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A Cross Sectional Study Assessing Relation Between Serum Uric Acid Level with Blood Pressure & Waist to Hip Ratio (WHR) In Young Population of Western Maharashtra District

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1. Introduction

Hypertension has become a global health concern in young population pertaining to its association with various life threatening complications like stroke, cardiovascular disease and chronic kidney disease.^{1, 2} There is also an alarming rise in prevalence of obesity and many studies have shown the association of hypertension with obesity.³ Obesity can be assessed by many tests including various obesity indices. One of the indices to assess obesity is Waist to Hip ratio (WHR) which is a better and widely accepted index.⁴

Studies have also shown a positive association of hyperuricemia with obesity as obesity increases the expression of xanthine oxidase reductase enzyme which is required for synthesis of uric acid.⁵ Uric acid is the end product of purine metabolism and hyperuricemia has been reported as one of the risk factors for development of hypertension. In fact, raised level of uric acid is observed even before the occurrence of significant vascular damage.⁶ The probable mechanism linking the two is raised uric acid causes increase oxidative stress, nitric oxide reduction, endothelial damage, vascular smooth muscle proliferation and activation of renin-angiotensin system leading to hypertension.⁷ Very few studies have been done to determine the relation between uric acid level and blood pressure in young population of India taking into consideration the waist to hip ratio (WHR). Raised uric acid level can be predicted by increased WHR in young population. So, raised uric acid level can be used as one of the risk factor for future development of hypertension & cardiovascular diseases. Thus, the present study was planned to assess relation between serum uric acid level with blood pressure and WHR in young population of western Maharashtra district.

Aim: A cross-sectional study assessing relation between serum uric acid level with blood pressure & waist to hip ratio (WHR) in young population of western Maharashtra district.

Objectives:

1. To determine the relation between serum uric acid level with systolic blood pressure, diastolic blood pressure and waist to hip ratio in young population of 20-40 years' age.

2. Material & Methods:

The present study was a cross-sectional study. The study was conducted in local medical college of western Maharashtra district inclusive of 180 volunteers of either sex within age group of 20 to 40 years. The study was conducted after institutional ethical committee approval. The sample size estimation was done using the results of study done by Perez Quartey et al.⁶ The Correlation coefficient was $r=0.15$ with 15% of expected precision and 95 % confidence level, minimum sample size was calculated to be 180. Volunteers with history of smoking, consumption of alcohol, hypertension, subjects suffering from cardiovascular disease, gout, diabeto mellitus, renal disease, malignancy and subjects on medications were excluded from the study. Healthy volunteers were selected by simple random sampling method keeping inclusion and exclusion criteria into consideration. The purpose and procedure of the study was explained to volunteers and a written informed consent was obtained. Detailed history of the subjects was taken and all subjects were clinically evaluated.

Parameters Measured:

- 1) Serum Uric Acid Level:**^{8,9}SUA level was estimated by modified Trinder' s peroxide method using TOOS reagent by fully Automated Clinical Chemistry (Randox Imola). SUA level of range 3.4–7.0 mg/dl for male and 2.4– 5.7 mg/dl for female was considered as normal range.
- 2) Blood Pressure Measurement:** Systolic and diastolic blood pressure was recorded after 10 min of rest in supine position with automatic blood pressure measuring apparatus (OMRON 907). Systolic blood pressure of <120 mmHg and diastolic blood pressure of <80 mmHg was considered as normal range. Hypertension was defined as a systolic blood pressure ≥ 140 mmHg and or diastolic pressure ≥ 90 mmHg.¹⁰
- 3) Waist to Hip Ratio (WHR):**^{11,12}As per WHO protocol, the waist circumference was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of iliac crest. Hip circumference was measured at the maximum protuberance

of the buttocks, and the waist to hip ratio was calculated. WHR was calculated and WHR <0.90 for male and <0.85 for female was considered as normal. Statistical analysis was done by SPSS version 26.0. Descriptive tables were computed consisting of mean and standard deviation for all the variables. Data was analyzed initially by Pearson correlation coefficient and relation between serum uric acid and systolic blood pressure, diastolic blood pressure and waist to hip ratio was determined with “*r* value”. Data was further analyzed by multiple linear regression analysis to estimate the level of change occurring post statistical significance through ANOVA was established for the models.

3. Observations and Results

Present study included 180 subjects of either sex.

Table No. 1 shows mean and standard deviation value of anthropometric parameters (age and weight), waist circumference, Systolic blood pressure (SBP), Diastolic blood pressure (DBP), Waist to Hip ratio (WHR) and serum uric acid (SUA) level in subjects.

Parameters	n=180
	Mean ± SD
Age (years)	29.27 ± 5.65
Weight (kg)	70.52 ± 13.32
Waist Circumference (WC)(cm)	85.78 ± 9.92
Hip Circumference (HC) (cm)	99.15 ± 10.08
WHR	0.87 ± 0.07
SBP(mmHg)	117.78 ± 10.99
DBP(mmHg)	72.83 ± 7.45
SUA(mg/dl)	5.50 ± 1.76

Table No. 2 shows the correlations of serum uric acid (SUA) level with SBP, DBP and WHR in subjects. SUA is positively correlated with SBP ($r = 0.747$), DBP ($r = 0.737$) and WHR ($r = 0.617$) and are statistically significant with p-value being < 0.001.

Correlation of parameters (n=180)	r value	p-value
WHR vs SUA (mg/dl)	0.617	< 0.001*
SBP(mmHg) vs SUA (mg/dl)	0.747	< 0.001*
DBP(mmHg) vs SUA (mg/dl)	0.737	< 0.001*

p<0.001*- statistically highly significant

Table 3: ANOVA analysis shows that the dependent variable serum uric acid (SUA) is influenced by independent variables SBP, DBP (F= 178.76) and WHR (F= 108.79) and turned out to be statistically significant.

Model		Sum of Squares	df	Mean Square	F-value	p-value
SBP and DBP	Regression	372.57	2	186.28	178.76	<0.001*
	Residual	183.41	176	1.042		
	Total	555.99	178			
WHR	Regression	211.597	1	211.597	108.749	< 0.001*
	Residual	344.394	177	1.946		
	Total	555.991	178			

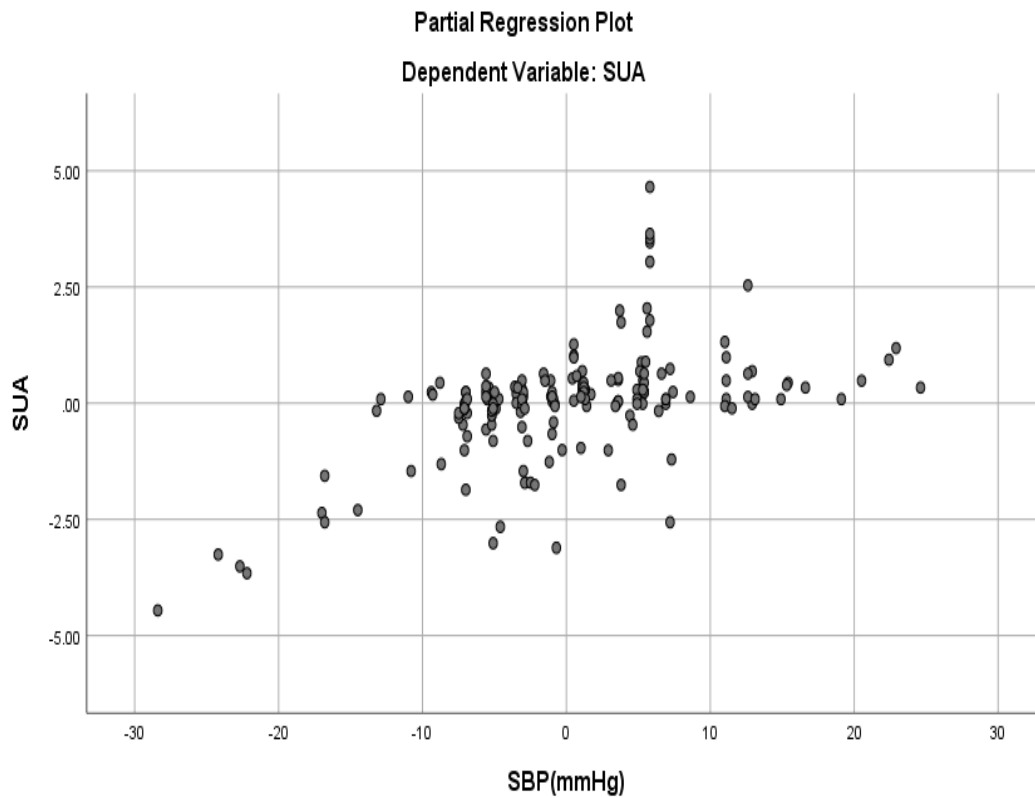
p <0.001*- statistically highly significant

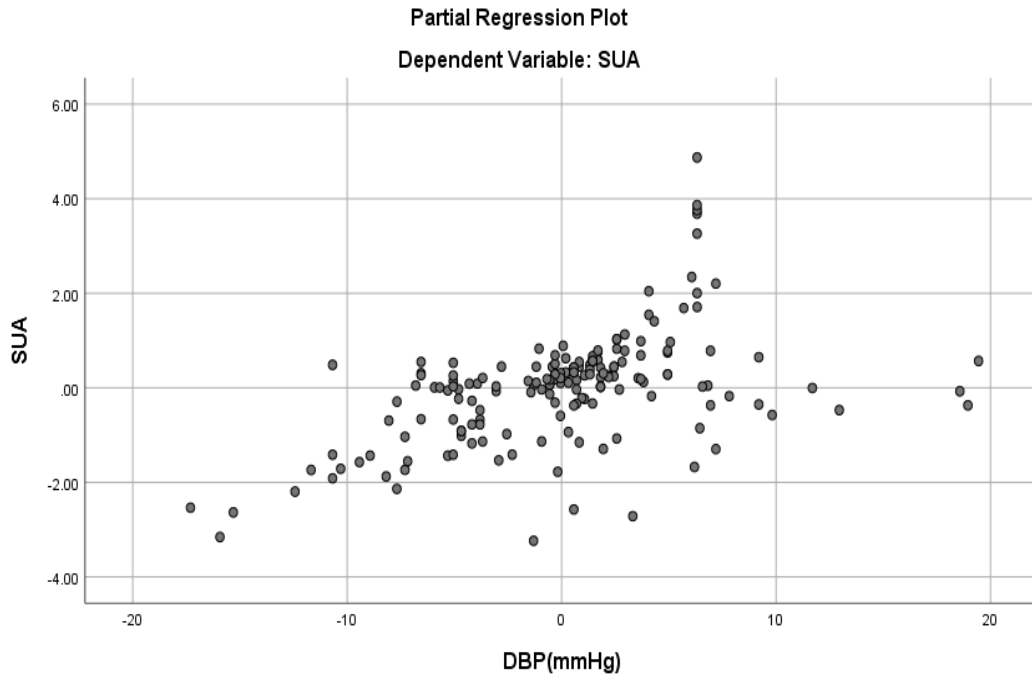
Table 4 shows Multiple Regression Analysis of serum uric acid (dependent variable) with blood pressure (independent variables) and WHR (independent variable)

Model	Unstandardized Coefficients		Standardized Coefficients	t value	p-value	95.0% Confidence Interval for B		
	B	Std. Error	Beta			Lower Bound	Upper Bound	
1	(Constant)	-10.850	.872	-	-12.448	<0.001*	-12.570	-9.130
	SBP (mmHg)	.075	.009	.465	8.214	<0.001*	.057	.093
	DBP (mmHg)	.104	.013	.437	7.719	<0.001*	.077	.130
2	(Constant)	-7.253	1.228	-	-5.906	<0.001*	-9.677	-4.829
	WHR	14.720	1.412	.617	10.428	<0.001*	11.935	17.506

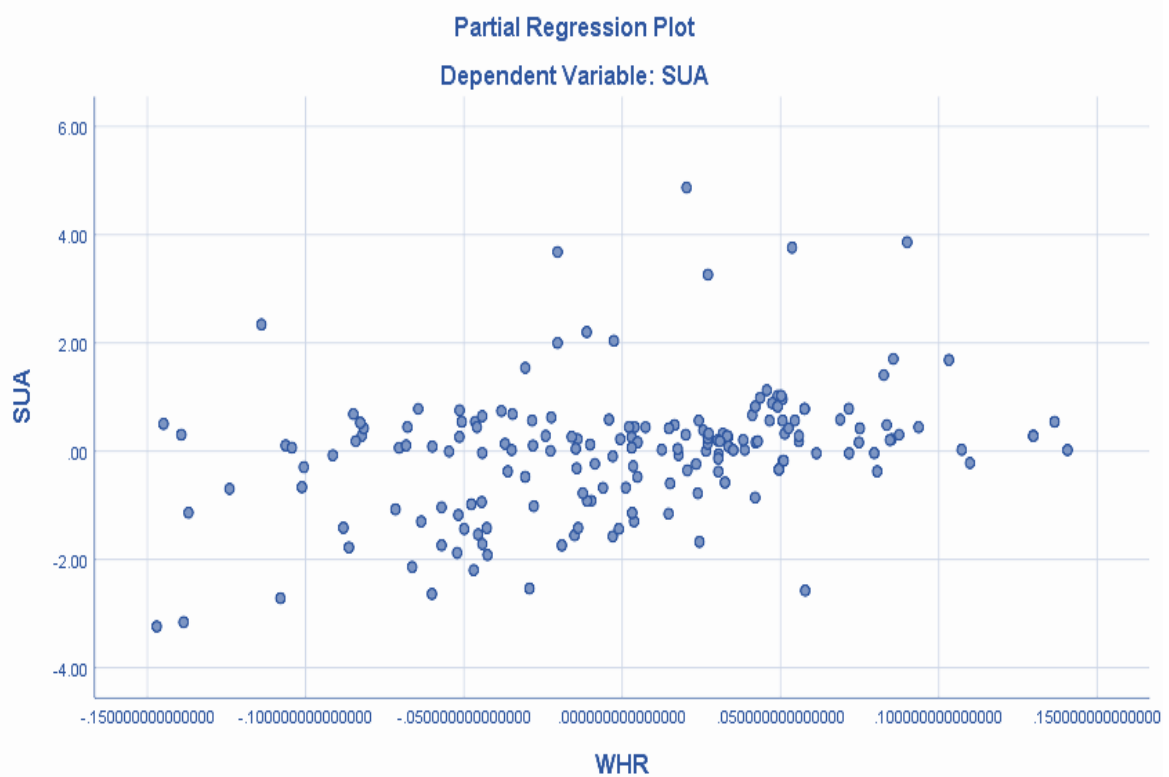
p<0.001*- statistically highly significant

Graph 1 shows regression graph of SUA and systolic blood pressure and diastolic blood pressure





Graph 2 shows regression graph of SUA and WHR



4. Discussion

The present study included 180 subjects of either sex. The mean age of volunteers was 29.27 ± 5.65 years. Mean systolic blood pressure (SBP) and mean diastolic blood pressure (DBP) was 117.78 ± 10.99 mmHg and 72.83 ± 7.45 mmHg respectively. Mean WHR recorded was 0.87 ± 0.07 and mean serum uric acid level was 5.50 ± 1.76 mg/dl (Table no.1).

The present study showed a significant positive correlation between serum uric acid level with systolic blood pressure (SBP), diastolic blood pressure (DBP) and waist to hip ratio (WHR).(Table no. 2)

In present study, multiple linear regression coefficient analysis further showed that dependent variable serum uric acid (SUA) level is influenced by both independent variables SBP and DBP ($F= 178.76$) and uric acid has statistically significant impact on both SBP and DBP. Present study showed that a unit increase in the SBP (mmHg) occurs with 0.075 unit increase in the uric acid. Likewise, a unit increase in the DBP (mmHg) occurs with 0.104 unit increase in the uric acid (Table 3 and 4).

Studies have shown a significant positive association between serum uric acid level and blood pressure.^{13,14,15} A longitudinal study done by Todd S Perlstein et al showed that serum uric acid level (SUA) independently predicts the development of hypertension during 21.5 years of follow up and also SUA can be used as marker for risk of hypertension.¹⁶

Cross sectional study done by Masanari Kuwabara et al¹⁷ in Japanese individuals also showed that the odds ratio of hypertension was 1.20 for each 1 mg/dl increase in uric acid level. Study conducted by Lauren F. et al observed strong positive association between uric acid level and blood pressure in boys as compared to girls.¹⁸

The probable mechanism for development of hypertension by raised uric acid level was demonstrated by Marilda Mazzali et al¹⁹ in their mild hyperuricemic rat model. Their study found that sustained increased uric acid level can result in increased blood pressure due to increased juxtaglomerular renin content and nitric oxide synthase expression in macula densa cell, resulting in both afferent and efferent arteriolar vasoconstriction. This results in activation of renin-angiotensin system and increased blood pressure.

Another study showed that COX-2 activity is also increased by hyperuricemia, resulting in vascular smooth muscle cell proliferation and macrophage infiltration causing atherosclerosis.²⁰ Uday Khosla et al conducted an experimental study and found that hyperuricemia in rats causes impaired nitric oxide generation in cultured endothelial cells which results in hypertension.²¹

Present study also found a significant positive linear correlation between serum uric acid (SUA) and waist to hip ratio (WHR)[Table 2]. In our study, multiple regression coefficient analysis also showed that serum uric acid (SUA) level was also influenced by WHR($F= 108.79$) independently. Our study ($F= 108.79$). found that WHR has a statistically significant impact on uric acid and a unit increase in the WHR results in 14.720 increase in the uric acid.

Studies have found a positive association of uric acid level with BMI, WC, and WHR.^{22,23,24}

Study done by Mao T et al showed that prevalence of hyperuricemia was increased to 2.57 times in participants with high body mass index as compared to participants with low BMI.²⁵ Study conducted by Feng X et al observed that increase in odds ratio (OR) with each 10 unit rise in uric acid was different for different obesity metabolic phenotypes and maximum increase in OR was observed in MAOO (metabolically abnormal and overweight/obese) phenotypes for each 10 unit rise in uric acid level.²⁶

Experimental study done by Tsushima Y et al⁵ explained the probable mechanism of increased uric acid synthesis due to obesity. Their study found that activity of xanthine oxidoreductase was increased by obese adipose tissue, causing increase uric acid synthesis. Adipose tissue in obese individual also increases purine synthesis due to increased fatty acid synthesis resulting in increased uric acid synthesis.

In the present study, a significant positive correlation between serum uric acid level with blood pressure and waist to hip ratio (WHR) in young population explains that raised serum uric acid level could be used as independent risk factor for future development of hypertension in young population and raised uric acid level can be predicted by increased WHR in young population.

5. Conclusion:

Present study showed a significantly positive independent correlation between serum uric acid level with both systolic & diastolic blood pressure and waist to hip ratio (WHR) in young population of western Maharashtra district.

Recommendations:

Our study highlighted the importance of raised serum uric acid level and its impact on development of hypertension in young population. Present study also highlighted the importance of maintaining WHR within normal range by choosing healthy lifestyle. Keeping WHR within normal range will maintain SUA within normal range thus preventing future risk of development of hypertension and other cardiovascular complications in young population.

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