Frontiers in Health InformaticsISSN-Online: 2676-7104 www.healthinformaticsjournal.com
2024; Vol 13: Issue 3 Open Access

Relationship between total cholesterol and HDL ratio and Lipid Profile in predicting stroke in overweight apple and pear shape individuals

Rahayu Anggraini[1]*, Firdaus[2], Hanifiyatul Millah[1]
[1]*Faculty of Health, Universitas Nahdlatul Ulama Surabaya, 60237 Surabaya, East Java, Indonesia*
[2]*Faculty of Nursing and Midwifery, Universitas Nahdlatul Ulama Surabaya, 60237 Surabaya, East Java, Indonesia.*
*Corresponding author: anggrek@unusa.ac.id

Cite this paper as: Rahayu Anggraini, Firdaus, Hanifiyatul Millah (2024) Relationship between total cholesterol and HDL ratio and Lipid Profile in predicting stroke in overweight apple and pear shape individuals. *Frontiers in Health Informatics, 13* (3), 7249-7258

Abstract

Stroke is still an unresolved health problem. The Indonesian Ministry of Health obtained data that stroke turned out to be the most common cause of death in people over 45 years old, which amounted to 15.4 percent. Ischemic stroke has many risk factors, one of which is hypercholesterolemia. However, when viewed from an increase in the ratio of total cholesterol to HDL, this is a very strong predictor of stroke risk. The aim of this study was to evaluate the ratio of total cholesterol and HDL in individuals with apple and pear body shapes with overweight (BMI 25-30). Analytical observational research methods in 15 apple body shape patients and 15 pear body shape patients, then examined the levels of total cholesterol, triglycerides, LDL cholesterol, and HDL by colorimetric enzymatic end point method using a photometer. The results of the characteristics of respondents, aged 46-55 years, the most, namely 12/30 (40%). Based on gender, most were female as many as 24/30 (80%). The average total cholesterol level of apple shape is 225 mg/dL, and pear shape is 213.6 mg/dL. The average LDL cholesterol level of apple shape was 211 mg/dL and pear shape was 145 mg/dL. The average HDL cholesterol level of the apple shape was 44 mg/dL and the pear shape was 44.5 mg/dL. The average triglyceride level of the apple shape was 160 mg/dL, and the pear shape was 120.7 mg/dL. The average ratio of total cholesterol to HDL of the apple form was 5.8, and that of the pear form was 5.1. Spearman correlation test between the ratio of apple total cholesterol to HDL apple with total cholesterol p=0.000 (p<0.050), with triglycerides p=0.324 (p>0.050), with HDL p=0.055 (p>0.050), with LDL p=0.023 (p<0.050). The results of the ratio of pear total cholesterol to pear HDL with total cholesterol p=0.000 (p<0.050), with triglycerides p=0.021 (p<0.050), with HDL p=0.000 (P<0.050), with LDL p=0.000 (p<0.050). In conclusion, looking at the ratio of total cholesterol to HDL in apple body shape can predict the occurrence of stroke because it shows a risk in total cholesterol and LDL levels, while in pear body shape can predict the occurrence of stroke because all dyslipidemia parameters are abnormal.

Keywords: *Ratio of total cholesterol to HDL; Stroke prediction; Dyslipidemia; Apple and Pear shape; Overweight individuals.*

Introduction

According to World Stroke Organization data, there are 13.7 new cases of stroke each year and around 5.5 million deaths.(1) Based on Basic Health Research (Riskesdas 2018), the prevalence of hypertension in Indonesia was 34.1%, an increase compared to the prevalence of hypertension in Riskesdas 2013 of 25.8%.

Meanwhile, stroke cases increased from 12.1% in 2020 to 14.9% in 2021. (2)Stroke is still a health problem. In developing countries stroke is the third highest cause of death after heart disease and cancer. According to data from the Indonesian Ministry of Health, stroke is the first cause of death in hospitals. Stroke has two classifications, namely ischemic stroke and hemorrhagic stroke.(3) Ischemic stroke has many risk factors, one of which is high cholesterol levels in the blood or can be referred to as hypercholesterolemia. (3)
Hypercholesterolemia can cause blockages and atherosclerosis. Atherosclerosis is formed due to damage to the endothelium caused by high blood pressure, smoking, or high amounts of cholesterol, which can interfere with endothelial function. In preventing atherosclerosis, HDL and antioxidants play a role in the oxidative stress stage where HDL reduces oxidation of LDL and VLDL. (4) HDL as anti-thrombotic plays a role in preventing calcification and fibrosis, so that the elasticity and diameter of blood vessels are maintained. Hypercholesterolemia condition is an increase in total cholesterol levels accompanied by an increase in Low Density Lipoprotein (LDL) and a decrease in High Density Lipoprotein (HDL) levels, so that the ratio between total cholesterol levels to HDL will increase. (5)The ratio is a comparison between total cholesterol and HDL. The normal value is less than 4.6 for men and less than 4.0 for women. The higher the ratio of total cholesterol to HDL, the higher the risk of atherosclerosis which can lead to ischemic stroke. (3,6)
The World Health Organization (WHO) defines stroke as a clinical syndrome with symptoms of globally impaired brain function that can cause death or abnormalities that persist for more than 24 hours, without any other cause except vascular disorders that can cause reduced mobility due to decreased muscle strength. Stroke is the second leading cause of death worldwide. Stroke accounts for 23.48% of all deaths in Indonesia.(1,7)

The results of Oktavia's research, in 2021, the average ratio of total cholesterol / HDL levels in obesity groups I and II was 5.13 and 4.80 ($p = 0.93$). The correlation showed a very weak positive ($r=0.12$) and statistically insignificant ($p=0.35$). (8) The results of Sumarni's research in 2016, there was a significant difference in waist circumference in obese adults and non-obese adults ($p<0.001$), while lipid profile levels in obese and non-obese groups were not statistically different ($p>0.05$). Bivariate correlation analysis showed a significant positive correlation between waist circumference with total cholesterol, ($r = 0.342$; $p = 0.005$) and triglycerides ($r = 0.377$; $p = 0.002$), to the TG/HDL ratio ($r = 0.280$, $p = 0.022$). (9) From the results of these two studies, the researcher wants to prove how much the ratio of total cholesterol to HDL to lipid profile (total cholesterol, triglycerides, LDL, and HDL) in overweight apple and pear shape individuals.

Materials and Methods

2.1 Respondents who have met the inclusion criteria with a Body Mass Index (BMI) of between 25-30, were examined for apple and pear body shapes in the following way, if there is fat accumulation focused on the upper part around the chest and abdomen that will make the body look like an apple, while fat accumulation around the lower abdomen, thighs, and buttocks will cause the body to look like a pear. Then the respondent's blood was drawn on the arm, then the blood was centrifuged for serum. Serum is intended for lipid profile examination, namely total cholesterol, triglyceride, LDL, and HDL levels. The four were examined enzymatically colorimetric with a photometer and Glory reagent. (10)

2.2 Quantitative measurement of total Cholesterol in serum by Glory Kit. Mono reagent was prepared at room temperature, then into each tube that has been labelled (blank, standard, sample), all tubes are inserted 1000 µL Mono reagent, then in the blank tube contains only Mono reagent, standard tube filled with 10 µL Standard with a level of 200 mg/dL, sample tube filled with 10 µL of serum with unknown levels. The tubes that have been filled with these materials, mixed evenly, then incubated at 37oC for 5 minutes or at room temperature for 10 minutes. Using the BTS-310 photometer endpoint method, each tube was measured for cholesterol levels starting from blank, standard, then sample at a wavelength of 546 nm.(11)

2.3 Quantitative measurement of triglycerides in serum by Glory Kit. Mono reagent was prepared at room temperature, then into each tube that has been labelled (blank, standard, sample), all tubes are inserted 1000 µL Mono reagent, then in the blank tube contains only Mono reagent, standard tube filled with 10 µL Standard with a level of 200 mg/dL, sample tube filled with 10 µL of serum with unknown levels. The tubes that have been filled with these materials, mixed evenly, then incubated at 37oC for 5 minutes or at room temperature for 15 minutes. Using the BTS-310 photometer endpoint method, each tube was measured for Triglycerides starting from blank, standard, then sample at a wavelength of 546nm.(11)

2.4 Quantitative measurement of HDL-cholesterol in serum by Glory Kit. Precipitating reagent, HDL-cholesterol standard, Mono reagent Cholesterol were prepared at room temperature, then precipitation was carried out (precipitating total cholesterol, triglycerides, and LDL-cholesterol) into each standard and sample tube inserted 400 µL Precipitating reagent each, then 200 µL standard and sample were inserted respectively, then incubated 10 minutes at room temperature for 10 minutes and then centrifuged 4000rpm for 10 minutes, then separated the supernatant. The tubes that have been labelled (blank, standard, sample), then all tubes are inserted 1000 µL of Cholesterol Mono reagent, then the blank tube only contains Mono reagent, the standard tube is filled with 50 µL of Standard supernatant with a level of 50 mg/dL, the sample tube is filled with 50 µL of serum supernatant of unknown level. The tubes that have been filled with these materials, mixed evenly, then incubated at 37oC for 5 minutes or at room temperature for 10 minutes. Using the BTS-310 photometer endpoint method, each tube was measured for HDL-cholesterol levels starting from blank, standard, then sample at a wavelength of 546nm.(11)

2.5 Quantitative measurement of LDL cholesterol in serum using the Friedel wald formula (Total Cholesterol-(TG/5)-HDL Cholesterol)(12)

Results

2. Results

Characteristics of Respondents

2.1 Identification of age and gender in overweight individuals

Table 2.1 Distribution of overweight Respondents Overweight Respondents

Characteristic	Total	Percentage (%)
Age		
26 – 33 years	7	23.3
34 – 40 years	1	3.3
41 – 47 years	6	20
48 – 54 years	12	40
55 – 61 years	2	6.7
62 – 68 years	2	6.7
Total	30	100

Gender		
Male	6	20
Female	24	80
Total	30	100

Source: Primary data, 2024

Table 1 shows that the majority of respondents were aged 48-54 years, 40% (12/30). The gender of the respondents was mostly female, 80% (24/30).

2.2 Identifying the distribution of total cholesterol levels in overweight apple and pear-shaped individuals

Table 2.2a Distribution of total Cholesterol levels in overweight apple-shaped individuals

Cholesterol total levels	Total	Percentage (%)
<200 mg/dL (Normal)	4	24.7
>200 mg/dL (Abnormal)	11	73.3
Total	15	100

Source: Primary Data, 2024

Table 2.2b Distribution of Cholesterol levels in pear-shaped overweight individuals

Cholesterol total levels	Total	Percentage (%)
<200 mg/dL (Normal)	7	46.7
>200 mg/dL (Abnormal)	8	53.3
Total	15	100

Source: Primary Data, 2024

The results showed that abnormal total cholesterol levels (>200 mg/dL) were seen in 73.3% (11/15) of overweight apple-shaped individuals, while abnormal total cholesterol levels (>200 mg/dL) in overweight pear-shaped individuals were seen in 53.3% (8/15).

2.3 Identify the distribution of triglyceride levels in apple- and pear-shaped overweight individuals.

Table 2.3a Distribution of Triglyceride levels in apple-shaped overweight individuals

Triglyceride levels	Total	Percentage (%)
<150 mg/dL (Normal)	13	86.7
150-200 mg/dL (Normal high)	2	13.3
>200 mg/dL (Abnormally)	0	100
Total	15	

Source: Primary Data, 2024

Table 2.3b Distribution of Triglyceride levels in pear-shaped overweight individuals

Triglyceride levels	Total	Percentage (%)
<150 mg/dL (Normal)	12	80
150-200 mg/dL (Normal high)	2	13.3
>200 mg/dL (Abnormally)	1	7.7
Total	15	100

Source: Primary Data, 2024

The results showed that normal triglyceride levels (<150 mg/dL) were seen in 86.7% (13/15) of overweight apple-shaped individuals, while normal triglyceride levels (<150 mg/dL) were seen in 80% (12/15) of overweight pear-shaped individuals.

3 Identification of the distribution of LDL cholesterol levels in apple- and pear-shaped overweight individuals

Table 2.4a Distribution of LDL cholesterol levels in apple-shaped overweight individuals

LDL-cholesterol levels	Total	Percentage (%)
<100 mg/dL (Normal)	2	13.3
100-129 mg/dL (Normal high)	2	13.3
130-159 mg/dL (Abnormally low)	5	33.4
160-190 mg/dL (moderate abnormal)	3	20
>190 mg.dL (abnormally high)	3	20
Total	15	100

Source: Primary Data, 2024

Table 2.4b Distribution of LDL cholesterol levels in pear-shaped overweight individuals

LDL-cholesterol levels	Total	Percentage (%)
<100 mg/dL (Normal)	3	20
101-129 mg/dL (Normal high)	3	20
130-159 mg/dL (Abnormally low)	4	26.7
160-190 mg/dL (moderate abnormal)	2	13.3
>190 mg.dL (abnormally high)	3	20
Total	15	100

Source: Primary Data, 2024

The results showed that normal LDL cholesterol levels (<130 mg/dL) were observed in 26% (4/15) of overweight apple-shaped individuals, while normal LDL cholesterol levels (<130 mg/dL) were observed in 40% (6/15) of overweight pear-shaped individuals.

4 Identification of the distribution of HDL cholesterol levels in apple- and pear-shaped overweight individuals

Table 2.5a Distribution of HDL cholesterol levels in apple-shaped overweight individuals

HDL-cholesterol levels	Total	Percentage (%)
<45 mg/dL (Abormal)	6	40
45-60 mg/dL (Normal high)	9	60
>60 mg/dL (Normal)	0	0
Total	15	100

Source: Primary Data, 2024

Table 2.5b Distribution of HDL-cholesterol levels in overweight pear shape individuals

HDL-cholesterol levels	Total	Percentage (%)
<45 mg/dL (Abormal)	8	53.3
45-60 mg/dL (Normal high)	6	40
>60 mg/dL (Normal)	1	6.7
Total	15	100

Source: Primary Data, 2024

The results showed that abnormal HDL cholesterol levels (<45 mg/dL) were observed in 40% (6/15) of overweight apple-shaped individuals, while abnormal HDL cholesterol levels (<45 mg/dL) were observed in 53.3% (8/15) of overweight pear-shaped individuals.

5 Test the normality and homogeneity of research data

Table 2.6. Shapiro-Wilk test on Total/HDL Cholesterol Ratio, Total Cholesterol, Triglycerides, LDL Cholesterol, HDL Cholesterol in overweight individuals with apple and pear body shapes

Parameters	Statistic Shapiro-Wilk	df	Sig
hsCRP Apple	0.662	15	0.000
hsCRP Pear	0.764	15	0.001
Chol Apple	0.981	15	0.977
Chol Pear	0.895	15	0.080
TG Apple	0.422	15	0.000
TG Pear	0.822	15	0.007
HDL Apple	0.902	15	0.104
HDL Pear	0.906	15	0.118
LDL Apple	0.531	15	0.000
LDL Pear	0.910	15	0.136

7. Non parametric statistical test of Spearman's Rho Correlation in individuals with overweight apple and pear body shapes

Tabel 2.7a Spearman Correlation Analysis on 15 apple-shaped overweight people

Spearman's rho		Rasio Chol/HDL	Chol Apple	TG Apple	HDL Apple	LDL Apple
Rasio CoefficientChol/HDL Apple	Correlation	1.000	0.818	0.273	-0.504	0.582
	Sig. (2-tailled)	.	**0.000**	0.324	0.055	**0.023**
	N	15	15	15	15	15

The results of Spearman's rho analysis in Table 2.7a show that the Spearman's rho correlation between the ratio of total cholesterol and HDL cholesterol compared to total cholesterol in the apple type with a relationship strength (rs) of 0.818 and p=0.000 (p<0.050), there is a relationship in individuals with apple type overweight. This means that when the ratio of total cholesterol and HDL levels increases, the total cholesterol level also increases. Spearman correlation between the ratio of total cholesterol and HDL cholesterol compared to LDL cholesterol in apple type with the strength of the relationship (rs.) 0.582 and p=0.023 (p<0.050), there is a relationship in individuals with apple type overweight body shape. This means that when the ratio of total and HDL cholesterol levels increases, LDL levels also increase.

Tabel 2.7b Spearman Correlation Analysis on 15 pear-shaped overweight individuals

Spearman's rho		Rasio Chol/HDL	Chol Apple	TG Apple	HDL Apple	LDL Apple
Rasio Chol/HDL Pear	Correlation Coefficient	1.000	0.913	0.589	-0.900	0.926
	Sig. (2-tailled)	.	**0.000**	**0.021**	**0.000**	**0.000**
	N	15	15	15	15	15

The results of Spearman's rho analysis in Table 2.7b show that the Spearman's rho correlation between the ratio of total cholesterol and HDL compared to total cholesterol in pear type with the strength of the relationship (rs) 0.931 and p=0.000 (p<0.050), there is a relationship in individuals with pear body shape who are overweight. This means that when the ratio of total cholesterol and HDL levels increases, the total cholesterol level also increases. Spearman correlation between the ratio of total cholesterol and HDL compared to triglycerides in pear type with the strength of the relationship (rs.) 0.589 and p=0.021 (p<0.050), there is a relationship in individuals with overweight pear type. This means that when the ratio of total cholesterol and HDL levels increases, TG levels also increase. Spearman correlation between the ratio of total cholesterol and HDL compared to HDL in pear type with the strength of the relationship (rs.) - 0.900 and p=0.000 (p<0.050), there is a relationship in overweight individuals of pear type. This means that when the ratio of total cholesterol and HDL levels increases, HDL levels decrease. Spearman correlation between the ratio of total cholesterol and HDL compared to LDL in pear type with the strength of the relationship (rs.) 0.926 and p=0.000 (p<0.050), there is a relationship in overweight individuals of pear type. That is, when the ratio of total cholesterol and HDL levels increases, LDL levels also increase.

Discussion

The characteristics of respondents in terms of gender were mostly female, namely 80% (24/30). This is similar to the results of research from Brandt, 2023 which states that there are some significant gender differences on certain cognitive tests, where women outperform men on scores from the Rey Auditory Verbal Learning Test (ps < 0.01). (13)

According to Ekowatiningsih, 2014, unhealthy lifestyles put young individuals between 18 and 45 years old at risk of stroke. In addition to eating high-cholesterol foods and lack of exercise, smoking, stress, diabetes mellitus, obesity, and hypertension greatly support the incidence of stroke. This statement is in accordance with the results of this study that the age of overweight people is mostly between 26-54 years old, those aged between 26-33 years are 23.3%, 41-47 are 20% and 48-54 are 40%. (14)
Numerous studies have shown that abnormal cholesterol levels are associated with a high attributable risk for cardiovascular disease (CVD).

The results of the De Louis study, 2021, stated that in this menopausal obese population, the parameters of adiposity, blood pressure, fasting glucose, insulin, HOMA-IR, C reactive protein, total cholesterol, LDL cholesterol, and triglycerides were carried out in both genotype groups (CC vs. CT+TT). HDL cholesterol (8.5+1.2 mg/dl; p=0.01) and total cholesterol/HDL cholesterol ratio (0.5±0.2; p=0.04) were higher in T allele carriers. (15) When considered with the results of this study in apple-shaped overweight individuals there is no relationship with HDL, but there is a relationship with total cholesterol and LDL, while in pear-type overweight individuals, there is a relationship between the ratio of total cholesterol/HDL with HDL with a strong relationship of 0.900 and a p value of 0.000 (p <0.050), it is possible that the body shape in the De Louis study is mostly pear-shaped overweight individuals.

The results of the Quispe, 2020 study found no significant relationship between individuals with LDL cholesterol and non-HDL cholesterol less than the median, 26% and 21% had inappropriate TC/HDL cholesterol at or above the median, respectively. These individuals had a 24% (hazard ratio (HR) 1.24, 95% confidence

interval (CI) 1.09, 1.41) and 29% (HR 1.29, 95% CI 1.13, 1.46) greater risk of atherosclerotic cardiovascular disease events, respectively, compared to those with TC/HDL-cholesterol less than the median after multivariable adjustment. (15) Another case with the results of Khusnulzan's research in 2018 there is a strong relationship between the ratio of total cholesterol / high density lipoprotein cholesterol (HDL) and Peripheral Arterial Disease (PAP). While the Ankle brachial index (ABI) is the ratio between systolic blood pressure in the lower leg and upper arm and is a non-invasive screening test to detect the occurrence of this PAP. (16) From the results of this study in which overweight individuals with pear type in all four lipid profile parameters were significantly associated with the total cholesterol/HDL ratio. This is likely because the study subjects were overweight individuals not due to different intakes as in Sunu's study where there was a significant relationship between physical activity and the ratio of total cholesterol / HDL ($p = 0.038$; 95% CI: 0.98-61.33), dietary allowances of the macronutrient energy and the ratio of total cholesterol / HDL ($p = 0.068$), protein intake to the ratio of total cholesterol / HDL ($p = 1.000$), fat intake to the ratio of total cholesterol / HDL ($p = 0.081$), and the intake of carbohydrates to the ratio of total cholesterol / HDL ($p = 0.088$) because the type of intake does not necessarily cause hypercholesterolemia which affects the incidence of stroke (17).

Conclusion

The age distribution in this study was mostly in 48-54 years by 40% (12/30), and the most female gender by 80% (24/30).
From the results of the Spearman correlation between the ratio of total cholesterol and HDL cholesterol compared to total cholesterol and LDL in apple shape, there is a relationship in overweight apple shape individuals. Its mean when Ratio Total cholesterol and HDL levels increase, total cholesterol and LDL levels also increase. Spearman's correlation between the ratio of total cholesterol and HDL cholesterol compared to total cholesterol, triglycerides, HDL, and LDL cholesterol in pear type, there is a relationship in overweight apple shape individuals. Its mean when Ratio Total cholesterol and HDL levels increase, total cholesterol, Triglycerides, and LDL levels increase, but HDL levels decrease. So the effect of the ratio of total cholesterol and HDL, greatly affects the lipid profile levels in pear type compared to apple type. For future researchers, it is recommended that fasting blood glucose, HBA1c or Insulin be examined to determine the tendency of overweight individuals to increase disorders towards the pancreas to cause insulin inactivation disorders.

Author contributions

Rahayu Anggraini: Conceptualization- Methodology- Data curation- Writing- Preparation of initial draft- Visualization- Investigation. Firdaus: Supervision- Software- Validation; Hanifiyatul Millah: Writing- Review and Editing.

Conflict of Interest

There is no conflict of interest.

Acknowledgment(s)

Thank you to Universitas Nahdlatul Ulama Surabaya for providing the opportunity to conduct research.

References

1. WHO. Raised cholesterol. Word Health Organization. 2022;
2. Nuraini B. Risk Factors of Hypertension. J Majority. 2015;4(5).

3. Tawadros A, Bhurwal A, Reja D, Pioppo L, Makar M, Kabaria S, et al. Mo1509 NAFLD AND ISCHEMIC STROKE: PREVALANCE AND EFFECTS ON OUTCOMES. Gastroenterology. 2020;158(6).

4. Guijarro C, Cosín-Sales J. LDL cholesterol and atherosclerosis: The evidence. Clinica e Investigacion en Arteriosclerosis. 2021;33.

5. Anggriyani N, Wijayahadi N, Miokard I. EFEK REMOTE ISCHEMIC PRECONDITIONING TERHADAP KADAR. jurnal kedokteran diponegoro. 2016;5(4).

6. Calling S, Johansson SE, Wolff M, Sundquist J, Sundquist K. Total cholesterol/HDL-C ratio versus non-HDL-C as predictors for ischemic heart disease: a 17-year follow-up study of women in southern Sweden. BMC Cardiovasc Disord. 2021;21(1).

7. Carrillo-Larco RM, Guzman-Vilca WC, Bernabe-Ortiz A. Who is getting screened for diabetes according to body mass index and waist circumference categories in Peru? a pooled analysis of national surveys between 2015 and 2019. PLoS One. 2021;16(8 August).

8. Oktavia N, Nasrul E, Efrida E. Korelasi Kadar Protein C-Reaktif dengan Rasio Kolesterol Total / HDL pada Penyandang Obes di RSUP Dr M Djamil Padang. Jurnal Kesehatan Andalas. 2021;10(2).

9. Sumarni S. HUBUNGAN ANTARA LINGKAR PINGGANG DAN DERAJAT LEMAK VISERAL DENGAN RESISTENSI INSULIN PADA DEWASA OBES. Healthy Tadulako. 2017;3(1).

10. Koley S, Sur A. Association of Lipid Profile Parameters with High-Sensitive C–reactive Protein (hsCRP) in Patients with Dyslipidemia. Ann Med Health Sci Res. 2018;8(1).

11. Ekayanti IGAS. ANALISIS KADAR KOLESTEROL TOTAL DALAM DARAH PASIEN DENGAN DIAGNOSIS PENYAKIT KARDIOVASKULER. International Journal of Applied Chemistry Research. 2020;1(1).

12. Rahayu C, Agriyanti A. Perbedaan Hasil Pemeriksaan Ldl Direk (Metode Homogen) Dengan Indirek (Formula Friedewald) Pada Pasien Penderita Dislipidemia Di Rumah Sakit Islam Jakarta Cempaka Putih. Anakes : Jurnal Ilmiah Analis Kesehatan. 2019;5(1).

13. Brandt E, Singh S, Bowren M, Bhagvathi A, Tranel D, Boes AD. The role of gender in cognitive outcomes from stroke. Journal of the International Neuropsychological Society. 2023;29(9).

14. Ekowatiningsih D, Arifuddin. Hubungan Tingkat Pengetahuan dan Gaya Hidup Dengan Upaya Pencegahan Stroke Pada Penderita Hipertensi Di Ruang Rawat Jalan RSU. Haji Kota Makassar. Jurnal Ilmiah Kesehatan Diagnosis. 2014;4(5).