col Med. 2008;4(1):8-19.
32. Mešalić L, Tupković E, Kendić S, Balić D. Correlation between hormonal and lipid status in women in menopause. Bosnian journal of basic medical sciences. 2008 May;8(2):188.
33. Burtis CA, Ashwood ER. Tietz Textbook of Clinical Chemistry, 2nd Edition, W.B. Saunders Co., Philadelphia, PA 1994: p 1017.
34. Yousif JM, Abdel-Magied NA, Abou Zeid OA, Kumosani TA. Therapeutic effects of herbal leaves group (Green tea & Sage) on liver cancer. Science. 2007;19(1).
35. Flegg HM. Ames award lecture 1972. An investigation of the determination of serum cholesterol by an enzymatic method. Annals of Clinical Biochemistry. 1973 Jan;10(1-6):79-84.
36. Rautela GS, Liedtke RJ. Automated enzymic measurement of total cholesterol in serum. Clinical chemistry. 1978 Jan 1;24(1):108-14.
37. Rifai N, Warnick GR, Dominiczak MH, editors. Handbook of lipoprotein testing. Amer. Assoc. for Clinical Chemistry; 2nd edition,2000, page no. 767.
38. Genest Jr J. Genetics and prevention: a new look at high-density lipoprotein cholesterol. Cardiology in review. 2002 Jan 1;10(1):61-71.
39. Gotto Jr AM. Lipoprotein metabolism and the etiology of hyperlipidemia. Hospital practice. 1988 Jun 1;23(sup1):4-13
40. Razay G, Heaton KW, Bolton CH. Coronary heart disease risk factors in relation to the menopause. QJM: An International Journal of Medicine. 1992 Nov 1;85(2-3):889-96.
41. Derby CA, Crawford SL, Pasternak RC, Sowers M, Sternfeld B, Matthews KA. Lipid changes during the menopause transition in relation to age and weight: the Study of Women's Health Across the Nation. American journal of epidemiology. 2009 Jun 1;169(11):1352-61.
42. Jensen J, Nilas L, Christiansen C. Influence of menopause on serum lipids and lipoproteins. Maturitas. 1990 Nov 1;12(4):321-31.

Figures

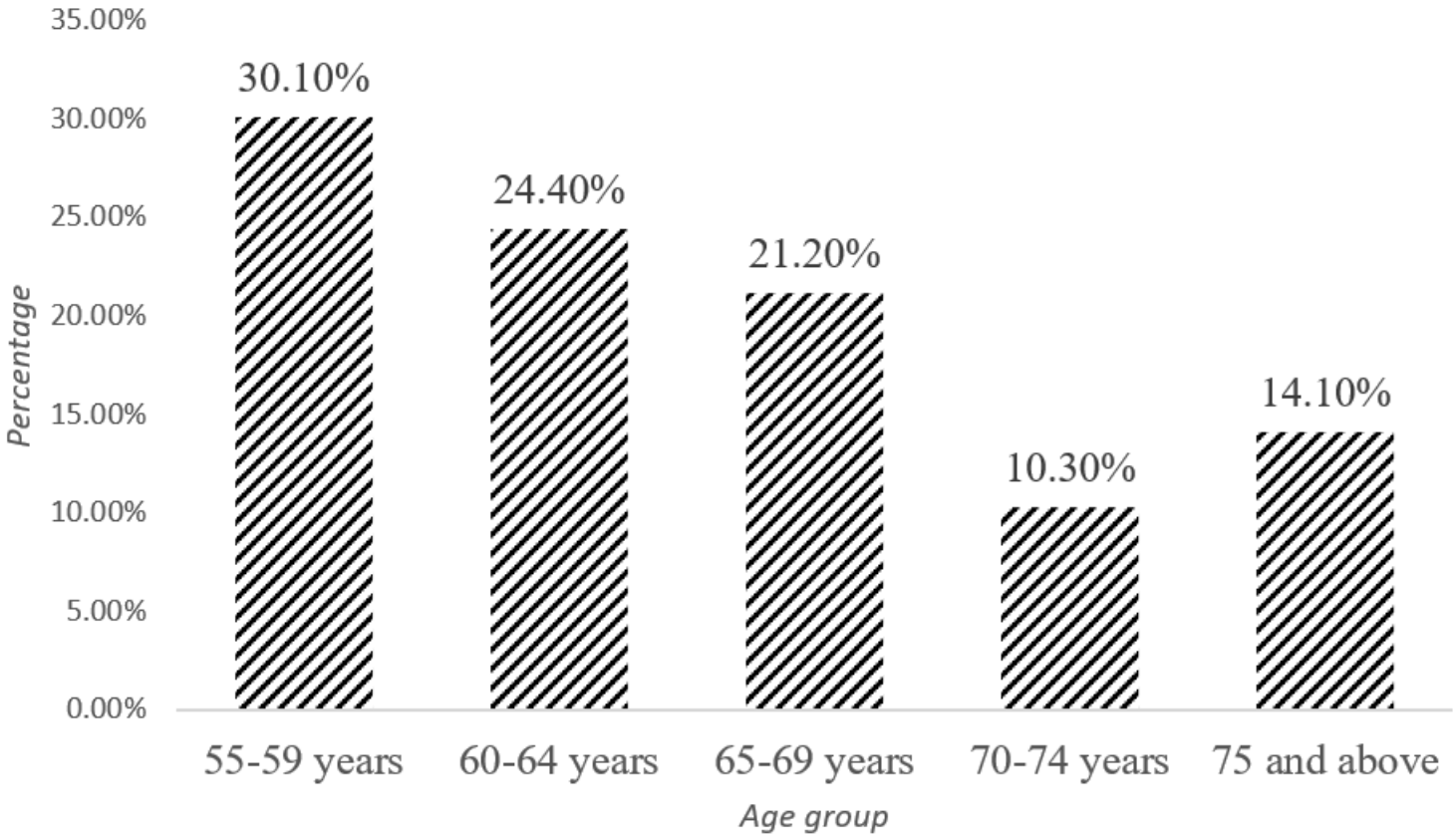


Figure 1

Age distribution among post-menopausal women attending Arogyam medical college teaching hospital (n=156)