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Serum uric acid, hyperuricemia and body mass index in children and adolescents with intellectual disabilities

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ABSTRACT

The aims of the preset study were to describe the profile of serum uric acid, the prevalence of hyperuricemia and its risk factors among children and adolescents with intellectual disabilities. We conducted a cross-sectional study of 941 children and adolescents with intellectual disabilities (aged 4–18 years) who participated in annual health examinations in three special schools in Taiwan. This study indicated 30.6% boys and 17.9% girls with intellectual disabilities were with hyperuricemia in Taiwan. The factors of gender, age and BMI were variables that can significantly predict the hyperuricemia occurrence in this vulnerable population. Those children and adolescents with intellectual disabilities were boys (OR = 2.93, 95% CI = 2.02–4.26) and older age (OR = 6.49, 95% CI = 2.19–19.21) were more likely to be hyperuricemia. With regard to BMI to hyperuricemia occurrence, those children and adolescents with intellectual disabilities were overweight (OR = 1.16–3.21, 95% CI = 1.16–3.21) and being obese (OR = 4.95–11.58, 95% CI = 4.95–11.58) was more likely to have a hyperuricemia than the normal weight group. This study provides the general profile of serum uric acid, hyperuricemia and its risk factors of children and adolescents with intellectual disabilities. Medical professionals should be highly

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alert to the possible consequences of hyperuricemia and provide useful information about the clinical manifestation of this condition for caregivers of children and adolescents with intellectual disabilities.

1. Introduction

Excessive amounts of uric acid known as hyperuricemia is one of the most frequent metabolism disturbances. Hyperuricaemia (Campion, Glynn, & De Labry, 1987; Hall, Barry, Dawber, & McNamara, 1967) and high mean serum uric acid concentrations (Glynn, Campion, & Silbert, 1983; Tausche et al., 2006) as risk factors for gout have been well documented in the past decades.

Hyperuricemia has long been known to be associated with cardiovascular disease, and it is particularly common in people with hypertension, metabolic syndrome, or kidney disease (Choi & Ford, 2007; Conen et al., 2004; Culleton, Larson, Kannel, & Levy, 1999; Heinig & Johnson, 2006; Johnson, Kivlighn, Kim, Suga, & Fogo, 1999; Lee, Wahlqvist, Yu, & Pan, 2007; Lohsoonthorn, Dhanamun, & Williams, 2006). Chronic hyperuricemia is strongly associated with chronic tubulointerstitial disease, and many of these patients have decreased renal function (Johnson, Kivlighn, Kim, Suga, & Fogo, 1999).

According to Wallace, Riedel, Joseoh-Ridge, and Wortmann (2004) analyzed data of older adults in a managed care population in the US, they found the prevalence of gout and/or hyperuricemia in the overall study population increased during the 10-year period. In Taiwan, hyperuricemia is an increasing health issue, with an estimated prevalence of 20.3–25.8% in men and 14.0–15.0% in women (Chou, Soong, & Lin, 1993; Lin, Lin, & Chou, 2000). Chang, Pan, Yeh, and Tsai (2001) found that 26% of adult males (≥19 years) and 22% of older males (≥45 years) either had hyperuricemia or were taking medication for it. Lee et al. (2005) found the overall prevalence of hyperuricemia in the elderly to be 36% (46% for males and 26% for females). In addition, Lin, Yen, and Chang (2006) found that approximately half of the professional and collegiate athletes had hyperuricemia.

To our knowledge, data on the prevalence of hyperuricemia of people with intellectual disabilities (ID) are limited. There were only seven studies related to people with ID in the past decades (Bazelon, Stevens, Davis, Seegmiller, & Green, 1968; Chapman & Stern, 1964; Hoefnagel, 1965; Michener, 1967; Pant, Moser, & Krane, 1968; Rundle & Fannin, 1966; Shapiro, Sheppard, Dreifuss, & Newcombe, 1966). However, those studies were out of date and lacked an evaluation of related risk factors of hyperuricemia among this vulnerable population. Nan et al. (2006) pointed out that the prevalence of hyperuricemia and gout is strongly associated with economic development and lifestyle factors, and many studies found that those people with ID who are prevalent in diseases and higher medical care utilization than the general population (Hsu et al., 2009; Lin, Lin, Yen, Loh, & Chwo, 2009; Lin, Wu, & Lee, 2004; Lin, Yen, Li, & Wu, 2005; Lin, Yen, Loh, et al., 2006, 2007), therefore describing the current profile of hyperuricemia of this group of people to evaluate their health is needed. The purposes of the present study were to describe the profile of serum uric acid, the prevalence of hyperuricemia and its risk factors among children and adolescents with ID.

2. Methods

We conducted a cross-sectional study of 941 children and adolescents with ID who participated in annual health examinations in three special schools in Taiwan. The participants accepted health examination as they enrolled into special schools at the first year, the examination includes body physical exam, biochemical (blood, urine and stool specimen) and X-ray check-up. The study was designed to review all the health examination charts which included all eligible children aged 4–18 years and adolescents with ID from all three special schools. Research ethical approval and written informed consent were obtained from all the study special schools.

Participants underwent routine physical examinations that included demographic characteristics (age and gender), disability condition (type and level), determining body mass index (BMI; weight and height) and blood sample. BMI was calculated as weight in kilograms divided by square of height in meters (kg/m^2). Serum samples were used to determine participants' uric acid profiles. Uric acid is a waste product normally present in the blood as a result of the breakdown of purines. The condition of hyperuricemia was defined as a high level of uric acid concentration in the blood $\geqq 7$ mg/dl for men and $\geqq 6$ mg/dl for women (DOH, 2009).

Data were analyzed by SPSS 14.0. We first used number, percentage and chi-square method to describe the participant characteristics and analyzed their associations with hyperuricemia. Pearson's correlation coefficients were obtained for the relationship between BMI value and uric acid concentration. Logistic regression procedure was used to examine the risks of having a hyperuricemia condition.

3. Results

3.1. Characteristics of study subjects

The characteristics of study participants are reported in Table 1. Of the 941 children and adolescents with ID in this study, 562 were boys and 379 were girls, and the average age of the subjects was 15.05 ± 2.15 years (range 4–18 years). 65.5% of the study subjects were with ID solely while 34.5% were with ID accompanied by other disabilities (multiple disabilities) as well. In term of disability level, most of the persons with ID in this study belonged to the moderate and severe level of disability (48.3% and

Table 1
Characteristics of study subjects.

Characteristics	*N*	%	Mean ± S.D. (range)
Gender (*N* = 941)			
Boys	562	59.7	
Girls	379	40.3	
Age (*N* = 941)			15.05 ± 2.15 (4.0–18.0)
4–6	16	1.7	
7–12	67	7.1	
13–18	858	91.2	
Disability type (*N* = 941)			
ID	616	65.5	
Multiple[a]	325	34.5	
Disability level (*N* = 940)			
Mild	81	8.6	
Moderate	454	48.3	
Severe	314	33.4	
Profound	91	9.7	
Height (*N* = 922)			155.26 ± 14.24 (90.00–185.00)
Weight (*N* = 922)			53.02 ± 18.06 (8.70–121.50)
BMI (kg/m^2) (*N* = 920)			21.57 ± 5.72 (8.67–50.41)
Boys	548		21.61 ± 5.80 (8.67–50.41)
Girls	372		21.53 ± 5.60 (9.86–42.29)
BMI (kg/m^2) (*N* = 920)			
Underweight	275	29.2	
Normal	315	34.2	
Overweight	120	13.0	
Obese	210	22.8	
Uric acid (mg/dl) (*N* = 941)			
Boys	562		6.33 ± 1.77 (1.80–15.20)
Girls	379		4.85 ± 1.39 (1.50–10.40)

[a] ID accompanied with other disabilities.

Table 2
Hyperuricemia and personal characteristics of study subjects.

Variable	Hyperuricemia[a]		χ^2	p-Value
	No (percent)	Yes (percent)		
Gender ($N = 941$)			19.10	<0.001
Male	390 (69.4)	172 (30.6)		
Female	311 (82.1)	68 (17.9)		
Age ($N = 941$)			18.56	<0.001
4–6 years	16 (100.0)	0 (0.0)		
7–12 years	62 (92.5)	5 (7.5)		
13–18 years	623 (72.6)	235 (27.4)		
Disability type ($N = 941$)			0.59	0.442
ID	454 (73.7)	162 (26.3)		
Multiple[b]	247 (76.0)	78 (24.0)		
Disability level ($N = 940$)			3.72	0.293
Mild	54 (66.7)	27 (33.3)		
Moderate	339 (74.7)	115 (25.3)		
Severe	236 (75.2)	78 (24.8)		
Profound	72 (79.1)	19 (20.9)		
BMI ($N = 920$)			159.00	<0.001
Underweight	247 (89.8)	28 (10.2)		
Normal	261 (82.9)	54 (17.1)		
Overweight	86 (71.7)	34 (28.3)		
Obese	89 (42.4)	121 (57.6)		

[a] Male $\geqq$ 7 mg/dl, female $\geqq$ 6 mg/dl (DOH, 2009).
[b] Multiple = ID + other disabilities.

33.4%, respectively). With regard to the physical figure of the participants, the results of BMI analysis indicated that 34.2% participants were normal, 13.0% were overweight, 22.8% were obese and 29.2% were underweight Table 2.

3.2. Serum uric acid and hyperuricemia

The mean concentration of serum uric acid (mg/dl) was 6.33 ± 1.77 (range = 1.80–15.20) in the boys and 4.85 ± 1.39 (range = 1.50–10.40) in the girls (Table 1). Table 3 analyzed Chi-square correlation between hyperuricemia and subject's characteristics in the bivariant analysis. The results showed the gender, age, and BMI were significantly correlated to hyperuricemia ($p < 0.001$). Boys with ID (prevalence = 30.6%) were more inclining to be hyperuricemia than girls with ID (prevalence = 17.9%), and subjects of aged 13–18 (prevalence = 27.4%) were nearly 3.7 times to be hyperuricemia of aged 7–12 (prevalence = 7.5%), and aged 4–6 was no hyperuricemia cases in the study. Finally, the body figure analyzed found different BMI will vary significantly on hyperuricemia prevalence in those children and adolescents with ID. The body weight increased and the hyperuricemia prevalence increases consistently. Obese individuals (prevalence = 57.6%) had a significantly higher prevalence of hyperuricemia than

Table 3
Hyperuricemia cases and BMI by gender ($N = 237$).

Variable	Hyperuricemia		χ^2	p-Value
	Boys (percent)	Girls (percent)		
BMI			9.60	0.022
Underweight	21 (12.3)	7 (10.6)		
Normal	45 (26.3)	9 (13.6)		
Overweight	28 (16.4)	6 (9.1)		
Obese	77 (45.0)	44 (66.7)		

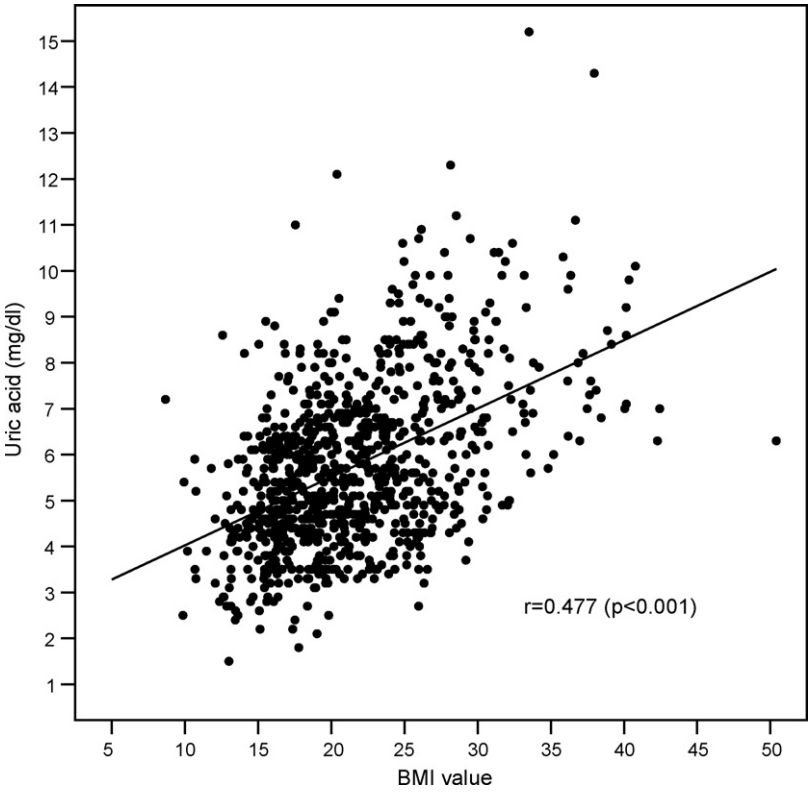

Fig. 1. Correlation between serum uric acid and BMI value among the subjects ($N = 920$).

overweight (prevalence = 28.3%), normal (prevalence = 17.1%), or underweight persons (prevalence = 10.2%). The factor of disability type, ID solely or multiple disabilities was not significantly related to hyperuricemia prevalence ($p > 0.05$).

Figs. 1–3 illustrated the correlations between serum uric acid and BMI value, the results showed they were significantly correlated among the participants ($r = 0.477$, $p < 0.001$), in the boy ($r = 0.528$, $p < 0.001$) and girl group ($r = 0.520$, $p < 0.001$).

3.3. Hyperuricemia and risk factors

Table 3 tested the relationship between hyperuricemia prevalence and BMI by gender. The gender factor varied significantly on hyperuricemia prevalence in those children and adolescents with ID ($p < 0.05$). The hyperurcemia cases in girls tend to be more prevalent in the obese group than in boys in general (66.7% and 45.0%, respectively). In the logistic regression model of the hyperuricemia occurrence, we found that the factors of gender, age and BMI were variables that can significantly predict they have a hyperuricemia condition after controlling factors of disability type, and disability level in the study (Table 4). Those children and adolescents with ID were boys (OR = 2.93, 95% CI = 2.02–4.26) and older age (OR = 6.49, 95% CI = 2.19–19.21) were more likely to be hyperuricemia. With regard to BMI to hyperuricemia occurrence, those children and adolescents with ID were underweight was less chance to be hyperuricemia compared to normal weight group (OR = 0.48, 95% CI = 0.29–0.80). However, the occurrence risk of hyperuricemia increased as their body weight increased, the overweight group OR was 1.93 (95% CI = 1.16–3.21) and obese group OR was 7.57 (95% CI = 4.95–11.58).

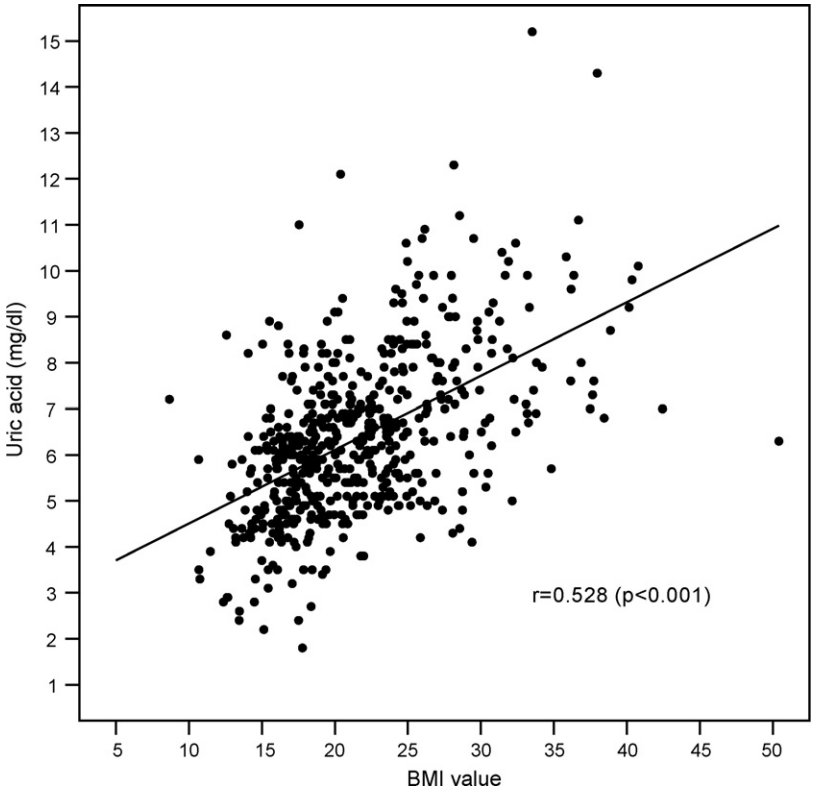

Fig. 2. Correlation between serum uric acid and BMI value in the boys ($N = 548$).

4. Discussions

The present study is one of the first on the prevalence of hyperuricemia in people with ID. This study indicated 30.6% boys and 17.9% girls with ID were with hyperuricemia in Taiwan. The factors of gender, age and BMI were variables that can significantly predict the hyperuricemia occurrence in this vulnerable population. Compare to other studies in Taiwan, Chang, Chang, Wu, Wang, and Ko (1995) surveyed 1236 aged 4–15 years aborigines in Taiwan, the hyperuricemia prevalence ($\geqq$7.5 mg/dl) was 28.5%. They found the uric acid concentration was significant related to age, gender, BMI, race, triglyceride and cholesterol in adjusted logistic regression model. Lee et al. (2007) analyzed 2001–2002 Nutrition and Health Survey in Taiwan elementary school children in aged 6–12, they found boys have higher uric acid concentrations and hyperuricemia (uric acid $\geq$7 mg/dl) rate (26.5% vs. 18.8%) than girls. In addition, Ko, Wang, Tsai, Chang, and Chang (2002) explored the prevalence and related factors of hyperuricemia among adolescent Taiwan, they found obese boys with higher creatinine were most likely to have hyperuricemia after adjustment by the logistic regression model. Liu, Li, and Lin (2003) conducted a cross-sectional study of aboriginal children aged 4–13, they found 40.2% girls and 29.5% boys were with hyperuricemic. Children with hyperuricemia had significantly higher BMI, blood pressure, and triglyceride and creatinine concentrations than those with normal uric acid concentrations. Chang et al. (2001) found that geographic area, age and BMI are important factors associated with hyperuricemia in males, whereas geographic area, and BMI are the factors associated with hyperuricemia in females in multivariate analyses.

In China, Nan et al. (2006) conducted in a population-based cross-sectional survey for hyperuricemia and gout of 2438 adults, they found hyperuricemia was more prevalent in men than in women in China (32.1% vs. 21.8%; $p < 0.001$), the factors of obesity, hypertension, and

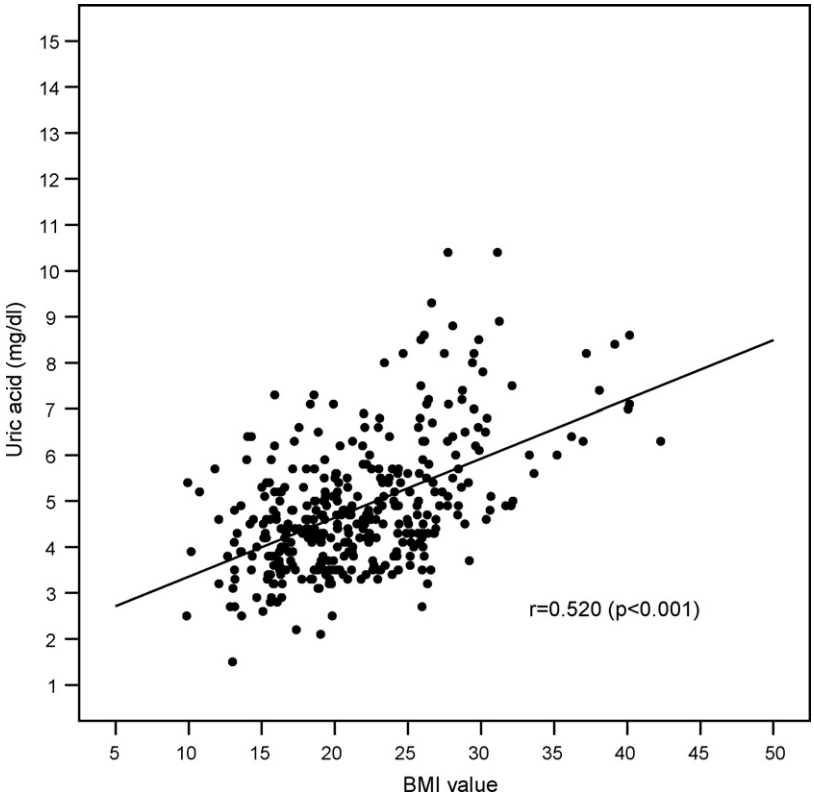

Fig. 3. Correlation between serum uric acid and BMI value in the girls ($N = 372$).

dyslipidemia are the major factors associated with hyperuricemia in this study. Miao et al. (2008) collected data from 5003 subjects randomly recruited from 5 coastal cities in Eastern China, they found the prevalence for hyperuricemia was 13.19% and the prevalence was significantly higher in men as compared to women. They also found that 58.6% of the hyperuricemic individuals were overweight or obese. Finally, they concluded that there was a remarkable increase for the prevalence of hyperuricemia and gout, which is highly correlated with the development of the economy as manifested by dietary and lifestyle changes.

In New Zealand study, Klemp, Stansfield, Castle, and Robertson (1999) found hyperuricaemia was significantly more common in Maori men (27.1%) than in European men (9.4%) and in Maori women (26.6%) than in European women (10.5%). The above references highlight the different prevalence is due to the different identification standards of hyperuricemia in the studies. However, we can conclude that the age, gender and BMI are the vital factors which affect the hypercuricemia occurrence.

Hyperuricemia is caused by accelerated generation of uric acid and/or impaired excretion in the kidney (Yamamoto, 2008). Both serum urate and hyperuricemia are significant risk factors for the metabolic syndrome which is an antecedent of chronic diseases (Lee et al., 2007). Serum uric acid is strongly correlated with blood pressure in childhood primary hypertension (Feig & Johnson, 2003). The prevalence of hyperuricemia in adolescents mirrors the incidence of adult gout, implying a predisposition for adult gout in childhood, with genetic and/or environmental components presumably contributing to the differences and these factors needed to be focused on them (Ko et al., 2002).

Several potential limitations of the present study should be considered. First, our participants come from three special schools, the results may not apply to the general children and adolescents with ID.

Table 4
The logistic regression model of hyperuricemia in children and adolescents with ID ($N = 919$).

Variable	β	S.E.	OR	95% CI	p-Value
Constant	−3.76	0.65	0.02		<0.001
Gender					
Girl			1.00		
Boys	1.08	0.19	2.93	2.02–4.26	<0.001
Age					
4–12 years			1.00		
13–18 years	1.87	0.55	6.49	2.19–19.21	0.001
Disability type					
ID			1.00		
Multiple	0.14	0.21	1.15	0.75–1.74	0.524
Disability level					
Mild			1.00		
Moderate	−0.47	0.30	0.63	0.35–1.12	0.114
Severe	−0.30	0.33	0.74	0.39–1.40	0.350
Profound	−0.35	0.44	0.71	0.30–1.67	0.427
BMI					
Normal			1.00		
Underweight	−0.73	0.26	0.48	0.29–0.80	0.005
Overweight	0.66	0.26	1.93	1.16–3.21	0.012
Obese	2.02	0.22	7.57	4.95–11.58	<0.001

Second, data on several important clinical characteristics were unavailable, such as other biochemical data. The biochemical factors mediating decline in health are poorly elucidated in people with ID (Carmeli, Bachar, Barchad, Morad, & Merrick, 2008). However, this study provides the general profile of serum uric acid, hyperuricemia and its risk factors of children and adolescents with ID. The results suggest the medical professionals should be highly alert to the possible consequences of hyperuricemia and provide useful information about the clinical manifestation of this condition for the caregivers of children and adolescents with ID.

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