Cardiology and Cardiovascular Research
2022; 6(1): 39-44
http://www.sciencepublishinggroup.com/j/ccr
doi: 10.11648/j.ccr.20220601.16
ISSN: 2578-8906 (Print); ISSN: 2578-8914 (Online)

Evaluation of Lipid Profile on Hypertensive Patients: An Observational Study from North Sulawesi, Indonesia

Diana Shintawati Purwanto[1, 2, *], Yanti Meilen Mewo[1], Edmond Leonard Jim[3]

[1]Department of Biochemistry, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia

[2]Department of Clinical Laboratory, R. D Kandou Central General Hospital, Manado, Indonesia

[3]Department of Cardiovascular Medicine, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia

Email address:

dianashintapurwanto@unsrat.ac.id (D. S. Purwanto)

[*]Corresponding author

To cite this article:

Diana Shintawati Purwanto, Yanti Meilen Mewo, Edmond Leonard Jim. Evaluation of Lipid Profile on Hypertensive Patients: An Observational Study from North Sulawesi, Indonesia. *Cardiology and Cardiovascular Research.* Vol. 6, No. 1, 2022, pp. 39-44.
doi: 10.11648/j.ccr.20220601.16

Received: March 1, 2022; **Accepted**: March 24, 2022; **Published**: March 31, 2022

Abstract: Hypertension is a major cause of premature death worldwide and a risk factor for cardiovascular disease (CVD). The prevalence of hypertension in Indonesia is 34.11%, and about 95% of hypertension in Indonesia is essential hypertension of unknown cause and multifactorial. Dyslipidemia is characterized by an increase or decrease in the lipid fraction in plasma. Patients with hypertension who are accompanied by dyslipidemia have a risk of 18.1 times more likely to develop coronary heart disease than those without dyslipidemia. This study aimed to determine the prevalence and relationship between lipid profile levels and blood pressures of hypertensive patients in North Sulawesi, Indonesia. This was a cross-sectional study conducted on 132 inpatients and outpatients with hypertension. Physical examinations including systolic and diastolic blood pressure (SBP, DBP) and body mass index (BMI) were performed. Fasting lipids including total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C) were evaluated. Overall, 79.5% of the subjects had dyslipidemia, and more prevalent in females and over 45 years of age. The most common type of dyslipidemia observed was hypercholesterolemia (51.5%), followed by high LDL-C (34.1%), elevated TG (31.8%), and low HDL-C (31.1%). There were statistically significant correlations found between lipid profiles and other cardiovascular risk factors only in females, namely a positive correlation between LDL-C and DBP and a negative correlation between HDL-C and age. As conclusion, the prevalence of dyslipidemia in this study was high. A statistically significant positive correlation between lipid profile and blood pressures was found only in females.

Keywords: Hypertension, Dyslipidemia, Blood Pressures

1. Introduction

Hypertension is a major cause of premature death worldwide and a risk factor for cardiovascular disease (CVD) [1]. Cardiovascular disease causes approximately 80% of deaths and 87% of disabilities in low- and middle-income countries [2]. Based on the Indonesian Basic Health Research in 2018, the prevalence of hypertension in Indonesia is 34.11% and particularly for North Sulawesi province is 33.12% [3]. Many adult patients with hypertension have other risk factors for CVD, one of which is dyslipidemia [4]. Dyslipidemia is characterized by an increase or decrease in the lipid fraction in plasma. The main lipid fraction abnormalities are increase in total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and triglycerides (TG), and a decrease in high density lipoprotein cholesterol (HDL-C). Patients with hypertension who are accompanied by disorders of lipid metabolism or dyslipidemia have a risk of 18.1 times more likely to develop coronary heart disease than those without dyslipidemia [5].

A study by Choudhury *et al.* (2014) proved that hypertensive patients were more likely to exhibit dyslipidemia than normotensive patients [6]. Nayak *et al.* (2016) reported a significant increase in the levels of TC, LDL-C, and TG in

hypertensive patients compared to the control group [7]. Lipid profile abnormalities and uncontrolled blood pressure predispose to other cardiovascular diseases [8].

About 95% of hypertension in Indonesia is essential hypertension of unknown cause and multifactorial [9]. Regular measurement of lipid profile is very important for hypertensive patients, to prevent cardiovascular disease, stroke, and other comorbidities. This study aimed to determine the prevalence and relationship between lipid profile levels and blood pressures of hypertensive patients in North Sulawesi, Indonesia. The results of this study are expected to provide information so that interventions can be carried out as early as possible to reduce the mortality rates due to hypertension and cardiovascular disease.

2. Material and Methods

2.1. Study Design

This cross-sectional study was conducted at Noongan Regional General Hospital, Minahasa Regency, North Sulawesi, Indonesia during May-August 2021. This study was approved by the Medical Research Ethics Committee of R. D. Kandou General Hospital (No. 078/EC/KEPK-KANDOU/V/2021). Written informed consent was taken from all subjects. Populations were all inpatients and outpatients with hypertension.

2.2. Measurements

Physical examinations including systolic and diastolic blood pressure (SBP, DBP) and body mass index (BMI) were performed. Blood pressure measurement was measured two times of the selected subjects with mercury sphygmomanometer, and the average of two reading scores was used. The height was measured with a stadiometer (cm) and weight was measured with a weighing scale (kg). The patients' BMI values were calculated using the formula of weight (kg)/height (m^2), and divided into normal (18.5-24.9), overweight (25-29.9), and obese (≥ 30). Venous blood was taken from all subjects after overnight fasting. Total cholesterol, TG, LDL-C, and HDL-C were analyzed using Sysmex BX-3010 chemistry analyzer.

2.3. Definitions of Terms

Hypertension was defined as SBP ≥140 mmHg and/or DBP ≥90 mmHg, using criteria from the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension [10]. Dyslipidemia was defined as a raised serum total cholesterol level ≥ 200 mg/dL and/or serum LDL cholesterol ≥ 130 mg/dL and/or serum triglyceride ≥ 150 mg/dL and/or serum HDL cholesterol < 40 mg/dL according to the National Cholesterol Education Program (NCEP) ATP III [11].

2.4. Statistical Data Analysis

Statistical analysis was performed using the SPSS version 26 software. The data was represented by number, percentage, mean value, and standard deviation (SD). Continuous variables of independent measurements showing normal distribution were analysed using an independent samples t-test and one-way analysis of variance, while data with abnormal distribution were analysed using the Kolmogorov Smirnov and Kruskal-Wallis ANOVA tests. Continuous variables with abnormal distribution were analysed using the Spearman's correlation coefficient, while categorial variables were used Lambda correlation to identify the relationship between the variables and the direction. A p–value of <0.05 was considered to be statistically significant.

3. Results

Blood specimens were collected from 132 hypertensive patients. The age of the subjects was between 27 and 100 years with an average age of 59.6±12.1 years. Sixty seven of 132 patients were females (50.8%). The most common symptoms complained by subjects were chest pain (34.8%), followed by headache (21.2%) and shortness of breath (17.4%). We observed that majority of subjects had normal BMI (55.3%) and were stage 1 hypertension (62.9%) based on the Eight Joint national Committee (JNC 8) guidelines (Table 1).

Table 1. *The characteristics of subjects (demographic and clinical).*

Characteristics	Category	N (%)
Age (year)	25 – 34	4 (3.0)
	35 – 44	7 (5.3)
	45 – 54	38 (28.8)
	55 – 64	35 (26.5)
	65 – 74	38 (28.8)
	≥ 75	10 (7.6)
Sex	Male	65 (49.2)
	Female	67 (50.8)
Symptoms	Chest pain	46 (34.8)
	Headache	28 (21.2)
	Shortness of breath	23 (17.4)
	Dizziness	14 (10.6)
	Extremity weakness	9 (6.8)
	Nausea	7 (5.3)
	Vomit	4 (3.0)

Characteristics	Category	N (%)
BMI (kg/m^2)	Normal	73 (55.3)
	Overweight	39 (29.5)
	Obese	20 (15.2)
Hypertension grade JNC 8	Stage 1	83 (62.9)
	Stage 2	49 (37.1)

There were no significant differences in blood pressures, total cholesterol, total cholesterol, triglycerides, LDL-C, and TC/HDL-C ratio, however males had significantly higher BMI and lower HDL-C than females (Table 2).

Table 2. *Characteristics of hypertension patients based on gender.*

Characteristics	Total (n=132)	Male (n=65)	Female (n=67)	*p*-value
Age (years)	59.6±12.1	60.0±11.3	59.1±12.9	0.588
BMI (kg/m^2)	24.0±2.6	24.3±2.7	23.6±2.5	0.008*
SBP (mmHg)	160.0±26.8	159.0±28.4	161.0±25.5	0.832
DBP (mmHg)	86.6±15.3	88.8±15.7	84.6±14.7	0.655
TC (mg/dL)	200.0±51.4	191.0±50.8	208.0±51.1	0.363
TG (mg/dL)	138.0±61.7	139.0±56.6	137.0±66.7	0.961
HDL-C (mg/dL)	44.1±11.6	40.5±10.2	47.4±11.9	<0.001*
LDL-C (mg/dL)	120.0±43.8	115.0±45.5	124.0±41.2	0.644
TC/HDL-C ratio	4.7±1.6	4.9±1.9	4.5±1.2	0.256

TC = total cholesterol; LDL-C = low density lipoprotein cholesterol; TG = triglycerides;
HDL-C = high density lipoprotein cholesterol.

Overall, 79.5% of the subjects had dyslipidemia with at least 1 abnormal lipid profile. Table 3 shows that based on gender and age, the most prevalent abnormal lipid fraction was high total cholesterol, which found more in females and age group of 45-54 years. Meanwhile, high LDL-C, high TG, and low HDL-C were found in about one third of the population, which were 34.1%, 31.8%, and 31.1%, respectively, and dominated by the same age group as high total cholesterol.

Table 3. *Prevalence of dyslipidemia based on gender and age.*

	High TC (≥200 mg/dL)	High LDL-C (≥130 mg/dL)	High TG (≥150 mg/dL)	Low HDL-C (<40 mg/dL)	High TC/HDL-C (≥5)
Total	68 (51.5)	45 (34.1)	42 (31.8)	41 (31.1)	59 (44.7)
Male	30 (22.7)	23 (17.4)	24 (18.2)	25 (18.9)	34 (25.8)
Female	38 (28.8)	22 (16.7)	18 (13.6)	16 (12.1)	25 (18.9)
p value	0.321	0.580	0.690	0.615	0.597
Total	68 (51.5)	45 (34.1)	42 (31.8)	41 (31.1)	59 (44.7)
Age (years)					
25 – 34	2 (1.5)	2 (1.5)	2 (1.5)	1 (0.8)	1 (0.8)
35 – 44	3 (2.3)	1 (0.8)	1 (0.8)	3 (2.3)	4 (3.0)
45 – 54	21 (15.9)	16 (12.1)	14 (10.6)	13 (9.8)	19 (14.4)
55 – 64	20 (15.2)	13 (9.8)	12 (9.1)	10 (7.6)	17 (12.9)
65 – 74	19 (14.4)	11 (8.3)	10 (7.6)	13 (9.8)	15 (11.4)
≥ 75	3 (2.3)	2 (1.5)	3 (2.3)	1 (0.8)	3 (2.3)

Values are expressed as n (%). TC = total cholesterol; LDL-C = low density lipoprotein cholesterol;
TG = triglycerides; HDL-C = high density lipoprotein cholesterol.

There were statistically significant correlations found between lipid profiles and other cardiovascular risk factors only in females, namely a positive correlation between LDL-C and DBP and a negative correlation between HDL-C and age (Table 4).

Table 4. *Correlation of lipid profile with other cardiovascular risk factors based on gender.*

	Total		Male		Female	
	correlation coefficient (r)	*p*-value	correlation coefficient (r)	*p*-value	correlation coefficient (r)	*p*-value
Total Cholesterol						
Age	0.050	0.573	-0.001	0.993	0.104	0.402
BMI	0.084	0.186	0.124	0.367	0.097	0.467
SBP	-0.009	0.461	0.189	0.166	-0.232	0.078
DBP	-0.047	0.309	0.161	0.240	-0.229	0.082
Triglycerides						
Age	-0.056	0.262	-0.031	0.809	-0.084	0.498
BMI	0.010	0.456	-0.001	0.996	-0.025	0.851
SBP	0.017	0.427	0.215	0.116	-0.090	0.497
DBP	-0.035	0.356	-0.008	0.955	0.000	1.000

	Total		Male		Female	
	correlation coefficient (r)	*p*-value	correlation coefficient (r)	*p*-value	correlation coefficient (r)	*p*-value
LDL-C						
Age	-0.077	0.185	-0.154	0.247	-0.04	0.972
BMI	0.007	0.471	0.074	0.594	-0.056	0.674
SBP	-0.014	0.443	0.211	0.122	-0.245	0.061
DBP	-0.058	0.269	0.185	0.177	0.274	0.036*
HDL-C						
Age	0.103	0.129	-0.205	0.123	-0.373	0.002*
BMI	0.114	0.115	0.194	0.156	0.182	0.168
SBP	0.007	0.472	0.123	0.373	-0.121	0.360
DBP	-0.034	0.358	0.175	0.201	-0160	0.226

LDL-C = low density lipoprotein cholesterol; HDL-C = high density lipoprotein cholesterol; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure.

4. Discussion

In the present study, the prevalence of dyslipidemia in hypertensive patients was 79.5%. The present finding is consistent with the results reported in Lithuania (89.7%) [12], South Africa (85.0%) [13], India (78.4%) [14], and Poland (77.2%) [15]. Contrary to this, the prevalence is higher than previous studies reported in Africa (25.5%) [16], Iran (30.0%) [17], China (32.2%) [18], Eastern Ethiopia (34.8%) [19], India (50.7%) [20], Uganda (63.3%) [21], Pallestine (66.4%) [22], and South Africa (67.3%) [23]. This difference might be due to variation in cut-offs, period of study, study settings, socioeconomic status, and subjects' lifestyles. The high prevalence of dyslipidemia may be due to decreased physical activity, changes in eating habits, increased socioeconomic status, changes in work intensity, and smoking [24].

We observed a higher prevalence in females than males and this is in line with our previous finding [25]. Similar finding was reported by Wang et al in their study investigating gender heterogeneity in the prevalence of dyslipidemia conducted in the Chinese population [26]. The higher rates of hypertension in females could be attributable to estrogen hormones, which acts as protector agent to prevent high blood pressure in young age [27].

This study also showed that the clinical symptoms most frequently complained of by hypertensive patients were chest pain, headache, and shortness of breath, which were 34.8%, 21.1%, and 17.4%, respectively. Patients with systemic hypertension often experience chest pain, which is caused by coronary microvascular dysfunction. Capillary thinning and endothelial dysfunction as structural and functional coronary microvascular abnormalities are common causes of angina pectoris in hypertensive patients [28].

With the exception of BMI and HDL-C, there were no significant differences between males and females in terms of clinical features and lipid profile. On average, males had slightly higher BMI than females in the present study. This has also been previously reported among India population [29]. Body mass index (BMI) is positively related to systolic blood pressure (SBP) and diastolic blood pressure (DBP). Primary prevention through reduction of BMI has a significant effect on reducing cardiovascular morbidity and mortality in hypertensive patients, including stroke, heart attack, and heart failure [30].

As demonstrated in this study, dyslipidemia is prevalent in subject between 45 and 54 years of age in both genders. Study in Nigeria reported that subjects age group 55-64 was the most prevalent [24]. The prevalence of dyslipidemia increases with age. Reduced catabolism and clearance of plasma lipoproteins can lead to hyperlipidemia with advancing age [31].

The most common type of dyslipidemia observed was hypercholesterolemia (51.5%), followed by high LDL-C (34.1%), elevated TG (31.8%), and low HDL-C (31.1%). Findings in this recent study are consistent with the previous study reported in Nigeria, which were 43.4%, 30.3%, 20.8%, and 12.9%, respectively [24]. However, study in Ethiopia reported that high LDL-C was the most prevalent (49.5%), followed by elevated triglyceride (40.2%) [32]. Differences of ethnic, diet, socio-economic, and environmental factors may contribute to these differences.

Based on association between lipid profile with other cardiovascular risk factors, we found a significant relationship only in females. We found a positive correlation between LDL-C and DBP (r=0.274, p=0.036) A significant positive correlation of serum LDL-C with level of DBP (r= 0.190, p= <0.0001) was also reported by Oda and Kawai in Japanese women [33]. The exact mechanism of this association is unknown but has been reported to be associated with selective leptin resistance due to higher serum leptin levels in women than men. Another theory is related to impaired endothelial function or upregulation of AT1 receptors by LDL-C, causing an increase in diastolic blood pressure [33, 34]. We also observed a negative correlation between HDL-C and age (r=-0373, p=0.002). This is consistent with large-scale study from the Korean National Health and Nutrition Examination Survey 2017 (KNHANES VII-2) (r=−0.152, p< 0.001). Low HDL cholesterol levels represent an independent risk factor for coronary heart disease in elderly men and women [35].

The present study has some limitations. The number of subjects studied was small and may not represent the general rural population of Indonesia. As data were collected through questionnaires and the participant was voluntary, the effect of bias could not be ruled out. Also, since this was a cross-sectional study, a cause-and-effect relationship in our findings could not be demonstrated, therefore a large-scale prospective study is required.

5. Conclusion

The prevalence of dyslipidemia in this study was high. The most common abnormal lipid fraction was hypercholesterolemia, followed by high LDL-C and TG, and low HDL-C. A statistically significant correlation between lipid profile and other cardiovascular risk factors was found only in women, that is a positive correlation between LDL-C and DBP, and a negative correlation between HDL-C and age. Screening for early detection of dyslipidemia should be conducted to reduce the risk of cardiovascular diseases.

Conflict of Interest Statement

All the authors do not have any possible conflicts of interest.

Acknowledgements

This study was financially supported by the Directorate Research and Community Service, Sam Ratulangi University, Manado, Indonesia through the RDUU research scheme fiscal year 2021. The authors would like to thank Noongan Regional General Hospital and Biochemistry Department Faculty of Medicine Sam Ratulangi University for all the supports.

References

[1] Kannel W. Fifty years of Framingham Study contributions to understanding hypertension. J Hum Hypertens 2000; 14 (2): 83–90.

[2] Reddy KS. Cardiovascular Disease in Non-Western Countries. N Engl J Med 2004; 350 (24): 2438–40.

[3] Badan Penelitian dan Pengembangan Kesehatan. Hasil Utama RISKESDAS 2018. Kementerian Kesehatan RI; 2018.

[4] Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. J Am Coll Cardiol 2018; 71 (19): e127–248.

[5] Ariyanti R, Besral B. Dyslipidemia Associated with Hypertension Increases the Risks for Coronary Heart Disease: A Case-Control Study in Harapan Kita Hospital, National Cardiovascular Center, Jakarta. J Lipids 2019; 2019: 1–6.

[6] Islam S, Choudhury KN, Mainuddin A, Wahiduzzaman M. Serum lipid profile and its association with hypertension in Bangladesh. Vasc Health Risk Manag. 2014; 10: 327-32.

[7] Nayak P. Evaluation of Lipid Profile and Apolipoproteins in Essential Hypertensive Patients. J Clin Diagn Res 2016; 10 (10): BC01-04.

[8] Gebrie A, Gnanasekaran N, Menon M, Sisay M, Zegeye A. Evaluation of lipid profiles and hematological parameters in hypertensive patients: Laboratory-based cross-sectional study. SAGE Open Med 2018; 6: 205031211875666.

[9] Diana DAIAT, Astini DAAAS. Prevalence of hypertension among adults in Kintamani Subdistrict-Bali. IOP Conf Ser Mater Sci Eng 2018; 434: 012322.

[10] World Health Organization. A global brief on hypertension [Internet]. WHO Press; 2013. Available from: https://www.who.int/publications/i/item/a-global-brief-on-hypertension-silent-killer-global-public-health-crisis-world-health-day-2013

[11] Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA J Am Med Assoc 2001; 285 (19): 2486–97.

[12] Rinkūnienė E, Laucevičius A, Petrulionienė Ž, Dženkevičiūtė V, Kutkienė S, Skujaitė A, et al. The prevalence of dislipidemia and its relation to other risk factors: a nationwide survey of Lithuania. Clin Lipidol 2015; 10 (3): 219–25.

[13] Dave JA, Levitt NS, Ross IL, Lacerda M, Maartens G, Blom D. Anti-Retroviral Therapy Increases the Prevalence of Dyslipidemia in South African HIV-Infected Patients. Blackard J, editor. PLOS ONE 2016; 11 (3): e0151911.

[14] Banerjee R, Bhattacherjee S, Ray K, Roy JK, Datta S, Banerjee I. Dyslipidemia and its Relationship with Cardiovascular Risk Factors in a Selected Population of Siliguri City, West Bengal, India. Asian J Med Sci 2013; 5 (1): 1–8.

[15] Pająk A, Szafraniec K, Polak M, Polakowska M, Kozela M, Piotrowski W, et al. Changes in the prevalence, management and treatment of hypercholesterolemia and other dyslipidemias over 10 years in Poland. The WOBASZ study. Pol Arch Intern Med 2016; 126 (9): 642-52.

[16] Noubiap JJ, Bigna JJ, Nansseu JR, Nyaga UF, Balti EV, Echouffo-Tcheugui JB, et al. Prevalence of dyslipidaemia among adults in Africa: a systematic review and meta-analysis. Lancet Glob Health 2018; 6 (9): e998–1007.

[17] Najafipour H, Shokoohi M, Yousefzadeh G, Sarvar Azimzadeh B, Moshtaghi Kashanian G, Bagheri MM, et al. Prevalence of dyslipidemia and its association with other coronary artery disease risk factors among urban population in Southeast of Iran: results of the Kerman coronary artery disease risk factors study (KERCADRS). J Diabetes Metab Disord 2016; 15 (1): 49.

[18] Liu X, Yu S, Mao Z, Li Y, Zhang H, Yang K, et al. Dyslipidemia prevalence, awareness, treatment, control, and risk factors in Chinese rural population: the Henan rural cohort study. Lipids Health Dis 2018; 17 (1): 119.

[19] Sufa B, Abebe G, Cheneke W. Dyslipidemia and associated factors among women using hormonal contraceptives in Harar town, Eastern Ethiopia. BMC Res Notes 2019; 12 (1): 120.

[20] Wankhade PS, Pedhambkar RB, Pagare RS, Pedhambkar BS. Prevalence and risk factors of dyslipidemia among male industrial workers in India. Int J Community Med Public Health 2018; 5 (4): 1458.

[21] Bakesiima R, Byakika-Kibwika P, Tumwine JK, Kalyango JN, Nabaasa G, Najjingo I, et al. Dyslipidaemias in women using hormonal contraceptives: a cross sectional study in Mulago Hospital Family Planning Clinic, Kampala, Uganda. BMJ Open 2018; 8 (10): e022338.

[22] Ali I, Kharma A, Samara M, Odeh S, Jaradat N, Zaid AN, et al. Prevalence of Dyslipidemia in Undiagnosed Palestinian Men: A Cross-Sectional Study. J Lipids 2019; 2019: 1–6.

[23] Reiger S, Jardim TV, Abrahams-Gessel S, Crowther NJ, Wade A, Gomez-Olive FX, et al. Awareness, treatment, and control of dyslipidemia in rural South Africa: The HAALSI (Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa) study. Guerrero-Romero F, editor. PLOS ONE 2017; 12 (10): e0187347.

[24] Ayoade OG, Umoh I, Amadi C. Dyslipidemia and Associated Risk Factors among Nigerians with Hypertension. Dubai Med J 2020; 3 (4): 155–61.

[25] Purwanto DS, Mewo YM, Jim EL, Laloan RJ, Engka JNA, Kepel BJ. The Analysis of Electrolyte Levels on Hypertensive Patients in Noongan Regional General Hospital, North Sulawesi, Indonesia. Sci J Clin Med 2019; 8 (5): 54.

[26] Wang M, Liu M, Li F, Guo C, Liu Z, Pan Y, et al. Gender heterogeneity in dyslipidemia prevalence, trends with age and associated factors in middle age rural Chinese. Lipids Health Dis 2020; 19 (1): 135.

[27] Peters SAE, Muntner P, Woodward M. Sex Differences in the Prevalence of, and Trends in, Cardiovascular Risk Factors, Treatment, and Control in the United States, 2001 to 2016. Circulation 2019; 139 (8): 1025–35.

[28] Ettehad D, Emdin CA, Kiran A, Anderson SG, Callender T, Emberson J, et al. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. The Lancet 2016; 387 (10022): 957–67.

[29] Hossain FB, Adhikary G, Chowdhury AB, Shawon MSR. Association between body mass index (BMI) and hypertension in south Asian population: evidence from nationally-representative surveys. Clin Hypertens 2019; 25 (1): 28.

[30] Linderman GC, Lu J, Lu Y, Sun X, Xu W, Nasir K, et al. Association of Body Mass Index With Blood Pressure Among 1.7 Million Chinese Adults. JAMA Network Open 2018; 1 (4): e181271.

[31] Ericsson S, Eriksson M, Vitols S, Einarsson K, Berglund L, Angelin B. Influence of age on the metabolism of plasma low density lipoproteins in healthy males. J Clin Invest 1991; 87 (2): 591–6.

[32] Gebreegziabiher G, Belachew T, Mehari K, Tamiru D. Prevalence of dyslipidemia and associated risk factors among adult residents of Mekelle City, Northern Ethiopia. Spradley FT, editor. PLOS ONE 2021; 16 (2): e0243103.

[33] Oda E, Kawai R. LDL Cholesterol Is Associated With Blood Pressure in Japanese Women. Diabetes Care 2009; 32 (9): e113–e113.

[34] Behradmanesh S. Serum cholesterol and LDL-C in association with level of diastolic blood pressure in type 2 diabetic patients. J Renal Inj Prev 2012; 1 (1): 23-26.

[35] Cho K-H, Park H-J, Kim J-R. Decrease in Serum HDL-C Level Is Associated with Elevation of Blood Pressure: Correlation Analysis from the Korean National Health and Nutrition Examination Survey 2017. Int J Environ Res Public Health 2020; 17 (3): 1101.