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# LIPOPROTEINS AND TOTAL CHOLESTEROL IN ADULTS WITH NORMAL AND ELEVATED CHOLESTEROLEMIA IN A CLINIC IN LIMA-PERU 2022: A CORRELATIONAL STUDY

## LIPOPROTEÍNAS Y COLESTEROL TOTAL EN ADULTOS CON COLESTEROLEMIA NORMAL Y ELEVADA EN UN POLICLÍNICO DE LIMA-PERÚ 2022: UN ESTUDIO CORRELACIONAL

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## ABSTRACT

**Introduction:** To evaluate the degree of correlation between high-density, low-density, and very low-density lipoproteins and total cholesterol in patients with normal and high cholesterolemia. **Methods:** Observational, analytical and cross-sectional study carried out from January to September 2022 with 207 patients over 18 years of age divided into a group with normal cholesterol and another with hypercholesterolemia. The Spearman correlation test was performed. **Results:** In normocholesterolemic subjects there was a low and negative correlation between high-density lipoproteins and low-density lipoproteins (-0.263) as well as between high-density lipoproteins and very low-density lipoproteins (-0.220). In hypercholesterolemic patients there was a low and positive correlation between high-density lipoproteins and total cholesterol (0.344). In both groups there was a high correlation between cholesterol and low-density lipoproteins and a low and positive correlation between cholesterol and very low-density lipoproteins. **Conclusions:** Lipoproteins are correlated in normocholesterolemics and high-density lipoproteins are correlated in hypercholesterolemics.

**Keywords:** Cholesterol; Lipoproteins, HDL; Lipoproteins, LDL; Lipoproteins, VLDL; Statistics, Nonparametric; Correlation of Data. (Source: MESH-NLM)

## RESUMEN

**Introducción:** Evaluar el grado de correlación entre las lipoproteínas de alta densidad, baja densidad, muy baja densidad y el colesterol total en pacientes con colesterolemia normal y alta. **Métodos:** Estudio observacional, analítico y transversal realizado desde enero a setiembre de 2022 con 207 pacientes mayores de 18 años, divididos en un grupo de colesterol normal y otro con hipercolesterolemia. Se realizó la prueba de correlación de Spearman. **Resultados:** En normocolesterolémicos, hubo una correlación baja y negativa entre lipoproteínas de alta densidad y las lipoproteínas de baja densidad (-0.263) así como entre lipoproteínas de alta densidad y las de muy baja densidad (-0.220). En hipercolesterolémicos, hubo una correlación baja y positiva entre lipoproteínas de alta densidad con colesterol total (0.344). En ambos grupos, hubo una correlación alta entre colesterol y lipoproteínas de baja densidad y baja y positiva entre colesterol y lipoproteínas de muy baja densidad. **Conclusiones:** Las lipoproteínas se correlacionan en normocolesterolémicos y las lipoproteínas de alta densidad se correlacionan en hipercolesterolémicos.

**Palabras clave:** Colesterol; Lipoproteínas HDL, Lipoproteínas LDL; Lipoproteínas VLDL; Estadísticas no paramétricas; Correlación de datos. (Fuente: DeCS- BIREME)

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## INTRODUCTION

Lipoproteins are particles whose hydrophobic core contains non-polar lipids such as cholesterol and triglycerides; this core is surrounded by a membrane of cholesterol, phospholipids, and apolipoproteins [1]. The primary functions of lipoproteins involve transport, including the transportation of exogenous lipids (via chylomicrons) [2] and endogenous lipids, through very low-density lipoproteins (VLDL), high-density lipoproteins (HDL), low-density lipoproteins (LDL), and intermediate-density lipoproteins (IDL)[3]. They also play a role in inflammatory processes, where excessive oxidation of LDL, in response to damage caused by excess glucose[4], can damage the endothelial walls of blood vessels[5].

In inflammatory processes associated with Gram-negative and positive bacteria, HDL has the ability to bind to pathogenic components of the bacterial wall[6], neutralize their effects, and facilitate their elimination[7]; HDL also modulates the immune response[8] and interacts with immune cells through the regulation of available cholesterol [9]. The importance of HDL cholesterol becomes even more pronounced in systemic infections or sepsis [10], where it has been observed that a decrease in this lipoprotein, with the consequent reduction of ApoA, leads to a decrease in the oxidation of LDL in the cell wall[11] and is associated with higher mortality in septic patients[12].

Based on their density, lipoproteins are divided into chylomicrons (for the transport of exogenous triglycerides), very low-density lipoproteins (VLDL, which transport newly formed triglycerides to adipose tissue), low-density lipoproteins (LDL, transporting phospholipids, cholesterol, and triglycerides throughout the body), high-density lipoproteins (HDL, which collect cholesterol from throughout the body to the liver), and intermediate-density particles (IDL, transporting cholesterol and triglycerides) [13]. There have been numerous studies on the association of lipoproteins in various pathological contexts; for instance, Yu demonstrated an association between LDL and HDL in mortality from multiple causes in elderly hypertensive patients [14]. Vargas found that LDL and VLDL correlated better than VLDL alone in lipid profile analysis in patients with familial hyperlipidemia[15].

Xie discovered that elevated VLDL is a risk factor for cardiovascular and multiple-cause mortality in peritoneally dialyzed patients[16]. The numerous studies on lipids conducted and recorded in the medical literature are highly relevant, as they evaluated morbidity and mortality risks in different pathological and population groups and their main correlations, especially in patients with coronary artery disease [17]. However, studies evaluating the degree of association between these lipoproteins in relation to blood cholesterol levels have not been conducted. Therefore, the objective of this research was to evaluate the correlation between total cholesterol and HDL, LDL, and VLDL lipoproteins in patients with normal and elevated cholesterol levels. The results will allow for the determination of variations in the relationship of these macromolecular complexes in the clinical context of normocholesterolemia and hypercholesterolemia, contributing to the understanding of the pathophysiology of dyslipidemias, from the asymptomatic stage of these metabolic disorders.

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## METHODS

### Study design and population

An observational (no intervention on variables), analytical (aimed to evaluate a potential relationship between a factor and an effect or response), correlational (two variables were measured and their statistical relationship assessed), and prospective study was conducted. Data were collected from 207 patients aged 18 and older, evaluated at a polyclinic in the district of Villa el Salvador, Lima, Peru, from January to September 2022. These were asymptomatic individuals who came for routine evaluations during monthly health campaigns. Patients with a history of endocrine-metabolic diseases such as diabetes mellitus, thyroid disease, or polycystic ovary syndrome were excluded. Also excluded were patients with harmful habits like smoking, alcoholism, as well as those who reported frequent use of corticosteroids, beta-blocker antihypertensives. The sampling was non-probabilistic, as patients were considered ase don their order of arrival.

### Study Variables

The variables considered were age (in years), sex, HDL cholesterol with normal values (NV) of 40-65 mg/dl, LDL

(NV: 60-150 mg/dl), VLDL cholesterol (NV: 2-38 mg/dl), and total cholesterol (NV: 140-200 mg/dl). Information was gathered from clinical records during the monthly health campaigns and measured by the same laboratory to avoid inconsistency issues.

**Data Collection Procedure**

After coordinating with the management of the polyclinic, data were collected from clinical records of consultations and health campaigns conducted monthly, from January to September 2022. Once the information was gathered, it was entered into Excel 2016 software for storage and progressive organization. After the collection was completed, this information was analyzed and processed in the SPSS Statistics 25 statistical software, where the statistical tests relevant to the study design were performed.

**Data Analysis**

The analysis was carried out using SPSS Statistics 25 software. In the descriptive statistical analysis, sex and age were the categorical variables; the numerical variables described were HDL, LDL, VLDL, and total cholesterol. The variables were presented and dichotomized in 2 x 2 tables. The analytical statistical analysis was performed using bivariate correlational statistics through the Spearman correlation test, as the Kolmogorov-Smirnov normality test showed that the distribution was not normal. The cutoff point for the decision of statistical significance was an alpha value equal to 0.05

**Ethical Aspects**

The study and protocol were approved by the Ethics Committee of the medical center with registration CMD2022-05. Additionally, patient confidentiality was maintained; the recorded data did not include personal patient data, as the data of interest were solely the quantitative values extracted from clinical histories and health campaign results. Therefore, it was not necessary to request informed consent beyond that requested from the polyclinic management, which ensured the confidentiality of the identity of the análisis unit.

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## RESULTS

It was found that the mean total cholesterol was higher than the desirable values (211.61 mg/dl). HDL values had a mean within the normal range (48.48 mg/dl), as did the mean of LDL (132.06 mg/dl) and VLDL (32.66 mg/dl) (table 1).

**Table 1.** Minimum, maximum, and average values of total cholesterol, HDL, LDL, and VLDL.

| | N | Minimum | Maximum | Mean |
|---|---|---|---|---|
| **Total Cholesterol (mg/dl)** | 207 | 108 | 470 | 212.61 |
| **HDL (mg/dl)** | 207 | 30 | 87 | 48.48 |
| **LDL (mg/dl)** | 207 | 30 | 379 | 132.06 |
| **VLDL (mg/dl)** | 207 | 10 | 128 | 32.66 |

Source: Own elaboration

In patients with normal cholesterol levels, a low and negative correlation was found between HDL and LDL (Rho= -0.263), as well as with VLDL (Rho= -0.220), and a high and positive correlation between LDL and total cholesterol (Rho= 0.790) and between VLDL and total cholesterol (Rho= 0.302). This implies that these results represent the relationships under conditions of normal serum cholesterol in this group of people (table 2).

**Table 2.** Spearman Correlation between total cholesterol, HDL, LDL, and VLDL in patients with cholesterol levels equal to or less than 200 mg/dl

| | | HDL | LDL | VLDL | Total Cholesterol |
|---|---|---|---|---|---|
| **HDL** | Rho | 1 | -0,263* | -0,220* | -0,039 |
| | Sig | | 0,012 | 0,038 | 0,71 |
| | N | 105 | 105 | 105 | 105 |
| **LDL** | Rho | -0,263* | 1 | -0,007 | 0,790** |
| | Sig | 0,012 | | 0,947 | 0 |
| | N | 105 | 105 | 105 | 105 |
| **VLDL** | Rho | -0,220* | -0,007 | 1 | 0,302** |
| | Sig | 0.038 | 0.947 | | 0.004 |
| | N | 105 | 105 | 105 | 105 |
| **Total Cholesterol** | Rho | -0,039 | | 0,302** | |
| | Sig | 0,71 | 0 | 0,004 | |
| | N | 105 | 105 | 105 | 105 |

* The correlation is significant at the 0.05 level (two-tailed).
** The correlation is significant at the 0.01 level (two-tailed).
Rho: Spearman's Correlation Coefficient

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In patients with high cholesterol levels, a low and positive correlation was found between HDL and total cholesterol (Rho= 0.344), as well as a high and positive relationship between LDL and total cholesterol (Rho= 0.815) and a low and positive relationship between total cholesterol and VLDL (Rho= 0.337).

This implies that these results represent alterations from the conditions found in adults with normal cholesterolemia as shown in table 2, and it is suggested that hypercholesterolemia causes an imbalance in the interaction between lipoproteins and lipids from asymptomatic stages of these disorders (table 3).

**Table 3.** Correlation between total cholesterol, HDL, LDL, and VLDL in patients with cholesterol levels above 200 mg/dl

| | | HDL | LDL | VLDL | Total Cholesterol |
|---|---|---|---|---|---|
| **HDL** | Rho | 1 | 0,139 | 0,007 | 0,344** |
| | Sig | | 0,137 | 0,943 | 0 |
| | N | 102 | 102 | 102 | 102 |
| **LDL** | Rho | 0,139 | 1 | -0,046 | 0,815** |
| | Sig | 0,137 | | 0,623 | 0 |
| | N | 102 | 102 | 102 | 102 |
| **VLDL** | Rho | 0,007 | -0,046 | 1 | 0,337** |
| | Sig | 0,943 | 0.623 | | 0 |
| | N | 102 | 102 | 102 | 102 |
| **Total Cholesterol** | Rho | 0,344** | 0,815** | 0,337** | |
| | Sig | 0 | 0 | 0 | |
| | N | 102 | 102 | 102 | 102 |

* The correlation is significant at the 0.05 level (two-tailed).
** The correlation is significant at the 0.01 level (two-tailed).
Rho: Spearman's Correlation Coefficient

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## DISCUSSION

It was observed that in patients with cholesterol levels equal to or less than 200 mg/dl, there was a low and negative correlation between HDL and both LDL and VLDL. However, in patients with cholesterol levels above 200 mg/dl, no correlation was found between these lipoproteins. LDL, HDL, and VLDL have in common that they are produced in the liver (with HDL having greater production in the intestine) [18] to transport cholesterol and triglycerides to organs with specific receptors for LDL, VLDL, and HDL. The latter has the function of transporting systemic cholesterol to the liver for subsequent excretion in the feces through bile acids [19]. The results in patients with normal total cholesterol may reflect that the mechanisms of synthesis and transport of these lipoproteins are not affected and develop apparently balanced when there is no cholesterol overload in the body, and that an increase in HDL causes decreases in the other types of lipoproteins in this group of patients.

On the contrary, no correlation was observed between any lipoprotein when patients had total cholesterol levels greater than 200 mg/dl, which could mean that the association between these variables is probably lost due to the increase in total cholesterol. Additionally, a low and positive correlation was observed between total cholesterol and HDL, which can be interpreted as a manifestation of the lipid transport mechanisms of this lipoprotein that would increase in asymptomatic patients with hypercholesterolemia. It should be noted that the correlations between total cholesterol with LDL and VLDL remained similar (high and positive) in both the group with normal cholesterol and the group with elevated cholesterol. This result is consistent with empirical and experimental evidence about the function of LDL linked to cholesterol transport, as well as the lower correlation between cholesterol and VLDL, since this lipoprotein mainly transports triglycerides [20]. An absence of variations in the correlation of these lipoproteins with cholesterol, in both groups, would be due to the fact that the transport function of LDL and VLDL is not affected by cholesterol overload unlike HDL, which was observed to have a correlation in the presence of hypercholesterolemia and an absence of correlation in the presence of normal cholesterol.

The limitations of the study were primarily methodological: the sample size, the lack of randomization (the sampling was by convenience), so the results cannot be extrapolated to populations of other polyclinics and health centers or large population groups. This necessitates randomized designs with a larger population and sample size. However, the findings of this research justify the development of studies on the variation in lipid correlation according to cholesterol levels in large population groups. There was also the possibility of information bias from patients who might not know or wish to report any active chronic disease that could alter the results (thyroid disease, rheumatoid arthritis, diabetes mellitus in patients who might say they do not suffer from it, lupus, etc.). Additionally, it cannot be ruled out that patients may not have been truthful about practicing harmful habits such as alcoholism, smoking, as well as the intentional or accidental omission of mentioning occasional or frequent use of medications that could potentially raise cholesterol, such as some beta-blocker antihypertensives like atenolol, corticosteroids, and contraceptives; all these are factors that could generate an information bias and alter the results.

## CONCLUSIONS

In conclusion, in asymptomatic adults without known diseases or comorbidities, high-density lipoproteins correlate low and positively with low-density and intermediate-density lipoproteins in the presence of normal cholesterol. Also, high-density lipoproteins correlate low and positively with cholesterol in the presence of hypercholesterolemia.

It is recommended to conduct new studies with a different methodological design and a larger sample size. Additionally, these findings are important in understanding the physiology and biochemistry of the metabolism and transport of endogenous lipids in asymptomatic patients, thereby allowing us to approach an understanding of these phenomena from a preclinical and epidemiological context in terms of promotion and prevention of the cardiocirculatory and systemic complications of hypercholesterolemia. This is mainly because hypercholesterolemia and other dyslipidemias are asymptomatic and generally

manifest years later as cardiovascular and circulatory diseases, deleterious to the patient's quality and life expectancy. Therefore, the detection of alterations in the correlation of lipids and lipoproteins can be used as possible predictors or means of monitoring the patient's health status, years or decades, before the onset of acute and chronic diseases associated with lipid metabolism disorders.

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