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Research Article

ASSOCIATION BETWEEN SERUM URIC ACID AND METABOLIC SYNDROME COMPONENTS AT TERTIARY CARE HOSPITAL, NORTH WEST RAJASTHAN

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ABSTRACT

Objective: The term "metabolic syndrome" (MetS) refers to a concept rather than a specific illness. All cardiovascular events seen in participants cannot be explained by the established risk factors for metabolic syndrome. We investigated the relationship between uric acid levels and the different elements of the metabolic syndrome.

Methods: The Department of Medicine, S.P. Medical College, Bikaner, Rajasthan, conducted a case control study from January 2020 to December 2020 on 150 cases of metabolic syndrome as per NCEP ATP III definition criteria and harmonizing definition criteria, admitted in various wards, and 150 healthy individuals taken as controls selected by simple random sampling and matched for confounding factors.

Results: Both the study group and the control group had comparable socio-demographics. In the metabolic group (study group), the prevalence of hyperuricemia was 20% with a mean of 6.00±0.98 mg/dL, compared to 22.3% in men and 16.07% in women. When the maximal number of metabolic syndrome components (4 or 5) were present, the mean blood uric acid level was 6.4 1.03 mg/dL (p = 0.001).

Conclusion: The incidence of the metabolic syndrome and its elements was substantially correlated with serum uric acid levels.

Keywords: HOMA IR, Metabolic syndrome, Serum uric acid.

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INTRODUCTION

A collection of risk factors, such as obesity, dyslipidemia, hypertension, and insulin resistance, together characterize the metabolic syndrome (MetS) [1]. The NCEP ATP III definition and harmonizing definition criteria state that metabolic syndrome is present if three or more of the following five conditions are true: Waist circumference 90 cm (for men) or 80 cm (for women), blood pressure greater than 130/85 mmHg, fasting triglyceride (TG) level greater than 150 mg/dl, and fasting high-density lipoprotein (HDL) cholesterol level <40 mg/dl (for men) or 50 [2].

The prevalence of metabolic syndrome varies greatly over the world, from 10% to 84%. The prevalence of metabolic syndrome is estimated to be 27% in the United States (29% in women and 25.2% in men), and 15.7% in Taiwan (18.3% in men and 13.6% in women). There is evidence that the prevalence of metabolic syndrome ranges from 11% to 41% in India, a big nation with a diverse sociocultural heritage [3]. The previous research has demonstrated that the established risk factors for the metabolic syndrome are insufficient to account for all CVD events in the subject. As a result, it has been debatable whether or not to include other risk factors such inflammatory indicators, microalbuminuria, hyperuricemia, and coagulation abnormalities in the diagnosis of the metabolic syndrome. [4] According to some research, hyperuricemia is linked to metabolic syndrome [5].

Since humans lack urate oxidase or uricase, they are unable to catabolize uric acid into the more soluble molecule allantoin; hence, their serum uric acid concentration is higher than that of practically all other mammals. However, in the setting of enhanced oxidative stress, this high uric acid level in humans has been considered advantageous [6-8]. According to some research, the high uric acid concentrations in humans have an antioxidant impact that helps protect the brain from a number of neuroinflammatory and neurodegenerative illnesses [9].

Increased blood uric acid levels have been linked to a number of cardiometabolic risk factors, although the direct link to the metabolic syndrome (Mets) is still debatable and calls for more research. As a result, we investigated the relationship between uric acid levels and the different metabolic syndrome elements.

METHODS

In a case–control study conducted from January 2020 to December 2020 at the Department of Medicine, S.P. Medical College, Bikaner, Rajasthan, 150 cases of the metabolic syndrome were admitted in various wards in accordance with NCEP ATP III definition criteria and harmonizing definition criteria, and 150 healthy individuals were taken as controls and matched for confounding factors.

Sample size [10]

$N = 4pq/d^2 = 84$

p = prevalence of metabolic syndrome (30%) q = 1-p

d = allowable error (10%)

The minimum sample size was adjusted up to 100 because it was thought to be 30% unresponsive. Thus, using the NCEP ATP III definition criteria and harmonizing definition criteria, we examined 150 cases of metabolic syndrome that were admitted to various wards within the Department of Medicine. Case and control subjects who did not meet the metabolic syndrome criteria, were under the age of 18, were hospital employees or attendants unrelated to the cases, and were matched for age and sex. Patients with other co-morbidities, such as chronic liver disease, chronic kidney disease, malignancy, and chemotherapy, as well as those who did not provide written consent were excluded from the study.

DIAGNOSTIC CRITERIA FOR METABOLIC SYNDROME (NCEP ATP 3 GUIDELINES AND HARMONISING DEFINITION CRITERIA)

(Adult Treatment Panel, National Cholesterol Education Program) If three or more of the next five conditions are met, metabolic syndrome is present.

1. A specific medicine or a high blood triglyceride level (>150 mg/dl)
2. Low blood HDL cholesterol in men (40 mg/dL) and women (50 mg/dL) or use of a particular drug
3. Blood pressure less than 130 systolic or less than 85 diastolic, or using a certain medicine
4. A fasting plasma glucose level of less than 100 mg/dL, the use of a certain medication, or a history of type II diabetes
5. Waist circumference for men is 90 cm and for women is 80 cm (as per Harmonizing definition).

Methods

Before study admission, all patients provided their informed permission, which the institutional review board approved of the study. The pro forma was filled out and the patient's demographic, anthropometric, and clinical features were noted.

ANTHROPOMETRIC AND BLOOD PRESSURE MEASUREMENT

Subjects were weighed using digital scales while wearing the bare minimum of clothing and without shoes, and the weight was recorded to the closest 100 g. Subjects were asked to stand barefoot with their shoulders in a normal stance as they had been instructed, and their height was measured to the nearest 1 cm using a non-elastic tape meter. By dividing the body weight in kilograms (kg) by the square of the height in meters, the body mass index (BMI) was determined (m). Kg/m^2 was the standard unit of measurement for BMI. Using a mercury sphygmomanometer, blood pressure (BP) was twice measured in subjects' right arms after they had rested for at least 5 min in a seated position. For males, hyperuricemia was classified as >7 mg/dL and for females, >5.7 mg/dL.

LABORATORY MEASUREMENTS

After a 12- to 14-h overnight fast, participants' venous blood was drawn, and it was analyzed within 2 h. Autoanalyzer was used to determine the lipid profile. Using the glucose oxidase technique, FPG was measured. An autoanalyzer was used to measure the serum uric acid (enzymatic calorometric). Chemiluminescence was used to calculate the serum insulin levels. Insulin resistance was evaluated using the Homeostasis Model Assessment (HOMA) technique (IR).

$$\text{HOMA} - \text{IR} = (FBG(mg/dL) \times Serum\,insulin\ (\mu units/mL)) \div 405$$

Data were gathered in this way, entered into Microsoft Excel 2007, and statistical tests were run using the proper software, with p value of 0.05 being considered statistically significant.

RESULTS

The study population's mean age was 41.75±12.27 years, with the majority of cases (50%) belonging to the age range of 41–60 years and the least (13.3%) to the age range of cases >60 years. In the current study, both the study and control groups' majority of patients were men (62.66% and 66%, respectively). Due to the higher percentage of patients from rural areas admitted to our facility, the majority of cases in our study (51.33% and 58%, respectively) belonged to rural areas. About 67.33% of the participants in our study were using oral hypoglycemic medications, 56.66% were on anti-hypertensive medications, and 48% were receiving statin therapy. Table 1 displays the mean of the various variables. In the metabolic group compared to the non-metabolic group, the mean values of BMI, waist circumference (for males and females), systolic and diastolic blood pressure, total cholesterol, triglyceride, LDL cholesterol, fasting blood sugar, HbA1c, serum insulin, and HOMA IR were all higher. The metabolic group had lower HDL cholesterol.

As indicated in Table 2, the mean value of serum uric acid in our study was 6.00±0.98 mg/dL in the study group and 4.74±1.22 mg/dL in the control group. This difference was statistically significant (p=0.01) and can be seen.

According to Graph 1, the prevalence of hyperuricemia was 20% in the metabolic syndrome group (study group), 22.3% in men, and 16.07% in women.

When all five components of the metabolic syndrome were present, the mean blood uric acid level was at its highest, 6.4 mg/dL, and at its lowest, 4.73 mg/dL. The average serum uric acid in components 4 and 5 was combined because it was similar in both. The statistically extremely significant relationship between blood uric acid levels and metabolic syndrome factors was discovered (Graphs 2 and 3).

DISCUSSION

In our study, the mean age was 42.15±12.65 years in the study group and 41.34±11.91 years in the control group. This difference was found to be statistically insignificant (p>0.05). Culleton *et al*. (1999) [11] observed similar age groupings with a mean age of 47 years.

In comparison to the control group, the study group's mean BMI was 29.40±4.11 kg/m^2, and this difference was shown to be statistically significant (p>0.05). Similar to this, Osei-Yeboah *et al*. (2017) [12] showed that individuals with metabolic syndrome had mean BMI of 27.46±5.88 kg/m^2, which was substantially linked.

In the study group, the mean waist circumference for men was 97.45±10.80 cm, while the mean waist circumference for women was 96.87±10.69 cm, while the mean waist circumference for controls was 78.33±7.97 cm. This difference in both genders was found to be statistically significant (p 0.05). The difference between the mean systolic blood pressures of the study group (136.32±9.90 mmHg) and the control group (121.68±11.29 mmHg) was determined to be statistically significant (p 0.05). In a similar manner, Liou *et al*. (2006) [13] discovered that the metabolic syndrome was substantially correlated with both systolic blood pressure and waist circumference (WC).

The difference between the mean triglyceride levels in the study and control groups — 168.74±117.40 mg/dL versus 88.67±38.82 mg/dL — was determined to be statistically significant (p=0.01). In addition, Marbou *et al*. (2019) [14] discovered that metabolic syndrome was substantially linked with hypertriglyceridemia (53.97%) (p=0.001).

In the current study, 51 (34%) of the study group's female cases had HDL cholesterol levels above 50 mg/dL, while in the control group, 15 (10%) of the female cases had HDL cholesterol levels above 50 mg/dL. The mean HDL cholesterol in the study group was 34.73±6.62 mg/dL, while in the control group, it was 46.87±10.99 mg/dL. This difference was discovered statistically significant (p<0.05). Similarly, Marbou *et al*. (2019) [14] discovered that low-high-density lipoprotein was substantially related with the metabolic syndrome (HDL - C).

In the study group, 88% of participants had fasting blood sugars below 100 mg/dl, compared to 10% of control group participants. The difference between the mean random blood sugar in the control group and the mean fasting blood sugar in the study group was determined to be statistically extremely significant (p=0.001). In addition, Liou *et al*. (2006) [13] discovered a substantial correlation between the metabolic syndrome and blood glucose levels.

The difference between the mean HOMA IRs of the study (metabolic) group and the control group was statistically significant (p=0.05) at 5.13±2.02 versus 2.08±0.378. Similar findings were made by Adnan *et al*. (2019) [15], who discovered that participants with increased insulin resistance (IR) had a considerably higher likelihood of having metabolic syndrome (88.23% vs. 11.77%; p=0.0001). In addition, Das (2020) [16] found that children with metabolic syndrome had mean HOMA-IR values of 5.46 compared to 2.18 in children without metabolic syndrome (insulin resistance was more common in children with metabolic syndrome).

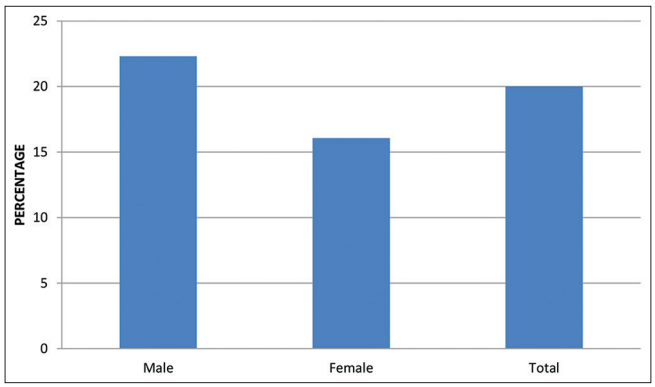
Based on pathophysiological and metabolic research, it is likely that insulin resistance (IR) and hyperuricemia (HU) have an impact on one

Table 1: Comparison of various parameters in study and control group

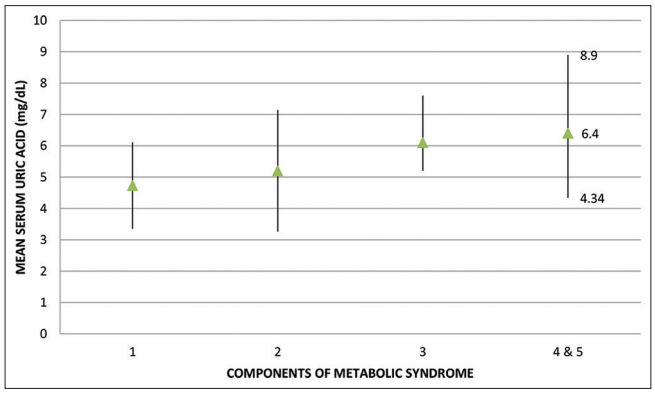
Variable	Study group (Mets group)	Control group (Non mets group)	p Value
Age (years)	42.15±12.65	41.34±11.91	0.568
BMI (kg/m^2)	29.40±4.11	24.03±2.71	0.0001
Waist circumference male (cm)	97.45±10.80	84.78±6.78	0.0001
Waist circumference female (cm)	96.87±10.69	78.33±7.97	0.0001
Systolic blood pressure (mmHg)	136.32±9.90	121.68±11.29	0.0001
Diastolic blood pressure (mmHg)	87.97±6.22	80.09±9.47	0.0001
Total cholesterol (mg/dL)	170.28±47.72	139.77±17.40	0.0001
Triglyceride (mg/dL)	168.74±117.40	88.67±38.82	0.0001
HDL cholesterol (mg/dL)	34.73±6.62	46.87±10.99	0.0001
LDL cholesterol (mg/dL)	102.06±36.49	75.45±11.76	0.0001
Fasting blood sugar (mg/dL)	127.39±26.96	98.06±21.85	0.0001
HbA1c (%)	6.49±1.11	5.38±0.49	0.0001
S INSULIN (µU/mL)	16.2±5.92	8.63±1.49	0.0001
HOMA IR	5.13±2.02	2.08±0.378	0.001

Table 2: Distribution of study subjects as per levels of serum Uric Acid

Serum uric acid (mg/dL)	Study group	Control group	p value
	Mean±SD	Mean±SD	
Male	6.27±1.20	5.30±1.31	0.0001
Female	5.54±1.20	3.63±1.22	0.0001
Total	6.00±0.98	4.74±1.22	0.0001

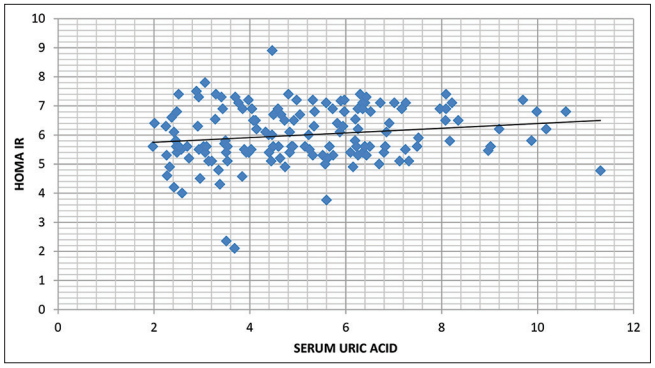


Graph 1: Prevalance of hyperuricemia in study group (mets group)



Graph 2: Association between serum uric acid level and components of metabolic syndrome

another. By lowering NO bioavailability and producing mitochondrial oxidative stress, uric acid can cause IR through a variety of methods [17]. On the other hand, IR limits uric acid excretion primarily



Graph 3: Correlation between HOMA-IR and serum uric acid. r=0.1669, p=0.041

via elevating sodium reabsorption in the renal tubules, which results in hyperuricemia [18]. In contrast, IR is a separate risk factor for later hyperuricemia [19]. Because changes in either one may occur before changes in the other, the results of these investigations revealed that the dynamic of the temporal relationship between hyperuricemia and IR is likely far from straightforward.

In our investigation, the mean serum uric acid level in the study (metabolic) group was 6.00±0.98 mg/dL whereas it was 4.74±1.22 mg/dL in the control group. This difference was statistically significant (p=0.01). Similar findings were made by Ali *et al*. (2020) [20] and Nejatinamini *et al*. (2015) [21], who discovered that patients in the metabolic syndrome group had significantly higher mean serum uric acid concentrations than those in the non-metabolic syndrome group (p 0.05). In addition, Chen *et al*. (2015) [22] discovered that uric acid was a potent and independent predictor for both men and women's metabolic syndrome.

Contrarily, Adnan *et al*. (2019) [15] found that the average serum uric acid level was higher in individuals with metabolic syndrome compared to individuals without metabolic syndrome, but that this difference was not statistically significant (6.62 vs. 6.28).

In our study, the prevalence of hyperuricemia was 20% in the group with metabolic syndrome (study group), 22.3% in men, and 16.07% in women. Similar to what Huang *et al*. (2017) [23] found, 21.0% of people have hyperuricemia. In addition, Zhang *et al*. [24] showed that the prevalence of hyperuricemia overall was 12.16%, with men substantially more likely than women to have it.

In our investigation, we discovered that the mean blood uric acid level was minimal 4.73±0.69 mg/dL when only one component of the metabolic syndrome was present and highest 6.4±1.03 mg/dL in

situations where both of its components were present. Four or five components were combined since the mean serum uric acid in each was comparable. The statistically extremely significant relationship between blood uric acid level and metabolic syndrome components was discovered. Similar findings were made by Porchia *et al.* (2018) [25], Huang *et al.* (2017) [23], and Zhang *et al.* [24] who found that uric acid levels were higher in the metabolic syndrome positive group and linked with the number of the syndrome's components. In addition, Chen *et al.* (2016) [26] noted a graded, positive association with total cholesterol, triglyceride, and a negative association with HDL cholesterol [27].

Overall, our research indicated that metabolic syndrome was associated with hyperuricemia. It was positively linked to an increase in the number of metabolic syndrome components.

CONCLUSION

In this investigation, the prevalence of the metabolic syndrome and its elements was substantially correlated with serum uric acid levels. Our research suggests that metabolic syndrome may include uric acid as one of its components. Future research should be done to determine the clinical implications of the current findings and the function of uric acid in the etiology of metabolic syndrome. The increased risk of metabolic syndrome and hyperuricemia for the general population should also be taken into consideration.

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AUTHORS' CONTRIBUTION

All the authors have contributed equally.

CONFLICT OF INTEREST

Nil.

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REFERENCES

1. Grundy SM, Brewer HB Jr., Cleeman JI, Smith SC Jr., Lenfant C, American Heart Association, *et al*. Definition of metabolic syndrome: Report of the national heart, lung, and blood Institute/American heart association conference on scientific issues related to definition. Circulation 2004;109:433-8.
2. Huang PL. A comprehensive definition for metabolic syndrome. Dis Model Mech 2009;2:231-7.
3. Khan Y, Lalchandani A, Gupta AC, Khadanga S, Kumar S. Prevalence of metabolic syndrome crossing 40% in Northern India: Time to act fast before it runs out of proportions. J Family Med Prim Care 2018;7:118-23.
4. Ramakrishna V, Jailkhani R. Oxidative stress in non-insulin-dependent diabetes mellitus (NIDDM) patients. Acta Diabetol 2008;45:41-6.
5. Chen LY, Zhu WH, Chen ZW, Dai HL, Ren JJ, Chen JH, *et al*. Relationship between hyperuricemia and metabolic syndrome. J Zhejiang Univ Sci B 2007;8:593-8.
6. Feig DI, Kang DH, Johnson RJ. Uric acid and cardiovascular risk. N Engl J Med 2008;359:181-21.
7. Berry CE, Hare JM. Xanthine oxidoreductase and cardiovascular disease: Molecular mechanisms and pathophysiological implications. J Physiol 2004;555:589-606.
8. Ames BN, Cathcart R, Schwiers E, Hochstein P. Uric acid provides an antioxidant defense in humans against oxidant-and radical-caused aging and cancer: A hypothesis. Proc Natl Acad Sci U S A 1981;78:6858-62.
9. Davis JW, Grandinetti A, Waslien CI, Ross GW, White LR, Morens DM. Observations on serum uric acid levels and the risk of idiopathic Parkinson's disease. Am J Epidemiol 1996;144:480-4.
10. Krishnamoorthy Y, Rajaa S, Murali S, Rehman T, Sahoo J, Kar SS. Prevalence of metabolic syndrome among adult population in India: A systematic review and meta-analysis. PLoS One 2020;15:e0240971.
11. Culleton BF, Larson MG, Kannel WB, Levy D. Serum uric acid and risk for cardiovascular disease and death: The Framingham heart study. Ann Intern Med 1999;131:7-13.
12. Osei-Yeboah J, Owiredu WK, Norgbe GK, Lokpo SY Gyamfi J, Allotey EA, *et al*. The prevalence of metabolic syndrome and its components among people with Type 2 diabetes in the Ho municipality, Ghana: A cross-sectional study. Int J Chronic Dis 2017;2017:8765804.
13. Liou TL, Lin MW, Hsiao LC, Tsai TT, Chan WL, Ho LT, *et al*. Is hyperuricemia another facet of the metabolic syndrome? J Chin Med Assoc 2006;69:104-9.
14. Marbou WJ, Kuete V. Prevalence of metabolic syndrome and its components in Bamboutos division's adults, West region of Cameroon. BioMed Res Int 2019;1:12.
15. Adnan E, Rahman IA, Faridin HP. Relationship between insulin resistance, metabolic syndrome components and serum uric acid. Diabetes Metab Syndr 2019;13:2158-62.
16. Das RR, Mangaraj M, Panigrahi SK, Satapathy AK, Mahapatro S, Ray PS. Metabolic syndrome and insulin resistance in schoolchildren from a developing country. Front Nutr 2020;7:31.
17. Lanaspa MA, Sanchez-Lozada LG, Choi YJ, Cicerchi C, Kanbay M, Roncal-Jimenez CA, *et al*. Uric acid induces hepatic steatosis by generation of mitochondrial oxidative stress: Potential role in fructose-dependent and -independent fatty liver. J Biol Chem 2012;287:40732-44.
18. Maaten JC, Voorburg A, Heine RJ, Wee PM, Donker AJ, Gans RO. Renal handling of urate and sodium during acute physiological hyperinsulinaemia in healthy subjects. Clin Sci (Lond) 1997;92:51-8.
19. Nakamura K, Sakurai M, Miura K, Morikawa Y, Nagasawa SY, Ishizaki M, *et al*. HOMA-IR and the risk of hyperuricemia: A prospective study in non-diabetic Japanese men. Diabetes Res Clin Pract 2014;106:154-60.
20. Ali N, Miah R, Hasan M, Barman Z, Mou AD, Hafsa JM, *et al*. Association between serum uric acid and metabolic syndrome: A cross-sectional study in Bangladeshi adults. Sci Rep 2020;10:7841.
21. Nejatinamini S, Ataie-Jafari A, Qorbani M, Nikoohemat S, Kelishadi R, Asayesh H, *et al*. Association between serum uric acid level and metabolic syndrome components. J Diabetes Metab Disord 2015;14:70.
22. Chen D, Zhang H, Gao Y, Lu Z, Yao Z, Jiang Y, *et al*. Cross-sectional and longitudinal associations between serum uric acid and metabolic syndrome: Results from Fangchenggang area male health and examination survey in China. Clin Chim Acta 2015;446:226-30.
23. Huang S, Liu X, Li H, Xu W, Jia H. Sex difference in the association of serum uric acid with metabolic syndrome and its components: A cross-sectional study in a Chinese Yi population. Postgrad Med 2017;129:828-33.
24. Zhang Q, Lou S, Meng Z, Ren X. Gender and age impacts on the correlations between hyperuricemia and metabolic syndrome in Chinese. Clin Rheumatol 2011;30:777-87.
25. Porchia LM, Gonzalez-Mejia ME, Torres-Rasgado E, Ruiz-Vivanco G, Pérez-Fuentes R. Low serum uric acid concentration augments insulin effects on the prevalence of metabolic syndrome. Diabetes Metab Syndr 2018;12:325-31.
26. Chen JH, Hsieh CH, Liu JS, Chuang TJ, Chang HW, Huang CL, *et al*. The power of serum uric acid in predicting metabolic syndrome diminishes with age in an elderly Chinese population. J Nutr Health Aging 2016;20:912-7.
27. Bonakdaran S, Kharaqani B. Association of serum uric acid and metabolic syndrome in Type 2 diabetes. Curr Diabetes Rev 2014;10:113-7.