Serum uric acid level and its association with metabolic syndrome in Korean adolescents

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INTRODUCTION

Elevated serum uric acid (UA) levels are associated with metabolic syndrome (MS), cardiometabolic risk factors (CMRFs) and non-alcoholic fatty liver disease (NAFLD) in adults. However, little is known about usefulness of UA to predict MS in adolescents.

As the prevalence of obesity among pediatric population has been increasing, it is important to know the factors associated with the CMRFs to prevent future development of diabetes and cardiovascular disease.

OBJECTIVE

We aim to evaluate the association between serum UA level and MS and CMRFs among Korean adolescents.

METHODS

Data collected from the Korea National Health and Nutrition Examination Survey in 2016 were used, which was a nationally representative cross-sectional data.

A total of 548 subjects (male 268, 48.9%) aged 13-20 years were included in this study. They were classified into tertiles of serum UA levels (T1, lower tertile, T2 mid-tertile, T3 upper-tertile) according to sex. Prevalence of MS and CMRFs including alanine aminotransferase (ALT) was compared by tertiles of UA..

RESULTS

The mean UA was higher in males than females (6.3 ± 0.1 mg/dL vs. 4.6 ± 0.1 mg/dL; P < 0.001).

Table 1. Clinical characteristics of study participants by sex

	Total	Male	Female	*p*-value
N (%)	548 (100%)	268 (51.2%)	280 (48.8%)	
Age (yr)	16.5 ± 0.1	16.4 ± 0.1	16.7 ± 0.2	0.127
Height z-score	0.17 ± 0.05	0.17 ± 0.08	0.17 ± 0.07	0.991
BMI z-score	0.03 ± 0.07	0.03 ± 0.10	0.03 ± 0.09	0.984
Waist circumference (cm)	73.4 ± 0.5	76.6 ± 0.8	70.0 ± 0.9	< 0.001
Waist circumference-height ratio	0.440 ± 0.003	0.445 ± 0.004	0.435 ± 0.004	0.074
Obesity, n (%)	72 (13.7%)	41 (14.7%)	31 (12.6%)	0.490
SBP (mm Hg)	109.9 ± 0.5	113.2 ± 0.7	106.5 ± 0.8	< 0.001
DBP (mm Hg)	68.4 ± 0.4	69.7 ± 0.6	67.0 ± 0.5	< 0.001
Uric acid	5.4 ± 0.1	6.3 ± 0.1	4.6 ± 0.1	< 0.001
Fasting glucose (mmol/L)	5.02 ± 0.02	5.08 ± 0.03	4.95 ± 0.03	0.003
HbA1c (%)	5.31 ± 0.02	5.31 ± 0.02	5.31 ± 0.02	0.971
Total cholesterol (mg/dL)	162.8 ± 1.4	157.6 ± 1.8	168.5 ± 2.0	< 0.001
Triglyceride (mg/dL)	74.9 ± 1.8	75.2 ± 2.5	74.6 ± 2.5	0.859
HDL cholesterol (mg/dL)	51.3 ± 0.5	48.9 ± 0.6	53.8 ± 0.8	< 0.001
Non-HDL-C (mg/dL)	109.7 ± 1.4	106.9 ± 1.7	112.6 ± 2.0	0.031
ALT (IU/L)	16.8 ± 0.7	20.6 ± 1.7	12.9 ± 0.8	< 0.001
Elevated ALT	47 (9.4%)	27 (10.1%)	20 (8.7%)	0.633
Abdominal obesity, n (%)	79 (14.7%)	43 (16.0%)	36 (13.4%)	0.383
Elevated fasting glucose, n (%)	5 (1.2%)	4 (1.6%)	1 (0.8%)	0.504
Elevated blood pressure, n (%)	101 (19.5%)	72 (26.9%)	29 (11.7%)	< 0.001
Elevated triglyceride, n (%)	101 (18.7%)	52 (19.2%)	49 (18.2%)	0.791
Low HDL-C, n (%)	58 (11.0%)	36 (12.8%)	22 (9.1%)	0.199
Metabolic syndrome (Cook), n (%)	35 (6.7%)	25 (9.2%)	10 (4.1%)	0.033

BMI z-score, waist circumference, waist circumference to height ratio, total cholesterol and non-HDL-cholesterol were significantly higher as T3 of UA in both sexes. Moreover, systolic blood pressure, triglyceride, ALT increased and HDL-cholesterol decreased in males. (Table 2.)

In T3 of UA, the prevalence and odds ratio increased significantly in abdominal obesity (23.3%; OR 3.1, 95% CI 1.5-6.4), elevated triglyceride (27.3%, OR 2.6, 95% CI 1.4-4.6), low HDL-cholesterol (18.3%; OR 4.7, 95% CI 1.9-11.3), elevated ALT (18.3%; OR 3.4, 95% CI 1.5-7.8), obesity (33.6%; OR 4.9, 95% CI 2.1-11.6) and MS (11.3%, OR 3.1, 95% CI 1.1-8.5), compared with T1 of UA. (Table 3.)

Proportion of participants with ≥ 3 CMRFs were 4.0% in T1, 5.6% in T2, and 11.3% in T3 (P = 0.003).

Table 2. Clinical characteristics of study participants by tertiles of serum uric acid

Sex	Variables	T1	T2	T3	*p*-value
Male	N (%)	104 (36.3%)	83 (34.9%)	81 (28.8%)	
	Uric acid (mg/dl) (range)	5.2 ± 0.1 (2.7, 5.8)	6.3 ± 0.1** (5.9, 6.7)	7.7 ± 0.1** (6.8, 9.9)	< 0.001
	Age (yr)	16.1 ± 0.2	16.7 ± 0.3	16.5 ± 0.3	0.205
	BMI z-score	-0.51 ± 0.16	-0.06 ± 0.16	0.82 ± 0.18**	< 0.001
	Waist circumference (cm)	72.2 ± 1.2	76.7 ± 1.1**	82.2 ± 1.5**	< 0.001
	Waist-height ratio	0.423 ± 0.006	0.442 ± 0.007*	0.477 ± 0.008**	< 0.001
	SBP (mm Hg)	111.3 ± 0.9	111.8 ± 1.3	117.4 ± 1.1**	< 0.001
	DBP (mm Hg)	68.8 ± 1.0	70.0 ± 1.0	70.3 ± 1.1*	0.562
	Fasting glucose (mmol/L)	5.13 ± 0.05	5.04 ± 0.04	5.07 ± 0.04	0.370
	HbA1c (%)	5.33 ± 0.03	5.30 ± 0.03	5.29 ± 0.02	0.677
	Total cholesterol (mg/dL)	157.2 ± 2.0	163.6 ± 2.2	169.1 ± 2.8**	0.003
	Triglyceride (mg/dL)	66.1 ± 3.1	76.8 ± 3.7*	86.3 ± 5.7**	0.006
	HDL cholesterol (mg/dL)	51.2 ± 0.9	47.3 ± 1.0**	48.1 ± 1.2*	0.012
	Non-HDL-C (mg/dL)	99.5 ± 2.5	106.8 ± 3.0	117.3 ± 3.5**	< 0.001
	ALT (IU/L)	16.9 ± 1.9	16.9 ± 1.0	29.5 ± 4.9*	0.039
Female	N (%)	110 (35.8%)	89 (34.6%)	81 (29.6%)	
	Uric acid (mg/dl) (range)	3.7 ± 0.1 (2.2, 4.2)	4.6 ± 0.1** (4.3, 4.9)	5.6 ± 0.1** (5.0, 7.1)	< 0.001
	Age (yr)	16.3 ± 0.3	17.4 ± 0.3**	16.4 ± 0.3	0.009
	BMI z-score	-0.24 ± 0.14	0.05 ± 0.17	0.32 ± 0.18*	0.040
	Waist circumference (cm)	68.3 ± 1.0	70.6 ± 0.9	71.5 ± 1.3	0.008
	Waist-height ratio	0.424 ± 0.006	0.438 ± 0.006	0.447 ± 0.008*	0.038
	SBP (mm Hg)	106.8 ± 1.1	105.8 ± 1.0	107.0 ± 1.8	0.756
	DBP (mm Hg)	67.0 ± 0.9	66.6 ± 0.9	67.6 ± 0.7	0.667
	Fasting glucose (mmol/L)	4.99 ± 0.04	4.89 ± 0.04	4.98 ± 0.10	0.160
	HbA1c (%)	5.27 ± 0.03	5.32 ± 0.03	5.34 ± 0.05	0.270
	Total cholesterol (mg/dL)	162.8 ± 2.8	172.5 ± 2.8*	171.0 ± 4.3	0.034
	Triglyceride (mg/dL)	71.0 ± 3.3	74.2 ± 4.2	79.7 ± 5.4	0.348
	HDL cholesterol (mg/dL)	54.4 ± 1.1	55.3 ± 1.5	51.5 ± 1.6	0.241
	Non-HDL-C (mg/dL)	106.6 ± 2.8	115.0 ± 3.2*	117.3 ± 4.1*	0.032
	ALT (IU/L)	12.6 ± 1.7	11.7 ± 0.9	14.7 ± 1.8	0.372

*P <0.05 compared with T1; **P<0.01 compared with T1

Table 3. Association between tertiles of uric acid and CMRF clustering and metabolic syndrome according to sex, age and BMI category

Variables	T1	T2	T3
Abdominal obesity			
Prevalence (%)	8.8%	13.7%	23.3%
OR (95% CI)	1 (ref)	1.5 (0.7, 3.3)	3.1 (1.5, 6.4)**
Elevated BP			
Prevalence (%)	17.6%	15.7%	26.4%
OR (95% CI)	1 (ref)	0.8 (0.4, 1.5)	1.7 (0.9, 3.1)
Elevated FPG			
Prevalence (%)	2.3%	0%	1.3%
OR (95% CI)	1 (ref)	-	0.6 (0.1, 6.3)
Elevated TG			
Prevalence (%)	12.8%	17.7%	27.3%
OR (95% CI)	1 (ref)	1.5 (0.8, 2.9)	2.6 (1.4, 4.6)**
Low HDL-C			
Prevalence (%)	4.6%	11.5%	18.3%
OR (95% CI)	1 (ref)	2.7 (1.1, 6.5)*	4.7 (1.9, 11.3)**
Elevated ALT			
Prevalence (%)	6.0%	5.5%	18.3%
OR (95% CI)	1 (ref)	08 (0.3, 2.3)	3.4 (1.5, 7.8)**
Obesity			
Prevalence (%)	5.9%	13.5%	33.6%
OR (95% CI)	1 (ref)	2.4 (1.0, 6.1)	4.9 (2.1, 11.6)**
Metabolic syndrome			
Prevalence (%)	4.0%	5.6%	11.3%
OR (95% CI)	1 (ref)	1.4 (0.5, 4.1)	3.1 (1.1, 8.5)*

*P <0.05 compared with T1; **P<0.01 compared with T1

CONCLUSION

In this national cross-sectional study, we found that serum UA level is associated with MS, its components and marker of NAFLD in Korean adolescents. Serum UA level could be used as an important marker to predict MS in adolescents.