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RESEARCH ARTICLE

Correlation between serum uric acid level with obesity indices and blood pressure in young males

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ABSTRACT

Background: Hyperuricemia is associated with lifestyle diseases such as hypertension and obesity. Studies have shown a positive association of obesity with uric acid and hyperuricemia causes endothelial injury resulting in hypertension. The prevalence of obesity is increasing in young adults. **Aims and Objectives:** The present study was planned to correlate serum uric acid (SUA) level with blood pressure to reflect the effect of hyperuricemia on hypertension. SUA level was also correlated with various obesity indices to indicate that these simple indices may be sufficient to predict raised uric acid level. **Materials and Methods:** The study was approved by the institutional ethical committee. The study group consisted of 74 males of 19–35 years of age. SUA level was estimated by modified Trinder's peroxide method. Blood pressure, body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) were measured as per the WHO protocol. Data were analyzed by Pearson correlation coefficient. Multiple regression analysis was done to determine independent predictor of SUA. **Results:** There was a statistically significant positive correlation <0.05 of SUA level with blood pressure and obesity indices (BMI, WC, WHR and WHtR). Among all obesity indices, WHR was independently correlated with SUA level. **Conclusions:** SUA level was positively correlated with blood pressure and obesity indices in young adults and WHR was independently correlated with uric acid.

KEY WORDS: Obesity Indices; Blood Pressure; Waist-to-hip Ratio; Body mass index

INTRODUCTION

Obesity and hypertension in adults have become a significant public health issue due to their association with future risk of cardiovascular diseases and organ damage. The prevalence of obesity and hypertension is increasing among adults in developing countries.[1,2] Experimental and clinical studies have shown a positive association of increased levels of uric acid with hypertension and obesity.[3]

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Hyperuricemia is an independent risk factor for the development of early hypertension that occurs even before significant vascular damage has occurred.[4]

Obesity is a disease characterized by excessive fat accumulation to the extent that health and well-being are affected. There are various obesity indices to predict abdominal obesity, for example, body mass index (BMI), waist circumference (WC), waist–hip ratio (WHR), and waist-to-height ratio (WHtR) which are widely accepted.[5]

Very few studies have been done to observe the relationship between uric acid level, blood pressure and obesity indices among young adults in India. Thus, the present study was planned to correlate serum uric acid (SUA) level with blood pressure and various obesity indices (BMI, WC, WHtR, and WHR) in young males. These obesity indices can help to

predict raised uric acid level which, in turn, can give us an idea about the development of hypertension and future risk of cardiovascular diseases.

MATERIALS AND METHODS

The present study was an observational cross-sectional study conducted from May 2015 to May 2016 in local medical college, Pune on 74 males of 19-35 years of age. The study was approved by the institutional ethical committee.

Subjects with a habit of smoking and alcohol consumption, suffering from hypertension, cardiovascular disease, gout, diabetes mellitus, renal disease, and malignancy, subjects on medications such as low-dose aspirin, thiazide and loop diuretics, immunosuppressants, and uricosuric drugs were excluded from the study.

Estimation of SUA level was done by modified Trinder's peroxide method using Fully Automated Clinical Chemistry (Randox Imola).[6,7] SUA level of range 3.4–7.0 mg/dl was considered as normal range.[8]

Systolic and diastolic blood pressure was recorded after 10 min of physical and mental rest in lying down position with mercury sphygmomanometer. Two consecutive readings were taken with 5 min interval. Systolic blood pressure of <120 mmHg and diastolic blood pressure of <80 mmHg were considered as normal range. Systolic blood pressure 120–139 mmHg was considered as prehypertension and blood pressure >140 mmHg was considered as hypertensive.[9]

Weight was recorded in kilograms on an empty bladder on a standard weighing scale to the nearest of 0.1 kg. Standing height of the subjects was measured with standard method to the nearest of 0.1 cm. Various obesity indices BMI, WC, WHR, and WHtR were measured as per the WHO protocol.[10-12]

Data analysis was done by Statistical Package for the Social Sciences (SPSS) version 20.0 and data were expressed as mean ± standard deviation. Data were analyzed by Pearson correlation coefficient and "*r* value" was determined.

Data was further analyzed by multiple regression analysis. SUA level (dependent variable) was correlated with blood pressure and various obesity indices (independent variables) to determine independent predictors of SUA level.

RESULTS

Table 1 shows anthropometric parameters, blood pressure, and SUA level in males (n = 74). Observed values of WC (cm), WHR, and SUA (mg/dl) were within normal range. BMI (27.20 ± 3.98 Kg/mt^2), WHtR, and blood pressure were more than normal range.

Of 74 males, 7 males were of normal weight, 18 males were overweight, 35 males were pre-obese, and 14 males were obese. In these subjects, 20 males were having systolic blood pressure >140 mmHg, 37 males were having systolic blood pressure in the range of 120–139 mmHg while 17 males were having blood pressure within normal range.

DISCUSSION

The present study showed a significant linear positive correlation between SUA level with systolic blood pressure and diastolic blood pressure in males. SUA level was also positively correlated with WC, BMI, WHtR, and WHR [Table 2].

In our study, it was observed that, of 74 males, 27.1% of males were hypertensive, 50% of males were prehypertensive while 22.9% of males were normotensive. Similar results were found in the many studies[13,14] and their results also showed a significant positive correlation between SUA level and blood pressure. Studies have found no independent association between uric acid and risk for incident hypertension in older subjects >60 years of age; however, positive association was found in subjects of <60 years of age.[15,16]

Table 1: Obesity indices, blood pressure, and serum uric acid level in males

Parameters	Male (n=74)	
	Normal value	Mean±Standard deviation
WC (cm)	<94	89.60±11.00
BMI (Kg/mt^2)	18–22.9	27.20±3.98
WHtR	<0.5	0.53±0.06
WHR	<0.9	0.86±0.08
SBP (mmHg)	<120	130.81±15.06
DBP (mmHg)	<80	83.01±8.58
SUA (mg/dl)	3.4–7	5.81±2.08

BMI: Body mass index, WC: Waist circumference, WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 2: Correlation of serum uric acid level with obesity indices and blood pressure

Correlation of parameters (I=74)	*r* value	*P* value
SBP (mmHg) versus SUA (mg/dl)	0.753	<0.001*
DBP (mmHg) versus SUA (mg/dl)	0.575	<0.001*
WC (cm) versus SUA (mg/dl)	0.724	<0.001*
BMI (Kg/m^2) versus SUA (mg/dl)	0.680	<0.001*
WHtR versus SUA (mg/dl)	0.742	<0.001*
WHR versus SUA (mg/dl)	0.629	<0.001*

P<0.05*: Statistically significant. BMI: Body mass index, WC: Waist circumference, WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Experimental studies have shown that sustained mild hyperuricemia resulted in increased blood pressure due to increased juxtaglomerular renin content and reduced expression of nitric oxide synthase in macula densa. These changes resulted in both afferent and efferent arteriolar vasoconstriction, thereby confirming activation of renin-angiotensin system and increased blood pressure.[17,18] Uric acid also causes vascular smooth muscle cell proliferation. Uric acid enters the cells through URAT1 transporters present on vascular smooth muscle and endothelial cells. It causes activation of specific mitogen-activated protein kinases (Erk1/2 and p38) and nuclear transcription factors (NF-kB and AP1), thus causing increased expression and activity of cyclooxygenase- 2. This induces local thromoxane A2 formation, production of platelet-derived growth factors, and inflammatory proteins (C-reactive protein [CRP] and monocyte chemotactic protein-1) resulting in vascular smooth muscle cell proliferation and macrophage infiltration, thus induces atherosclerosis.[19] Uric acid is associated with various inflammatory markers such as white blood cell, CRP, interleukin (IL)-1, IL-6, IL-10, and IL-18, suggesting hyperuricemia a pro-inflammatory state.[20]

In our study, of 74 males, 9.46% of males were of normal weight, 24.32% of males were overweight, 47.30% of males were pre-obese, and 18.92% of males were obese. A significant positive linear correlation between SUA level and obesity indices (BMI, WC, WHR and WHtR) and BMI was observed in males [Table 2]. Many studies[21,22] have also found similar result of positive correlation between uric acid level and BMI.

Positive association of SUA level with BMI and skinfold thickness was also reported by Ogura *et al*.[23] The study done by Zapolski *et al*. found a positive association of uric acid level with BMI, WC, and WHR. The study also highlighted that uric acid was independently associated with WHR.[24] Obesity is associated with inflammatory response in adipose tissue with an increased local expression of adipokines monocyte chemoattractant protein-), tumor necrosis factor-α, and IL-6. Increased adiponectin in adipose tissue causes stimulation of fat oxidation, acted as insulin sensitizer, and had antiatherogenic properties.[25]

Animal study done by Tsushima *et al*. showed an increase xanthine oxidoreductase activity in adipose tissue, thereby increasing the production and secretion of uric acid.[26] Another mechanism related to increase uric acid production due to obesity might be lipogenesis. Obese adipose tissue was responsible for active fatty acid synthesis which was closely associated with *de novo* purine synthesis through pentose phosphate pathway resulting in enhanced production and secretion of uric acid.[26]

SUA (dependent variable) was further correlated with obesity indices and blood pressure (independent variables) by multiple regression analysis to determine independent predictors of SUA level [Table 3]. Result of our study showed that uric acid is independently associated with systolic blood pressure as well as WHR. Our study is in accordance with Zapolski *et al*.[24] who also found an independent association of SUA level with WHR. Thus, among all obesity indices, WHR correlates independently with uric acid level.

In the present study, a significant positive correlation ($P < 0.001$) of SUA with systolic and diastolic blood pressure and various obesity indices demonstrates that elevated uric acid has a significant effect on blood pressure and simple obesity indices are sufficient to predict raised uric acid level.

Hence, in a nutshell, increased uric acid level in obesity might be due to increase expression of xanthine oxidase reductase enzyme, increase fatty acid synthesis which might lead to purine synthesis and high uric acid level production. Raised uric acid level might lead to the activation of renin-angiotensin system, impaired nitric oxide production causing endothelial dysfunction, vascular smooth muscle cell proliferation, and inflammation leading to increase blood pressure.

Limitations

Sample size was small and renal function tests were not assessed.

Table 3: Correlation of serum uric acid (dependent variable) with obesity indices and blood pressure (independent variables) by multiple regression analysis in males

Independent variables	Unstandardized coefficients		*P*-value	95% confidence interval for B	
	B	Std. error		Lower bound	Upper bound
Constant	−12.659	1.858	<0.001*	−16.37	−8.95
WC (cm)	−.002	0.035	0.95	−0.07	0.07
BMI (Kg/m^2)	0.096	0.074	0.20	−0.05	0.24
WHtR	0.844	7.664	0.91	−14.45	16.14
WHR	8.731	2.716	<0.05*	3.31	14.15
SBP (mmHg)	0.081	0.020	<0.001**	0.04	0.12
DBP (mmHg)	−0.030	0.029	0.30	−0.09	0.03

P<0.05*: Statistically significant. BMI: Body mass index, WC: Waist circumference, WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Recommendations

The present study highlighted the importance of WHR. Thus, maintaining WHR within normal range by healthy lifestyle will help to maintain SUA level within normal range. This might prevent hypertension and future risk of cardiovascular diseases in young adults.

CONCLUSIONS

The present study showed a significant positive correlation between SUA level with systolic and diastolic blood pressure in males. It was also significantly positively correlated with all measured obesity indices (WC, BMI, WHtR, and WHR). SUA level is independently associated with systolic blood pressure as well as WHR. Among all obesity indices, WHR correlated independently with uric acid.

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