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Original Article

Biochemistry Section

Correlation of Blood Pressure with Microalbuminuria and Dyslipidaemia in Patients with Essential Hypertension: A Case-control Study

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ABSTRACT

Introduction: Hypertension (HTN) is one of the most common disease affecting the people around the world. Microalbuminuria and dyslipidaemia has been considered as an early indicator of vascular damage, endothelial dysfunction and renal disease. Studies, conducted to evaluate microalbuminuria, dyslipidaemia in essential hypertensive patients are scarce.

Aim: To assess the microalbuminuria, dyslipidaemia in essential hypertensive patients and also, to correlate these parameters with Blood Pressure (BP).

Materials and Methods: This case-control study was conducted in the Department of Biochemistry at Veer Surendra Sai Institute of Medical Sciences and Research (VIMSAR), Sambalpur, Odisha, India, from January 2020 to February 2021. The study included 70 healthy individuals as controls and 70 essential hypertensive patients as cases in the age group of 25 to 55 years. According to Joint National Committee (JNC) 7 guidelines, out of 70, 20 cases were categorised as stage I (BP≥140-159/90-99 mmHg) and 50 as stage II (BP≥160/100 mmHg). Renal profile, lipid profile, total protein and albumin, microalbumin and Albumin-creatinine Ratio (ACR) were evaluated. Pearson correlation coefficient was applied to statistically analyse the data.

Results: In the present study, 38 (54.3%) were males and 32 (45.7%) were females. Whereas, in controls, 44 (62.8%) were males and 26 (37.2%) were females. The mean age in cases 44.4±8.58 years, Systolic Blood Pressure (SBP) 156.0±35.1 mmHg, Diastolic Blood Pressure (DBP) 101±12.9 mmHg, serum creatinine 1.08±0.29 mg/dL, serum uric acid 7.37±1.8 mg/dL, serum total cholesterol 171±44.7 mg/dL, serum triglycerides 173±48.4 mg/dL, Low-density Lipoprotein Cholesterol (LDL-C) 107±38.8 mg/dL, Very Low-density Lipoprotein Cholesterol (VLDL-C) 35.1±10.2 mg/dL, microalbuminuria 75±31.9 mg/L, and urinary ACR 78±44.1 were significantly increased and serum High-density Lipoprotein Cholesterol (HDL-C) 31.7±7.07 mg/dL levels were decreased in cases than controls. Urinary ACR was significantly increased in stage II. ACR was positively correlated with SBP, DBP, creatinine, uric acid, total cholesterol, triglycerides, VLDL-C and negatively correlated with HDL-C.

Conclusion: Blood pressure was positively correlated with lipid profile parameters, except HDL-C. Increased urinary albumin excretion rate may be useful and inexpensive marker for the identification of patients with higher cardiovascular risk and organ damage.

Keywords: Atherosclerosis, Cardiovascular disease, Lipid profile, Myocardial infarction

INTRODUCTION

Hypertension (HTN), one of the most common disease affecting the people around the world, is often called the silent killer [1]. In India, hypertension accounts for 10.8% of all deaths. Its incidence in urban areas is 20-40% and in rural areas is 12-17% [1]. Hypertension leads to the risk of cardiovascular complications such as dyslipidaemia, atherosclerosis, myocardial infarction, heart failure, peripheral arterial disease, stroke and renal complications. Renal complications are most common in hypertensive patients and around 20% of hypertensive patients experience deterioration of renal function [2-4].

Therefore, essential hypertension should be treated. If left untreated, around 50% of patients may develop heart diseases, 33% may develop stroke, and renal failure in 10%-15% [5]. It has been reported that, microalbuminuria has become a prognostic marker for cardiovascular disorders [6]. Microalbuminuria is defined as urinary albumin excretion of >30-300 mg/24 hours or albumin/creatinine ratio ranged between 30-300 mg/g [7]. Microalbuminuria, due to consequence of an augmented intraglomerular capillary pressure; intrinsic glomerular damage and tubular changes may also result in increased excretion of albumin in urine. Microalbuminuria, considered as an early indicator of vascular damage, endothelial dysfunction and renal disease [7]. An increase in urinary albumin excretion by 10 units increases the risk of stroke by 1.5 times [8]. Microalbuminuria also linked with cerebral vasculopathy, alzheimer's disease, memory loss etc., [9]. Khairallah MA et al., reported the association between microalbuminuria and hypertension and suggested that, microalbuminuria may be a useful marker to assess risk management of cardiovascular disease and renal disease [10]. Roopa AN et al., reported that microalbuminuria was observed in 70% of hypertensives and correlated with duration of HTN. Similarly, patients with dyslipidaemia also had (70%) microalbuminuria. The study suggested that, microalbuminuria patients had a higher degree of end organ involvement [11]. Onyegbutulem HC et al., reported that, dyslipidaemias is common in hypertensive patients. The most common dyslipidaemic type is low High-density Lipoprotein (HDL), followed by increased Low-density Lipoprotein (LDL), total cholesterol and triglycerides [12].

However, previous studies [10-13] reported separately on dyslipidaemia and microalbuminuria. Therefore, there is a need to study the correlation of BP with microalbuminuria and dyslipidaemia in patients with essential hypertension. Hence, present study was conducted to evaluate microalbuminuria, dyslipidaemia in essential hypertensive patients and their correlation with BP.

MATERIALS AND METHODS

The present case-control study was conducted in the Department of Biochemistry, Veer Surendra Sai Institute of Medical Sciences and Research (VIMSAR), Sambalpur, Odisha, India, from January 2020 to February 2021. The study has been approved by the Institutional Ethics Committee (IEC/IRB No:121/2020) and informed consent was obtained from the study subjects.

Inclusion criteria: Patients with essential hypertension (BP ≥140/90 mmHg), aged between 25 to 55 years were included as cases. Subjects with normal BP (≤120/80 mmHg), aged between 25 to 55 years were included as controls.

Exclusion criteria: Subjects with renal diseases, diabetes mellitus, congestive cardiac failure, cerebrovascular disease, patients with urinary tract infection, pregnant women, patients with obstructive uropathy and nephrolithiasis were excluded from the study.

Sample size calculation: Sample size was calculated with 80% power and 95% confidence interval by using the formula $N=(Z_{1-\alpha/2}+Z_{1-\beta})^2 S_1 \times S_2 / d^2$ [13]. The sample size arrived for each group was 70.

Study Procedure

A total of 70 essential hypertensions diagnosed patients attending Outpatient Department (OPD). According to JNC 7 guidelines, 20 cases were categorised as stage I (BP≥140-159/90-99 mmHg) and 50 as stage II (BP≥160/100 mmHg) [14]. Under aseptic conditions, 5 mL of fasting venous blood samples were collected. The blood samples were allowed to clot and centrifuged at 3000 rpm for 10 minutes to obtain the clear serum and obtained sample was used for the estimation of renal profile (urea, creatinine, uric acid), lipid profile (total cholesterol, triglycerides, HDL-C, LDL-C, VLDL-C), total protein and albumin. Urine sample was collected to measure microalbumin (30-300 mg/g) and ACR [15]. Blood pressure was recorded.

STATISTICAL ANALYSIS

Data were analysed by using Statistical Package for Social Sciences (SPSS) version 22.0. The results were represented in mean±SD. Mann-Whitney U test was applied to compare the parameters between cases and controls. Pearson correlation coefficient was applied between urinary ACR with blood pressure, renal profile and lipid profile of hypertensive patients. The p<0.05 considered as significant.

RESULTS

In the present study, 70 essential hypertensive patients as cases and 70 healthy subjects as controls were enrolled. In healthy controls, 44 (62.8%) were males and 26 (37.2%) were females. In the hypertensive cases, 38 (54.3%) were male and 32 (45.7%) were female. In the present study, SBP (p<0.001), DBP (p<0.001), serum creatinine (p<0.001), serum uric acid (p<0.001), serum total cholesterol (p< 0.001), serum triglycerides (p<0.001), LDL-C (p<0.001), VLDL-C (p<0.001) microalbuminuria (p<0.001), and urinary ACR (p<0.001) were significantly increased in cases than controls, whereas, serum HDL-C (p<0.001) showed significant decrease in cases than controls [Table/Fig-1].

In the present study, the cases were divided into two groups- stage I and II. SBP, DBP, urea, uric acid, microalbumin and ACR were significantly increased in stage II than stage I [Table/Fig-2]. Urinary ACR was positively correlated to SBP (r 0.690), DBP (r 0.669), serum urea (r 0.385), serum creatinine (r 0.566), serum uric acid (r 0.595), serum total cholesterol (r 0.219), serum triglycerides (r 0.519), VLDL-C (r 0.522), of hypertensive patients and negatively correlated with HDL-C (r -0.180) which was statistically significant [Table/Fig-3].

Parameters	Hypertensive patients cases (Mean±SD)	Healthy controls (Mean±SD)	p-value
Age (years)	44.4±8.58	39.1±7.75	0.04*
Gender			
Males	38 (54.3%)	44 (62.8%)	<0.001*
Females	32 (45.7%)	26 (37.2%)	
SBP (mmHg)	156.0±35.1	123.0±7.38	<0.001*
DBP (mmHg)	101±12.9	81.2±4.21	<0.001*
Serum urea (mg/dL)	23.5±6.85	21.8±6.28	0.29
Serum creatinine (mg/dL)	1.08±0.29	0.8±0.15	<0.001*
Serum uric acid (mg/dL)	7.37±1.8	4.67±1.3	<0.001*
Serum total protein (gm/dL)	6.83±0.5	6.95±0.4	0.32
Serum albumin (gm/dL)	4.46±0.7	4.36±0.4	0.49
Serum total cholesterol (mg/dL)	171±44.7	150±41.9	<0.001*
Serum triglycerides (mg/dL)	173±48.4	118±39.4	<0.001*
HDL-C (mg/dL)	31.7±7.07	36.3±5.6	<0.001*
LDL-C (mg/dL)	107±38.8	90.9±38.1	<0.001*
VLDL-C (mg/dL)	35.1±10.2	23.7±7.89	<0.001*
Microalbuminuria (mg/L)	75±31.9	21.2±9.14	<0.001*
Urinary ACR	78±44.1	23.5±10.7	<0.001*

[Table/Fig-1]: Comparison of biochemical parameters between hypertensive cases and healthy controls.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; VLDL-C: Very low-density lipoprotein cholesterol
*Significant, Mann-Whitney U test

Parameters	Stage I Hypertensive patients (n=20) Mean±SD	Stage II Hypertensive patients (n=50) Mean±SD	p-value
SBP (mmHg)	133.0±5.6	173.6±33.1	<0.001*
DBP (mmHg)	93.0±3.5	104.9±13.2	<0.001*
Serum urea (mg/dL)	22.6±8.1	27.6±6.0	0.005*
Serum creatinine (mg/dL)	0.95±0.26	1.1±0.29	0.068
Serum uric acid (mg/dL)	6.6±1.4	7.6±1.8	0.005*
Serum total protein (gm/dL)	6.6±0.83	6.6±0.85	0.566
Serum albumin (gm/dL)	4.6±0.86	4.3±0.71	0.133
Serum total cholesterol (mg/dL)	157.2±23.3	176.6±49.5	0.193
Serum triglycerides (mg/dL)	143.2±43.8	172.0±58.4	0.096
HDL-C (mg/dL)	30.8±6.5	32.1±7.2	0.666
LDL-C (mg/dL)	97.6±24.3	110.4±42.5	0.435
VLDL-C (mg/dL)	31.6±10.9	34.0±12.0	0.706
Microalbumin (mg/L)	59.1±33.1	81.2±29.1	0.009*
Urinary ACR	43±28.1	92± 41.8	<0.001*

[Table/Fig-2]: Comparison of urinary ACR in stage I and stage II hypertensive patients.
*Significant, Mann-Whitney U test

In the present study, DBP (r 0.767), total cholesterol (r 0.693), triglycerides (r 0.341), LDL-C (r 0.603), VLDL (r 0.252) were positively correlated with SBP whereas, HDL-C (r -0.545) negatively correlated and was significant. Similarly, SBP (r 0.767), total cholesterol (r 0.470), triglycerides (r 0.380), LDL-C (r 0.511) were positively correlated with DBP whereas, HDL-C (r -0.388) negatively correlated and was significant [Table/Fig-4].

DISCUSSION

The present study was conducted to evaluate microalbuminuria, dyslipidaemia in essential hypertensive patients and their correlation with blood pressure. In the present study, significant positive correlation was observed between ACR with blood pressure, lipid

Parameters	r-value	p-value
Systolic BP	0.690**	<0.001
Diastolic BP	0.669**	<0.001
Serum urea	0.385**	<0.001
Serum creatinine	0.566**	<0.001
Serum uric acid	0.595**	<0.001
Serum total cholesterol	0.219**	0.009
Serum triglycerides	0.519**	<0.001
LDL-C	0.133	0.117
HDL-C	-0.180*	0.033
VLDL-C	0.522**	<0.001

[Table/Fig-3]: Correlation of urinary ACR with blood pressure, renal profile and lipid profile of hypertensive patients.
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Parameters	Systolic BP		Diastolic BP	
	r-value	p-value	r-value	p-value
Systolic BP	-	-	0.767**	<0.001
Diastolic BP	0.767**	<0.001	-	-
Serum total cholesterol	0.693**	<0.001	0.470**	<0.001
Serum triglycerides	0.341**	0.004	0.380**	0.003
LDL-C	0.603**	<0.001	0.511**	<0.001
HDL-C	-0.545**	<0.001	-0.388**	0.006
VLDL-C	0.252*	0.035	0.103	0.398
Serum urea	0.359**	0.002	0.412**	0.001
Serum creatinine	0.422**	<0.001	0.424**	0.001
Serum uric acid	0.017	0.891	-0.114	0.349

[Table/Fig-4]: Correlation of blood pressure with renal profile and lipid profile in hypertensive patients.
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

profile parameters, except HDL-C, showed negative correlation. Hypertension, one of the most common disease affecting the people around the world, affecting the end organs of the body and it causes morbidity and mortality. Hypertension affects almost all organs in the body. To assess end organ damage, patients will not present with symptoms, unless severely affected. Most of them remain asymptomatic and the disease remains inadequately recognised [16]. Augmented afferent glomerular hydrostatic pressure, accentuated permeability of basal membrane of glomerulus, defects in tubular functions are some of the pathogenic changes in essential hypertension which are implicated in increased urinary excretion of albumin [17].

In the present study, blood urea, creatinine and uric acid levels were elevated in hypertensive cases than controls. Among these, elevated serum creatinine is thought to reflect derangement in endothelial structure and function or renal impairment [2]. In a study conducted by Schillaci G et al., reported that a serum creatinine value is a predictor of cardiovascular morbidity in patients with hypertension [18]. Hypertension and microalbuminuria commonly coexist. Microalbuminuria occurs in essential hypertensive patients is due to the consequence of an elevated transglomerular passage of albumin rather than the result of a reduction in the reabsorption of albumin in proximal tubule. It may also occur from haemodynamic-mediated mechanisms and/or functional or structural impairment of the glomerular barrier. Early detection of microalbuminuria in hypertensive patients is helpful to prevent end organ damage [19].

Hypertension increases the risk of Coronary Artery Disease (CAD), including myocardial infarction and Chronic Heart Failure (CHF). In the current study, serum total cholesterol, serum triglycerides, LDL-C, VLDL-C levels were significantly increased in hypertensive patients compared to healthy controls. Serum HDL-C showed significant decrease in hypertensive cases than controls. Ayoade OG et al., conducted a cross-sectional study on 544 Nigerian hypertensive patients to evaluate lipid profile parameters. They reported that 60.0% of the hypertensive patients had dyslipidaemia, with 43% having high total cholesterol, 30% high LDL-C, 20% elevated triglycerides and 12.9% low HDL-C, respectively, suggested that, high plasma Total Count (TC) is the most dominant pattern of dyslipidaemia [20]. Ariyanti R et al., conducted a case-control study in Jakarta to determine whether dyslipidaemia associated with hypertension increases the risks for the incidence of Coronary Heart Disease (CHD) or not by involving 82 cases and 81 controls. In the CHD group, dyslipidaemia was observed in 50% and in control group 17.3%. According to hypertension status, relationship of dyslipidaemia with CHD incidence was changed. In CHD cases, patients with dyslipidaemia were 18.1 times more likely to develop CHD than those non dyslipidaemic. In non hypertensives, those with dyslipidaemia were 2.5 times more likely to develop CHD than those non dyslipidaemia [21].

Recently, Cheng W et al., conducted a cross-sectional study to assess the association between atherosclerotic indices and hypertension prevalence in Chinese adults. They reported that, increased atherosclerosis indices in hypertensive population than normotensives. BP was positively correlated with atherosclerotic indices. Multivariate logistic regression analysis showed that, cholesterol index and non HDL-C were positively associated with the prevalence of hypertension [22]. Another study by Otsuka T et al., reported increased levels of total cholesterol, LDL-C and non HDL-C were linked with risk of hypertension [23]. Similarly, Rekha K et al., study from India, reported dyslipidaemia in hypertensive patients than controls. Microalbuminuria, indicator of subclinical atherosclerotic thickening of blood vessels. Therefore, dietary and lifestyle changes along with appropriate drug therapies to reduce the BP, as well as, correcting lipid alterations are essential to prevent development of CAD [24]. In addition, dysfunctional endothelium and inflammation have been suggested as possible causes to explain the association between microalbuminuria and cardiovascular disease [25]. In a study conducted by Brantsma AH et al., reported microalbuminuria to be a sensitive marker for detecting onset of cardiovascular risk factors [26]. Monfared A et al., study showed increased microalbuminuria is a risk factor for Left Ventricular Hypertrophy (LVH) which in turn an indicator of cardiovascular risk [27]. In a study by Maggon RR et al., reported that presence of microalbuminuria in a significant number of newly detected and untreated patients of essential hypertension. Further, microalbuminuria had a statistically significant relationship with LVH and Common Carotid Intima-media Thickness (CCIMT) [5].

In the present study, urinary ACR was significantly increased in hypertensive patients compared to healthy controls. Urinary ACR was higher in stage II hypertensive patients as compared to the stage I hypertensive patients. Jian G et al., conducted a cross-sectional study to evaluate the relationship between urinary ACR and microvascular disease hypertension patients without co-morbidities. They reported that, elevated urinary ACR was associated with microvascular disease in males whereas, in females, lower and higher urinary ACR was associated without co-morbidities [28]. Khattak MS et al., reported that the in hypertension, the frequency of microalbuminuria increases with increasing age. Therefore, it is essential to evaluate hypertensive patients to prevent end organ damage [29].

Limitation(s)

The study was limited with assessment of vascular damage markers and the subjects were not age and sex-matched.

CONCLUSION(S)

The present study results may conclude increase in BP, serum creatinine, serum uric acid, serum total cholesterol, serum triglycerides, LDL-C, VLDL-C, microalbuminuria, urinary ACR and decrease in serum HDL-C in hypertensive cases than controls. Significant positive correlation was observed between urinary ACR and BP, renal profile and dyslipidaemia. Similarly, significant positive correlation was observed between dyslipidaemia and blood pressure. Increased urinary albumin excretion rate may be useful and inexpensive marker for the identification of patients with higher cardiovascular risk and organ damage. Further studies with large sample size are required.

REFERENCES

[1] Pudota PN, Vedamanickam R. Prevalence of microalbuminuria in hypertension patients and its correlation with the severity of hypertension and end organ damage. Journal of Research in Medical and Dental Science. 2021;9(5):227-33.
[2] Kothari S, Trikha M, Gupta D. Microalbuminuria and essential hypertension: A critical evaluation. JK Science. 2020;22:110-15.
[3] Sharma R, Kamalakar S, McCarthy E, Fields T, Gupta K, Barua R, et al. Proteinuria in hypertensive nephropathy: A review. Open J Nephrol. 2014;4:92-99.
[4] Kumar AH, Rekha NH, Raghav ED. A study of microalbuminuria in patients with essential hypertension. Int J Contemporary Med Res. 2016;3(5):1468-70.
[5] Maggon RR, Malik R, Jain N, Isser HS. Study of the prevalence of microalbuminuria in patients of essential hypertension and its correlation with left ventricular hypertrophy and carotid artery intima-media thickness. J Clin Prev Cardiol. 2018;7:11-16.
[6] Todo RD. Microalbuminuria; definition, detection and clinical significance. J Clin Hypertens (Greenwich). 2004;6(11):02-07.
[7] Kumar V, Sweta, Khurana T, Kumar S. Essential hypertension is associated with higher prevalence of microalbuminuria- a cross-sectional study. Annals of International Medical and Dental Research. 2021;7(3):112-20.
[8] Sabharwal RK, Singh P, Arora MM, Somani BL, Ambade V. Incidence of microalbuminuria in hypertensive patients. Indian J Clin Biochem. 2008;23(1):71-75.
[9] Bacanu EV, Bacanu ME, Botez C. Microalbuminuria in essential hypertension at patients with or without type 2 diabetes. Proc Rom Acad Series B. 2011;2:145-54.
[10] Khairallah MKA, Ibrahim WHM. Frequency and possible associations of albuminuria in patients with essential hypertension: A single-center experience. Journal of Current Medical Research and Practice. 2019;4:373-77.
[11] Roopa AN, Reddy KSS, Chandrashekara P, Umabai KR, Madhuvan HS. Study of microalbuminuria and insulin resistance in patients with essential hypertension and metabolic syndrome and its relationship to target organ damage. J Med Sci Health. 2015;1(3):05-09.
[12] Onyegbutulem HC, Dogo D, Alu F, Dankyau M, Olorunfemi DS, Abdullahi FM, et al. Patterns of dyslipidemia amongst hypertensive patients in Abuja, North Central Nigeria. Pan Afr Med J. 2021;39:11.
[13] Tripathi SS, Mishra M. Prevalence and risk factors of microalbuminuria in hypertensive patients of tertiary care hospital. Int J Life Sci Scienti Res. 2017;3(5):1382-86.
[14] National High Blood Pressure Education Program. JNC 7 Express. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. NIH Publication No. 03-5233.
[15] Hoefield RA, Kalra PA, Baker PG, Sousa I, Diggle PJ, Gibson MJ, et al. The use of eGFR and ACR to predict decline in renal function in people with diabetes. Nephrol Dial Transplant. 2011;26 (3):887-92.
[16] Kuang ZM, Wang Y, Feng SJ, Jiang L, Cheng WL. Association between plasma homocysteine and microalbuminuria in untreated patients with essential hypertension: A case-control study. Kidney Blood Press Res. 2017;42:1303-11.
[17] Yadav R, Bhartiya JP, Verma SK, Nandkeoliar MK. Evaluation of blood urea, creatinine and uric acid as markers of kidney functions in hypertensive patients: A prospective study. Indian J Basic Appl Med Res. 2014;3(2):682-89.
[18] Schillaci G, Reboldi G, Verdecchiia P. High-normal serum creatinine concentration is a predictor of cardiovascular risk in essential hypertension. Arch Intern Med. 2001;161:886-91.
[19] Kaplan NM. Measurement of blood pressure, chapter 2, Kaplan's clinical hypertension, 8th edition, Lippincott Williams and Wilkins, 2010.
[20] Ayoade OG, Umoh I, Amadi C. Dyslipidemia and associated risk factors among Nigerians with hypertension. Dubai Medical Journal. 2020;3:155-61.
[21] 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. Journal of Lipids. 2019;2019:2517013.
[22] Cheng W, Zhuang J, Chen S. Dyslipidemia and the prevalence of hypertension: A cross-sectional study based on Chinese adults without type 2 diabetes mellitus. Front Cardiovasc Med. 2022;9:938363.
[23] Otsuka T, Takada H, Nishiyama Y, Kodani E, Saiki Y, Kato K, et al. Dyslipidemia and the risk of developing hypertension in a working-age male population. J Am Heart Assoc. 2016;5:e003053.
[24] Rekha K, Prasad RR. Effect of hypertension on lipid profile of individuals of Bihar State. Int J Sci Stud. 2016;4(5):197-99.
[25] Brantsma AH, Bakker SJ, de Zeeuw D, de Jong PE, Gansevoort RT. Urinary albumin excretion as a predictor of the development of hypertension in the general population. J Am Soc Nephrol. 2006;17:331-35.
[26] Brantsma AH, Bakker SJ, Hillege HL, de Zeeuw D, de Jong PE, Gansevoort RT; PREVEND Study Group. Urinary albumin excretion and its relation with C-reactive protein and the metabolic syndrome in the prediction of type 2 diabetes. Diabetes Care. 2005;28:2525-30.
[27] Monfared A, Salari A, Mirbolok F, Momeni M, Shafighnia S, Shakiba M, et al. Left ventricular hypertrophy and microalbuminuria in patients with essential hypertension. Iran J Kidney Dis. 2013;7:192-97.
[28] Jian G, Lin W, Wang N, Wu J, Wu X. Urine albumin/creatinine ratio and microvascular disease in elderly hypertensive patients without comorbidities. Bio Med Research International. 2021;2021:5560135.
[29] Khattak MS, Shah NUR, Khan MS, Haq LU, Hussain S, Pervez N. Frequency of microalbuminuria in essential hypertension in tertiary care hospital in Southern District of Khyber Pakhtunkhwa. Isra Med J. 2021;13(4):261-64.

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