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The relationship between the cholesterol-low density lipoprotein/cholesterol-high density lipoprotein ratio with the incidence of acute coronary syndrome at RSUD kota Bandung in 2019-2022

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ABSTRACT
The purpose of this study was to understand K-LDL levels with the incidence of acute coronary syndrome (ACS) in patients at the RSUD Kota Bandung Regional General Hospital (RSUD). The method used is a descriptive analytical method through a cross sectional approach to observe the Correlation of K-LDL/K-HDL Ratio with ACS (Acute Coronary Syndrome) events. The results of this study show that there is a correlation between the K-LDL/K-HDL ratio and ACS events at RSUD Kota Bandung in 2019 – 2021, this result can be concluded because it obtained a p value = 0.045. First, the majority of ACS patients at RSUD Kota Bandung in 2019 – 2021 are men, 65.6% of the total patients. Second, as many as 70.8% of the total patients of this study were active smokers. Third, the type of SKA that dominated in this study patient was APTS with 63.5% of the total respondents. Fourth, the average age of patients in these patients was 55.70 years. Fifth, the average ratio of LDL / HDL to ACS sufferers at RSUD Kota Bandung in 2019-2022 is 3,271. Sixth, the maximum and minimum values of LDL/HDL ratio in ACS patients at RSUD Kota Bandung in 2019 - 2022 are 7.037 and 0.215.

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INTRODUCTION

Cardiovascular disease is still one of the biggest causes of death in the world. Cardiovascular disorders are a group of diseases that attack blood vessels and the heart, especially CHD (coronary heart disease), heart failure, coronary arteries, ventricular arrhythmias, rheumatic heart disease, congenital heart disease, and ACS (Acute Coronary Syndrome). CHD is the leading cause among all cardiovascular diseases [1]. Based on WHO (World Health Organization) data, it was recorded that in 2019 deaths due to cardiovascular diseases were 43% [2]. This death rate is estimated to continue to increase to 23.3 million deaths annually by 2030 [3]. In the United States, mortality data in 2021

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was 173,800 events [4]. In Indonesia, cardiovascular disorders are the leading cause of death, responsible for one-third of deaths in Indonesia [5]. CHD is a cardiovascular disorder with the highest incidence rate in Indonesia, estimated at 11,592,990 events in 2020 and West Java is the province with the highest CHD incidence rate with an absolute number of 160,182 events [4], [6]. One of the heart problems that often causes death is ACS (acute coronary syndrome).

ACS (acute coronary syndrome) is experienced and associated with atherosclerotic arteries and may be asymptomatic. In fact, the signs that appear can take the form of pain such as non-ST-elevation myocardial infarction (NSTEMI), unstable angina, and ST-elevation myocardial infarction (STEMI) [7]. ACS is an acute manifestation of atherosclerotic plaque formation in coronary blood vessels that rupture or tear due to thinning of the fibrous layer and changes in plaque composition. ACS has risk aspects that are arranged into 2 groups, namely aspects that cannot be modified and aspects that can be modified. Aspects that cannot be modified include family history of coronary heart disease and ACS, gender and age [8], [9]. Factors that can be modified, including dyslipidemia profile, smoking, hypertension, type 2 diabetes mellitus (DM) or obesity, and physical activity [8]–[11].

One aspect of the risk of ACS disease that is closely associated with atherosclerosis is high cholesterol content. Until now, K-LDL (low-density lipoprotein cholesterol) is declared bad cholesterol because it transports cholesterol to tissues. What happens is that the quality of K-LDL cholesterol changes due to oxidation (H Tomkin &; Owens, 2012). Non-modifiable risk aspects and some modifiable risk aspects have a direct relationship with K-HDL and K-LDL levels in plasma [8], [10], [13]. However, there are several risk aspects that can be modified to have a direct relationship with the absorption process of K-LDL into the endothelial layer, including type 2 DM and hypertension [14]. High levels of K-LDL in blood plasma are the main factor in the atherosclerosis process in CHD and atherosclerosis plaque disorders in ACS [8], [15], [16]. K-LDL levels are lipid fractions that are atherogenic and commonly known as bad cholesterol [17]. Cholesterol-high density lipoprotein (K-HDL) known as good cholesterol has the function of restraining the formation of atherosclerotic plaques on artery walls [15]–[17].

K-LDL and K-HDL levels are parameters that can be assessed and have a relationship with the atherosclerosis process in CHD and atherosclerosis plaque disorders in ACS [15], [18]. High K-LDL levels correspond to low K-HDL levels in plasma, which affects the atherosclerosis process of the coronary arteries [15]. Atherosclerotic plaques are composed of connective tissue, smooth muscle, feces deposited in the arterial endothelium and fatty tissue. Atherosclerosis is caused by endothelial dysfunction resulting from oxidation of the cytotoxic properties of LDL. Oxidized LDL disrupts nitric oxide activity and synthesis which can lead to increased expression of inflammatory genes in the endothelium to facilitate attachment by monocytes. Monocytes then turn into macrophages and begin phagocyting oxidized LDL to form foam cells. The foam cell is surrounded by a fibrous capsule, and the thickness of the fibrous capsule establishes the susceptibility of the plaque to rupture. In

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addition, the hardness and size of the plaque core and the inflammatory stage experienced in the plaque also play a role [19]. Most ACS manifests acutely as plaques. The event is accompanied by the activation stage of the coagulation pathway and platelet aggregation, until the formation of platelet-rich thrombus (white thrombus). The clot blocks an opening in the coronary artery. In some patients, ACS occurs due to dynamic blockage due to focal spasm of the epicardial coronary arteries. Narrowing of coronary blood vessels without seizures or blood clots can be caused by plaque.

In patients with ACS who had undergone IKP (percutaneous coronary intervention) was found to be lower in the first year after the procedure, the rate of major adverse cardiovascular event (MACE) was significantly greater in patients who had a high K-LDL/K-HDL ratio. It can be concluded that the K-LDL/K-HDL comparison parameter can be an additional predictor of MACE in ACS patients [20]. K-LDL/K-HDL ratio also has an association with the development of atherosclerotic plaques in the coronary arteries, patients with a high K-LDL/K-HDL ratio have a higher risk of atherosclerotic plaque destruction [21].

In this study, the relationship between the ratio of K-LDL and K-HDL of ACS patients on the first day of admission to RSUD Kota Bandung will be an observed parameter because the relationship ratio can be an additional predictor of post-ACS MACE and prognosis of ACS patients [20]. In addition, because K-LDL levels are the therapeutic target of ACS events, observation of K-LDL/K-HDL comparison during treatment was not carried out [22], [23]. Sampling was carried out at RSUD Kota Bandung because RSUD Kota Bandung is a B-level regional hospital that provides medical services efficiently by providing training and education, research and development, and community services, focusing on recovery, treatment, prevention, remediation, and referral services. And this hospital is the central hospital in West Java, and Acute Coronary Syndrome is a disease that often occurs in this hospital and the data needed for research is available at this RSUD Kota Bandung.

METHOD

This study used a descriptive analytical method through a cross sectional approach to examine the correlation of K-LDL/K-HDL Ratio with ACS (Acute Coronary Syndrome) events. The following research subjects are secondary data in the form of medical record data for inpatients and outpatients "Acute Coronary Syndrome" at RSUD Kota Bandung in the 2019-2022 period. The collected data was then analyzed using univariate and bivariate analytics. The data will then be processed using SPSS software version 25 and displayed in the form of a table as in a dummy table. The division of ACS groups with high and low K-LDL/K-HDL ratios is based on the continuous nature of the data. The division of groups is carried out by looking at the middle or median data of the data obtained.

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RESULTS AND DISCUSSION

The following research was carried out at RSUD Kota Bandung, West Java Province, by recording medical record data directly. The following research aims to understand the correlation of HDL/LDL ratio with ACS events at RSUD Kota Bandung. The population of this study was outpatients and hospitalized patients who had been diagnosed with ACS. The total medical record data that has been recorded and included in the inclusion criteria of this study is 96 data. Medical record data recorded in the following research in the form of date of birth, medical record number, age, gender, religion, smoking history, total triglycerides, LDL cadara, HDL, total cholesterol, troponin, ECG and the patient's main diagnosis by entering these data into *a google spreadsheet* that has been made based on research interests. The research was carried out for several months which was divided into several stages, namely the stage of recording ACS patient medical record data at RSUD Kota Bandung, the stage of sorting medical record data based on research exclusion and inclusion criteria and the last stage was bivariate and univariate data analysis using *chi-square testing*, making results and presenting results.

Respondent Characteristics

Researchers analyzed the characteristics of patients according to sex, age, smoking history, clinical presentation and laboratory results, based on the results of univariate analysis it was found that the majority of patients were men, the history of active smoking in patients was at 70.8% of the total patients, the type of ACS that dominated in patients was the type of APTS, these data can be examined in Table 1.

Table 1. Overview of Basic Characteristics of ACS Patient Laboratory Results

		n		%
Demographics				
Gender:				
- Male		63		65,6
- Female		33		34,4
History of Active Smokers				
- Yes		68		70,8
- No		28		29,2
ACS Types				
- APTS, n (%)		61		63,5
- IMA-NEST, n (%)		21		21,9
- IMA-EST, n (%)		14		14,6
	Mean	Std. Deviation	Min.	Max.
Age, Year	55,70	10,371	23	80
Laboratory Results				
Rate K-LDL, mg/dL	132,01	51,85	35	383
Rate K-HDL, mg/dL	45,02	25,23	17	180

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Table 1 shows that 65.6% or 63 patients were men and 34.4% or 33 patients were women, patients had an average age of 55.70 and a standard deviation of 10.371. 70.8% of all patients in the study had a history of smoking before being diagnosed with coronary syndrome. While 63.5% of patients were diagnosed with APTS, 21.9% were diagnosed with NSTEMI and 14.6% were diagnosed with STEMI. The results of the patient's LDL laboratory examination showed a mean of 132.01 mg/dl where the standard deviation was 51.85, with the lowest score of 35 mg/dl and the highest score of 383 mg/dl. The results of the patient's HDL laboratory examination showed a mean of 45.02 mg/dl where the standard deviation was 25.23, the lowest score was 17 mg/dl and the highest score was 180 mg/dl.

Laboratory Results of LDL, HDL, Triglycerides, Total Cholesterol

Based on the results of univariate analysis, it was found that LDL levels in patients had a mean of 132.01 mg/dl, this result was included in the borderline high LDL category, with a median of 130 mg/dl, standard deviation of 51.85 and maximum and minimum values of 383 mg/dl and 35 mg/dl respectively. HDL levels in patients have a mean of 45.02 mg/dl, this data is included in the K-HDL high category, with a median of 40 mg/dl, standard deviation of 25.21, the highest score of 180 mg/dl and the highest score of 17 mg/dl.

Triglyceride and total cholesterol levels based on the results of univariate analysis, in patients obtained cholesterol levels have a mean of 174 mg/dl, where the standard deviation is 54.10, the highest score is 338 mg/dl and the lowest score is 90 mg/dl consecutively. While triglyceride levels in patients in this study obtained a mean of 162.04 mg/dl, where the standard deviation was 102.45, the highest score was 831 mg/dl and the lowest score was 56 mg / dl, the data can be observed in the table 2.

Table 2. Overview of Basic Characteristics of ACS Patient Laboratory Results

	Average	Standard deviation	Max	Min
Rate K-LDL (mg/dL)	132,01	51,85	383	35
Rate K-HDL (mg/dL)	45.02	25,23	180	17
Total Cholesterol Up (mg/dL)	174.38	54,10	338	90
Up to Triglyceride (mg/dL)	162.04	102,45	831	56

HDL/LDL Ratio in SKA Patients at RSUD Kota Bandung

Based on the results of bivariate analysis in this study, the ratio between LDL/HDL in ACS patients at RSUD Kota Bandung was obtained with a mean of 3.721, a median value of 3.039, a maximum value of 7.037, a minimum value of .251 and a standard deviation of 1.254. These data can be seen further in table 5, and using *Chi-Square testing* presents a significance level of 0.045 ($p < 0.05$), until it is found that there is a correlation between the HDL/LDL ratio and the incidence of ACS in patients at RSUD Kota Bandung. The results of the following research are not much different from Monika's research (2021) which explains that there is a correlation between the ratio of LDL/HDL with the incidence of ACS with the results of bivariate analysis *p=0,035.*

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Table 3. Comparative Overview of K-LDL/K-HDL in ACS Patients

	Average	Standard deviation	Median	Max	Min
K-LDL/K-HDL Comparison	3,271	1,254	3,039	7,037	0,215

Table 4. LDL:HDL Ratio Based on National Cholesterol Education Program

	Protective	Warning
Ratio LDL:HDL	< 2,5	More than equal to 2,6

Table 5. Chi-square Test of LDL/HDL Ratio Relationship to ACS Incidence

	ACS APTS		IMA-NEST		IMA-EST		Chi-square p-Value
	n	%	n	%	n	%	
Ratio LDL/HDL	61	63,5	21	21,9	14	14,6	0,045

Discussion

Gender

Most ACS sufferers are men totaling 63 individuals worth 65.6%. The following research is in line with research conducted by Monika Widi Sherina (2021) at Abdul Wahab Sjahranie Hospital Samarinda which shows that most ACS sufferers are men worth 80.4%. Research conducted [24] explained that the high hormone testosterone in men can add myocardial inflammation to have an impact on the stage of cardiac myocardial recovery, while in women the hormone estrogen acts to maintain protection in myocardial injury to guard against myocardial infarction. This is in line with the WHO presentation which explained that patients diagnosed with acute coronary syndrome are mostly experienced by men.

Smoke

Based on the results of the following research, the majority of smoking patients are 68 individuals as much as 70.8%. The following research is in line with research conducted by Maulidah which explained that there is a correlation between smoking and acute coronary syndrome events, which is worth 76.5%. Another research that is in line with the following research is research conducted by Muhibbah (2019) at RSUD Ulin Banjarmasin which states that most smoking subjects are 36 individuals from 51 ACS sufferers. Smoking behavior can cause acute coronary syndrome. Contaminants in tobacco can cause blood to clot which makes the mechanism of transporting oxygen needed by the body disrupted and the needs of the heart muscle increase due to plaque from these substances *(Cardiovascular Risk Factor 2015).* Another study by [25] also shows that there is a relationship between exposure to toxic substances in cigarettes that cause damage to the endothelium of blood vessels with unstable angina pectoris and can cause symptoms of chest pain.

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Age

As age increases, blood vessels continuously and gradually change which can have an impact on heart function [26]. According to other research conducted by [27] most of the age of patients with ACS is over 45 years old and is in line with the research carried out which found the majority of ACS sufferers are 55 years old.

Dyslipidemia

Dyslipidemia is one of the aspects that causes acute coronary syndrome in which the endothelium of blood vessels is damaged and causes an inflammatory response in SCS. Based on the results of research conducted by the author, a total of 96 individuals suffer from ACS. The following research results are in line with research [27]. Which shows the number of subjects suffering from dyslipidemia, namely 42 individuals from 51 ACS sufferers and based on research by Ghani et al., shows *that the number of people with abnormal lipid profiles causes more CHD incidence which is 85.6%* [28]. Based on theory and research, ACS has a significant relationship with high levels of LDL compared to HDL levels, as from the results of research conducted by [18], explained that there is a correlation between ACS and LDL levels where a score of p = 0.035 can be concluded that there is a correlation between ACS and high LDL levels. In theory, the results of the examination of high LDL levels above normal will result in atheroslecrosis plaque with narrowing of blood vessel arteries, which states that there is a correlation with ACS.

Cholesterol levels are also used as an initial screening to detect the presence of acute coronary syndrome. According to theory, it is said to be ACS if there are complaints of shortness of breath, chest pain, and the results of laboratory examination of cholestrol are increased. While HDL is in charge of carrying cholesterol back to the liver from blood vessels to be removed, to minimize the process of atherosclerosis. HDL (Good fat) is also a parameter that can be used to detect the presence of acute coronary syndrome if the HDL content is below the LDL content, the normal HDL level according to the *National Cholesterol Education Program* is 50 mg/dL, LDL/HDL ratio as a sensitive parameter of the risk of atherosclerosis disorders as a predictor for prognosis because together assess the content of HDL and LDL.

Table 6. Total Cholesterol, LDL, HDL and Triglyceride Values Based on National Cholesterol Education Program

	Normal	Borderline High Risk	Very High Risk
Total Cholesterol	<200 mg/dL	200-239 mg/dL	More than equal to 240 mg dL
LDL cholesterol	<130 mg/dL	130-159 mg/dL	More than equal to 240 mg dL
HDL cholesterol	More than equal to 50 mg dL	40-49 mg/dL	<40 mg/dL
Trigliserida	<200 mg/dL	200-399 mg/dL	More than equal to 400 mg dL

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Research Limitations

Based on the research process that has been carried out by the author, there are several obstacles and limitations when conducting research, including:

1) At the data selection stage, the author had difficulties in ethical licensing at the hospital that the researcher was going to, besides that the licensing process took a very long time.
2) The number of samples can be very limited.
3) The data obtained are not all samples have LDL *and HDL* cholesterol test results.
4) A lot of data cannot be used because there are some things missing, for example scattered data and unreadable writing.

CONCLUSION

Based on the description above, it can be concluded that there is a correlation between the K-LDL/K-HDL ratio and ACS events at RSUD Kota Bandung in 2019–2021, this result can be concluded because it obtained a p value = 0.045. First, the majority of ACS patients at RSUD Kota Bandung in 2019–2021 are men, 65.6% of the total patients. Second, as many as 70.8% of the total patients of this study were active smokers. Third, the type of ACS that dominated in this study patient was APTS with 63.5% of the total respondents. Fourth, the average age of patients in these patients was 55.70 years. Fifth, the average ratio of LDL/HDL to ACS sufferers at RSUD Kota Bandung in 2019-2022 is 3,271. Sixth, the maximum and minimum values of LDL/HDL ratio in ACS patients at RSUD Kota Bandung in 2019 - 2022 are 7.037 and 0.215.

REFERENCES

[1] N. D. Wong, “Epidemiological studies of CHD and the evolution of preventive cardiology,” *Nat. Rev. Cardiol.*, vol. 11, no. 5, pp. 276–289, 2014.
[2] Organização Mundial de Saúde., “World health statistics 2022 (Monitoring health of the SDGs),” *Monit. Heal. SDGs.*, 2022.
[3] A. P. Sunjaya, A. F. Sunjaya, and A. Priyana, “Insights and challenges of indonesia’s acute coronary syndrome telecardiology network: three year experience from a single center and in west Jakarta, Indonesia,” in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2019, p. 12142.
[4] J. Q. Xu, S. L. Murphy, K. D. Kochanek, and E. Arias, “Mortality in the United States, 2018. NCHS Data Brief, no 355. Hyattsville, MD: National Center for Health Statistics. 2020.” 2021.
[5] A. Maharani, Sujarwoto, D. Praveen, D. Oceandy, G. Tampubolon, and A. Patel, “Cardiovascular disease risk factor prevalence and estimated 10-year cardiovascular risk scores in Indonesia: The SMARThealth Extend study,” *PLoS One*, vol. 14, no. 4, p. e0215219, 2019.
[6] T. Ryan, Cooper, *Profil Kesehatan Indonesia 2020*. Paper Knowledge . Toward a Media History of Documents., 2020.

[7] A. R. Ekaputra, M. R. Akbar, and L. A. Garina, "Hubungan Indeks Massa Tubuh dengan Fraksi Ejeksi Ventrikel Kiri pada Pasien Sindrom Koroner Akut," *Pros. Pendidik. Dr.*, pp. 760–765, 2015.
[8] J. Brier, "lia dwi jayanti,"," *Implmentasi Layanan Deliv. Libr. Search. Serv. Sebagai Layanan Ref. Virtual Perpust. Univ. Syiah Kuala," Libr.*, vol. 21, no. 1, pp. 1–9, 2020.
[9] T. P. Varghese and A. V Kumar, "Predisposing risk factors of acute coronary syndrome (ACS): A mini review," *J. Pharm. Sci. Res.*, vol. 11, no. 5, pp. 1999–2002, 2019.
[10] R. Hajar, "Risk factors for coronary artery disease: historical perspectives," *Hear. views Off. J. Gulf Hear. Assoc.*, vol. 18, no. 3, p. 109, 2017.
[11] S. S. Virani *et al.*, "Heart disease and stroke statistics—2020 update: a report from the American Heart Association," *Circulation*, vol. 141, no. 9, pp. e139–e596, 2020.
[12] G. H Tomkin and D. Owens, "LDL as a cause of atherosclerosis," *Open Atheroscler. Thromb. J.*, vol. 5, no. 1, 2012.
[13] T. Quertermous and E. Ingelsson, "Coronary artery disease and its risk factors: leveraging shared genetics to discover novel biology," *Circulation Research*, vol. 118, no. 1. Am Heart Assoc, pp. 14–16, 2016.
[14] lia dwi jayanti. L. S. L. Brier J, *Pathophysiology of Heart Disease 5*. 2022.
[15] W. Hao and A. Friedman, "The LDL-HDL profile determines the risk of atherosclerosis: a mathematical model," *PLoS One*, vol. 9, no. 3, p. e90497, 2014.
[16] N. Uppal, V. Uppal, and P. Uppal, "Progression of coronary artery disease (CAD) from stable angina (SA) towards myocardial infarction (MI): role of oxidative stress," *J. Clin. diagnostic Res. JCDR*, vol. 8, no. 2, p. 40, 2014.
[17] Á. Hernáez *et al.*, "Role of HDL function and LDL atherogenicity on cardiovascular risk: A comprehensive examination," *PLoS One*, vol. 14, no. 6, p. e0218533, 2019.
[18] Á. Hernáez Camba *et al.*, "Role of HDL function and LDL atherogenicity on cardiovascular risk: A comprehensive examination," *PLoS One, 2019, vol. 14, num. 6, p. e0218533*, 2019.
[19] D. Li and J. L. Mehta, "Oxidized LDL, a critical factor in atherogenesis," *Cardiovascular research*, vol. 68, no. 3. Elsevier Science, pp. 353–354, 2005.
[20] Z. Zhong *et al.*, "Assessment of the LDL-C/HDL-C ratio as a predictor of one year clinical outcomes in patients with acute coronary syndromes after percutaneous coronary intervention and drug-eluting stent implantation," *Lipids Health Dis.*, vol. 18, no. 1, pp. 1–8, 2019.
[21] N. Kurebayashi *et al.*, "Impact of the low-to high-density lipoprotein cholesterol ratio on composition of angiographically ambiguous left main coronary artery plaque," *Circ. J.*, vol. 75, no. 8, pp. 1960–1967, 2011.
[22] E. A. Amsterdam *et al.*, "2014 AHA/ACC guideline for the management of patients with non–ST-elevation acute coronary syndromes: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines," *Circulation*, vol. 130, no. 25, pp. 2354–2394, 2014.
[23] R. S. Rosenson, H. B. Brewer, and D. J. Rader, "Lipoproteins as biomarkers and

therapeutic targets in the setting of acute coronary syndrome," *Circ. Res.*, vol. 114, no. 12, pp. 1880–1889, 2014.

[24] S. Chou, C. W. Chen, and Y. T. Kuo, "Flexibility, collaboration and relationship quality in the logistics service industry: An empirical study," *Asia Pacific J. Mark. Logist.*, vol. 30, no. 3, pp. 555–570, 2018, doi: 10.1108/APJML-08-2017-0170.

[25] F. de Galiza Barbosa *et al.*, "Genitourinary imaging," in *Clinical PET/MRI*, Elsevier, 2023, pp. 289–312.

[26] Y. Pan, S. Sheng, and F. T. Xie, "Antecedents of customer loyalty: An empirical synthesis and reexamination," *J. Retail. Consum. Serv.*, vol. 19, no. 1, pp. 150–158, 2012, doi: 10.1016/j.jretconser.2011.11.004.

[27] J. A. Fernandez-Higuero, A. M. Salvador, C. Martín, J. C. G. Milicua, and J. L. R. Arrondo, "Human LDL structural diversity studied by IR spectroscopy," *PLoS One*, vol. 9, no. 3, p. e92426, 2014.

[28] T. Hevonoja, M. O. Pentikäinen, M. T. Hyvönen, P. T. Kovanen, and M. Ala-Korpela, "Structure of low density lipoprotein (LDL) particles: basis for understanding molecular changes in modified LDL," *Biochim. Biophys. Acta (BBA)-Molecular cell Biol. lipids*, vol. 1488, no. 3, pp. 189–210, 2000.