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Serum Uric Acid level and its Correlation with Intelligence Quotient.

مستوى حامض البوليك في الدم وعلاقته مع نسبة الذكاء

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Serum Uric Acid level and its Correlation with Intelligence Quotient

Back ground:

Intelligence results from interplay between hereditary and environmental factors. Some psychologists emphasize genetic factors as having major significance. The higher the IQ the more brilliant is the child and is more capable of higher performance. Uric acid having similar structure to that of caffeine and theobromine acts as a cerebral stimulant. Uric acid is thought to be responsible for better development of brain and intelligence, they found that; more intelligent

persons have higher levels of uric acid. uric acid is the end product of purine metabolism. In man uricase enzyme is not present in the body that is why oxidation of uric acid to allantoin does not occur.

Aim of research:

This research aims to achieve the following objectives:

1- To assess the level of serum uric acid in medical and non medical students.

2- To assess the level of IQ in medical and non medical students

3- To Comparison of serum uric acid level in medical students according to their intelligence quotient (IQ).

4- Comparison of serum uric acid level in non medical students according to their intelligence quotient (IQ).

5- To find the correlation of intelligence quotient (IQ) and serum uric acid level among medical students.

6- To find the correlation of intelligence quotient (IQ) and serum uric acid level among non medical students.

7- To find the correlation of BMI and serum uric acid in medical and non medical students.

8- To detect the difference between males and females in intelligence quotient (IQ) medical and non medical students

Material and Methods:

One hundred volunteers from medical student's college (52 male; 48 female) and 50 volunteers from non medical students (30 male; 20 female); there age ranging between (19 - 24) years were selected. Full history taking, thoroughly clinical examined, with particular emphasis on body mass index (BMI), family history of gout, renal disease and hypertension. Serum uric acid level was done in private laboratory in Mosul city. The intelligence quotient (IQ) was determined by (a group IQ test prescribed by Raven for adult - progressive matrix test) the questionnaire comprised of 60 multiple choice questions – each

question carrying one mark with time limit of 60 minutes. The study was carried out through the period of (1 June – 2018 to 10 – October – 2018).

Results:

There is significant high IQ and serum uric acid level among the medical volunteers; the same thing is found among non medical volunteers. The IQ among the medical volunteers and there serum uric acid level are more in male compared with the female; the same thing were found among the non medical volunteers (p-value = 0.000). The IQ for the medical volunteers and there serum uric acid level are more than that for the non medical volunteers; the difference are highly significant (p – value = 0.000).

Conclusions:

There is a positive correlation between the IQ and serum uric acid level among the medical college volunteers. There is significant difference in Intelligence Quotient (IQ) and serum uric acid level between medical and non medical college volunteers.

Key words: Medical college students volunteers, Intelligence Quotient (IQ); Serum uric acid (SUA); Body mass index(BMI).

الخلفية:

حامض البوليك هو الناتج النهائي للتمثيل الغذائي لمادة البيورين(purine) في الجسم. يمتاز حامض البوليك بانه يشبه مادة الكافائين والثيوبرومايد (Caffeine and theobromine) من الناحية التركيبيه, لذا فانه يعمل على تحفيز الخلايا الدماغيه وزيادة نسبة الذكاء لدى الافراد. حيث ان العلماء وجدوا انه كلما زاد مستوى حامض البوليك في الدم كلما زادت نسبة الذكاء عند هؤلاء الاشخاص.

اهداف البحث : لبيان هل توجد علاقة بين مستوى حامض البوليك في الدم ونسبة الذكاء عند الاشخاص.

المواد وطريقة العمل:

شملت الدراسة (100 متطوع) من طلبة كلية الطب - جامعة الموصل (52 طالب و 48 طالبة), و (50 متطوع) من طلبة كليات اخرى في جامعة الموصل(30 طالب و 20 طالبة). وتم اجراء فحص مستوى حامض البوليك في الدم لكلا العينتين في المختبرات المحلية الخاصة في مدينة الموصل. كما تم اجراء فحص نسبة الذكاء لدى العينتين بالاعتماد على مقياس العالم(رافن) والذي يحتوي على 60 سؤال (اسئلة متدرجة الصعوبة) تتم الاجابة عليها خلال 60 دقيقة (1 دقيقة لكل سؤال) من قبل العينتين. كذلك تمت دراسة فحص ألوزن (BMI) لكلا العينتين.

النتائج: 1. اظهرت الدراسة ان مستوى حامض البوليك في الدم عند الطلاب أعلى من نسبته عند الطالبات في كلية طب الموصل, وان مستوى الذكاء لدى الطلاب اعلى من نسبة الذكاء لدى الطالبات.

2. كما اظهرت ان مستوى حامض البوليك في الدم عند الطلاب اعلى من مستواه عند الطالبات في الكليات الاخرى في جامعة الموصل , وان مستوى الذكاء لدى الطلاب اعلى من نسبة الذكاء لدى الطالبات في الكليات الاخرى.

3. اظهرت الدراسة ان مستوى حامض البوليك في الدم عند الطلبة (الذكور والاناث) في كلية الطب-جامعة الموصل اعلى من مستواه عند الطلبة في الكليات الاخرى, وان نسبة الذكاء لدى الطلبة (الذكور والإناث) في كلية طب الموصل أعلى من مستواه عند الطلبة في الكليات الاخرى.

4. لايوجد فرق جوهري بين مستوى حامض البوليك في الدم وعلاقته بالوزن عند الطلبة في كلية طب الموصل , وكذلك الحال عند الطلبة في الكليات الاخرى في جامعة الموصل

الخلاصة: اظهرت الدراسة بأنه هنالك علاقة ايجابيه بين ارتفاع مستوى حامض البوليك في الدم وزيادة مستوى الذكاء لدى الطلبة في كلية الطب - جامعة الموصل.مقارنة بمستوى حامض البوليك في الدم ومستوى الذكاء لدى الطلبة في الكليات الاخرى في جامعة الموصل , حيث تبين ان مستوى حامض البوليك عالي لدى طلبة كلية الطب والعلاقة طرديه مع مستوى الذكاء. وان مستوى حامض البوليك ومستوى الذكاء لدى الطلاب اعلى منه لدى الطالبات ضمن كلية طب الموصل. بينما كان مستوى حامض البوليك اقل لدى الطلبة من الكليات الاخرى , وكذلك الحال فيما يخص مستوى الذكاء لدى الطلبة في الكليات الاخرى.

Introduction:-

Intelligence results from interplay between hereditary and environmental factors. Some psychologists emphasize genetic factors as having major significance. The higher the IQ the more brilliant is the child and is more capable of higher performance. Uric acid having similar structure to that of caffeine and the obromine it may acts as a cerebral stimulant and thought to be responsible for better development of brain and more intelligence; So many researchers have tried to find out whether there is any relationship between the intelligence and serum uric acid level. This is based on assumption that comparatively more intelligent persons have higher levels of uric acid; A list of prominent leaders whose names and achievements are permanently recorded in the history. (Usha, et al., 2013, p.64-66), (Florkin & Duchateau, 1973, p. 298)

The high level of uric acid in blood distinguishes humans from other studied species of mammals. The reason behind this is the absence of the enzyme uricase, which is evolutionary determined. Hyperuricemia can be considered as a factor of “diseases of civilization.” The high level of uric acid in blood probably facilitated the emergence of intellectually advanced

primates; Uric acid can intensifies cognitive process and enhanced the human's motivation for active work, the role of hyperuricemia and gout in the development of genius. The biochemical basis for such effects is the potential for uric acid synthesis in the central nervous system and the penetration of the blood-brain barrier by its precursors, the inter relations between the metabolism of uric acid in the central nervous system and the metabolism of catecholamines and dopamine, the neuroprotective and anti oxidative properties of uric acid. (Tovchiga & Shtrygol, 2014,p. 210–221), (Acheson,1970,p.193–197), (Acheson,1969, p. 65–67).

Uric acid is a potent endogenous non enzymatic antioxidant in the body; Antioxidant properties of uric acid have long been recognized and as a result of its comparatively high serum concentrations, it is the most abundant scavenger of free radicals in humans. Elevation of serum uric acid concentration occurs as a physiologic response to increased oxidative stress. (Chaudhari, et al., 2010, p.77-81), (Singh, et al., 2004,p. 218-25), (Waring, et al., 2001, P. 365–371), (Sen , 1995,p. 177-96).

Uric acid can be oxidized following a non-enzymatic degradation and has been proved to be a selective antioxidant capable of reaction with hydroxyl radicals and hypochlorous acid. In plasma, uric acid, albumin and ascorbic acid accounts for more than 85% of total antioxidant capacity. Uric acid is a major contributor to total radical trapping capacity (TRAP) accounting between 38-47% of the entire total in contrast to vitamin C and vitamin E which contributes 13-17% and 2-8% respectively.(Ozcan, et al., 2004,p. 89-95).

The higher serum uric acid concentration seemed associated with elevated total serum antioxidant capacity among individuals with atherosclerosis; hyperuricemia may be a compensatory mechanism to counteract oxidative damage related to atherosclerosis and aging in humans. (Javier Nieto, et al., 2000 p. 131–139), (George & Ernst, 1966,p. 415-418).

The body produces uric acid when it breaks down purines, organic chemical compounds found naturally in foods and drinks. After digestion, uric acid enters the bloodstream to be processed by the kidneys and excreted in the urine. Serum uric acid level was higher in men

than in women (5.7 ± 1.2 mg/dl, 4.2 ± 0.9 mg/dl respectively). (Eunjeong, et al, 2017,p.34-46), (Maleki A, et al, 2014,p172-190).

Serum uric acid concentrations are determined by a number of demographic factors of which are age, sex, body mass index, nature of diet, socioeconomic class, intelligent social class, and alcohol consumption. (Talat, et al., 2016, p. 682-686), (Ohno, 2011,p.1039), (Kim, et al. , 2010 ,p.170-172), (Kanbay , et al., 2010, p. 288), (Hochberg , et al., 2008,p. 90-93), (Yanyan , et al., 2007p.63-74), (Gardner & Scott, 1980, p. 380–385).

When there is too much uric acid in the bloodstream it is called hyperuricemia, a person is considered hyperuricemic if he or she has more than (7.2 mg\dl). **(**Vidula ,et al. ,2010, 957–961) .

Aim of research:

This research aims to achieve the following objectives:

1- To assess the level of serum uric acid in medical and non medical student.

2- To assess the level of IQ in medical and non medical students

3- Comparison of serum uric acid level in medical students according to their intelligence quotient (IQ).

4- Comparison of serum uric acid level in non medical students according to their intelligence quotient (IQ).

5- To find the correlation of intelligence quotient (IQ) and serum uric acid level among medical students.

6- To find the correlation of intelligence quotient (IQ) and serum uric acid level among non medical students.

7- To find the correlation of BMI and serum uric acid in medical and non medical students.

8- To detect the difference between males and females in intelligence quotient (IQ) medical and non medical students

Material and Methods:

This study was approved by the scientific committee at the College of Medicine, University of Mosul. Formal consent was taken from volunteers and controls after explanations of the trial to them.

One hundred volunteers from medical students college (52 male) there mean age (21.13 ±1.46); (48 female) there mean age (21.60 ± 1.54); and (50 volunteers) from non medical students college (30 male) there mean age (20.53 ± 1.36); 20 female there mean age (20.50 ± 1.23). History taking from all subject according to special protocol which includes name, age, sex, address, marital history, past medical and surgical history. All subjects are thoroughly examined with particular emphasis on body mass index [BMI = (weight-kg)\(Length -m)^2]; if they are (below normal weight < 18.5% , normal weight 18.5 – 24.9% , over weight 25 – 29.9%, or obese >30%). (Obesity in Canada , 2011), (Canadian Guidelines for Body Weight Classification in Adults , 2003). Family history of gout and hypertension. Subjects with renal disease and hypertension were excluded from the study. Serum uric acid test were done in private laboratory in Mosul city. The intelligence quotient (IQ) was determined by (a group IQ test prescribed by Raven for adult, progressive matrix test) the questionnaire comprised of 60 multiple choice questions – each question carrying one mark with time limit of 60 minutes; in which the IQ classified to (average IQ = 90 - 110) (high average IQ =110-120) (superior IQ = 120 - 130) (Gifted IQ > 130). (Bilker ,et al., 2012) (Raven, 1936, p.67-75). The study was carried out during the period (1 - June - 2018 to 10 – October – 2018).

Statistical analysis:

The mean, standard deviation (SD) were calculated for volunteers in each parameter. The student (t) test used to calculate the differences between two means. ANOVA Test and Post Hoc (Duncan) test were used in analysis of results. The p value was considered significant if it is less than (< 0.05). Chi - square test was used in comparison of male and female IQ . (Dell'Aquila & Ronchetti , 2004,p.60), (Abramovich et al , 2000, P. 1–29).

Results :

Our study consist of (100) medical college volunteers; 52 male (52%); there mean age (21.13 ±1.46); and 48 female (48%); there mean age (21.60 ± 1.54).The non medical college volunteers was (50) ; 30 male (60%); there mean age(20.53 ± 1.36); and 20 female (40%), there mean age (20.50 ± 1.23).Table (1).

Table (1): The age and sex distribution for medical and non medical college volunteers.

Parameters	Medical college Volunteers (n=100)		Non medical college Volunteers (n=50)	
Sex	**Male**	**Female**	**Male**	**Female**
No.(%)	**52 (52.0)**	**48(48.0)**	**30 (60.0)**	**20 (40.0)**
Age (year) Mean ± SD (min-max)	**21.13 ±1.46 (19-24)**	**21.60 ± 1.54 (19-24)**	**20.53 ± 1.36 (19-23)**	**20.50 ± 1.23 (19-23)**

* One way ANOVA test and post Hoc (Duncan) test was used.

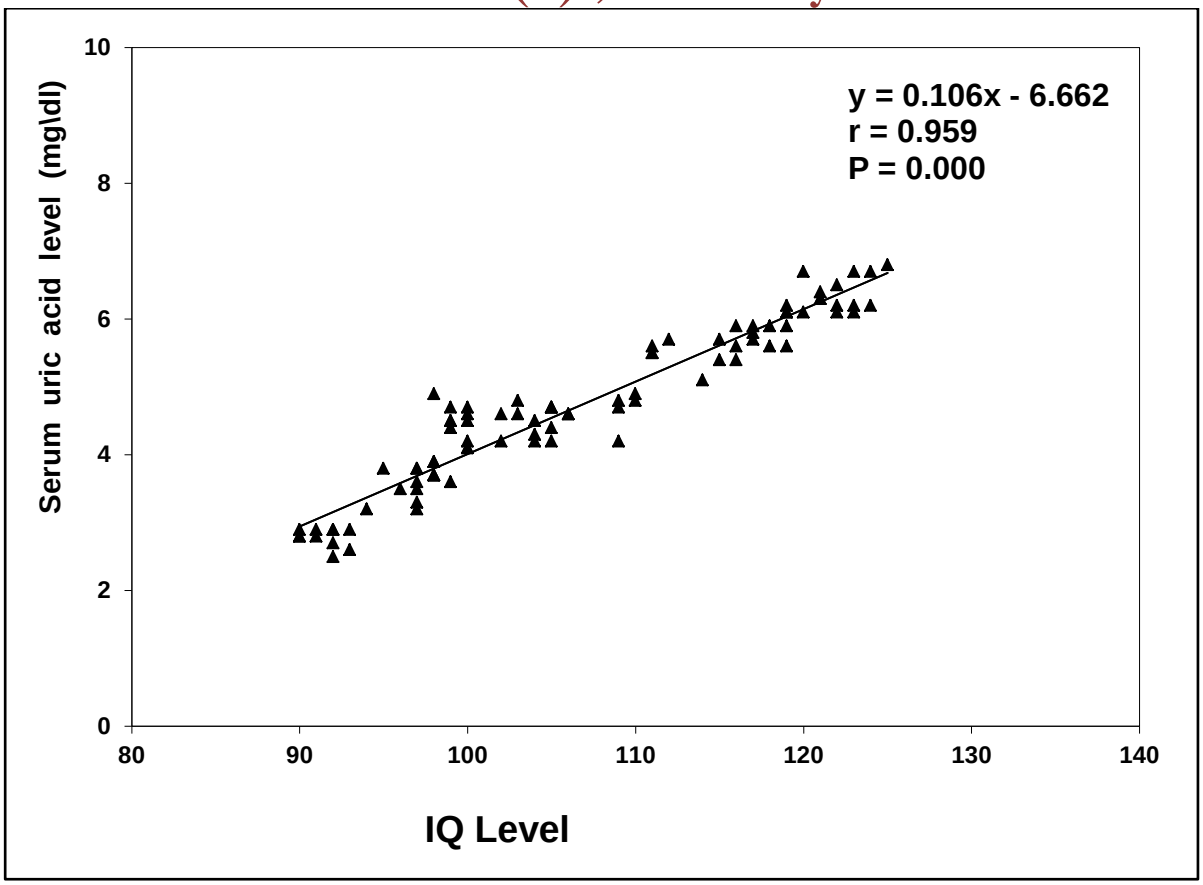
The serum uric acid level was significantly higher in medical group; those with higher IQ level have higher serum uric acid level. Table (2).

Table (2): The comparison between intelligence quotient (IQ) and serum uric acid level for medical college volunteers.

Intelligence quotient (IQ).	Medical college volunteers No. (%)	Serum uric acid level Mean ± SD	P*-value
90-	60 (60.0)	3.96 ± 0.70 **a**	0.000
110-	25 (25.0)	5.62 ± 0.35 **b**	
120-140	15 (15.0)	6.40 ± 0.26 **c**	
Total	100 (100.0)	4.74 ± 1.15	

* One way ANOVA test and post Hoc (Duncan) test was used.

There was positive correlation between serum uric acid level and IQ among medical college volunteers (r = 0.959). Figure (1)



Fig(1): Correlation between serum uric acid level and IQ in medical college volunteers.

The IQ and serum uric acid level was significantly high in non medical college volunteers (p-value = 0.000) ; but there was no one in gifted group. Table (3).

Table (3): Comparison between intelligence quotient (IQ) and serum uric acid level for non medical college volunteers.

Intelligence quotient (IQ).	Non medical college volunteers No. (%)	Serum uric acid level Mean ± SD	P*-value
90-	43 (86.0)	3.48 ± 1.06	0.000
110-	7 (14.0)	4.27 ± 0.13	
120-140	0 (0.0)	-------	-------
Total	**50 (100.0)**	**3.73 ± 1.17**	

*Independent t – test was used.

There was positive correlation between IQ and serum uric acid level among non medical college volunteers (r = 0.959). Figure (2)

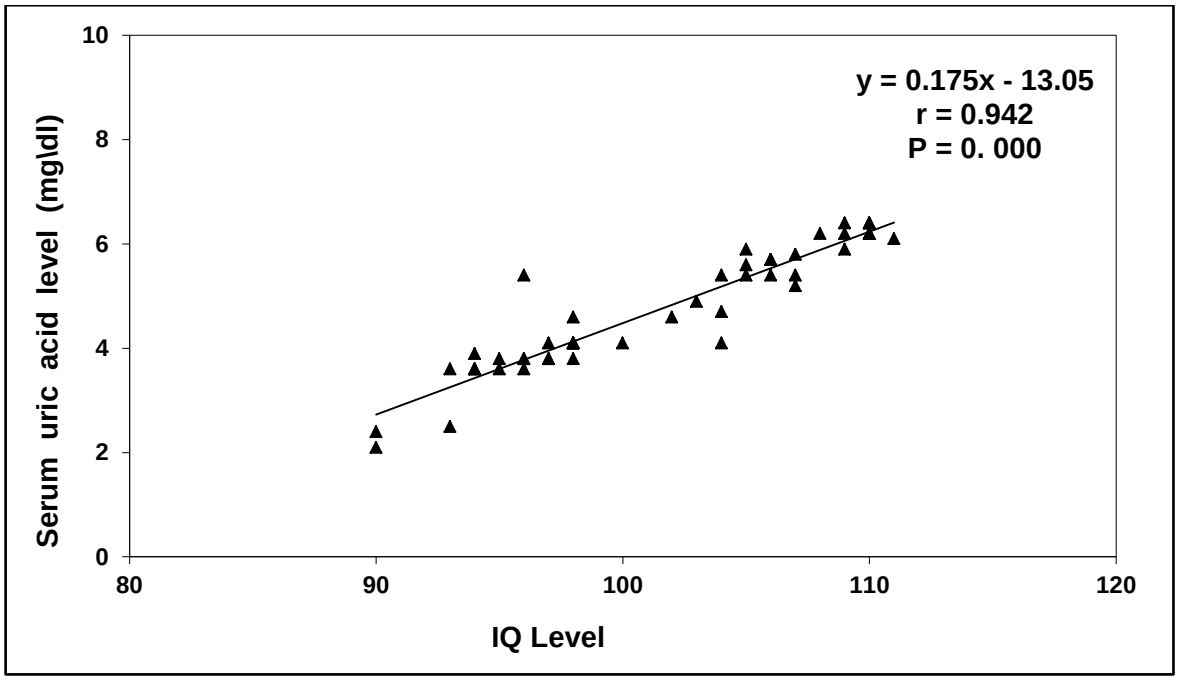


Fig (2): Correlation between IQ and serum uric acid level in non medical college volunteers.

There was no significant difference between the BMI and serum uric acid level in both medical and non medical group. Table (4)

Table (4): Comparison between body mass index and serum uric acid level for medical and non medical college volunteers .

BMI	Medical college Volunteers (n=100)		Non medical college Volunteers (n=50)		P*-value
	No. (%)	Serum uric acid level (mg\dl)	No. (%)	Serum uric acid level (mg\dl)	

Below Normal < 18.5 %	3(3.0)	4.03±1.47	2(86.0)	4.95±1.20	0.522
Normal weight 18.5-24.9%	94(94.0)	4.75±1.15	45(14.0)	4.70±1.18	0.815
Over weight 25-29.9%	3(2.0)	5.30±0.72	3 (0.0)	5.07±1.33	0.803
Obese > 30%	---	---	---	---	---
Total	**100(100)**	**4.74 ±1.15**	**50 (100)**	**4.73 ± 1.17**	**0.952**

* Independent t- test was used.

There was no correlation between BMI and serum uric acid level for medical college volunteers (r = 0.181). Fig(3)

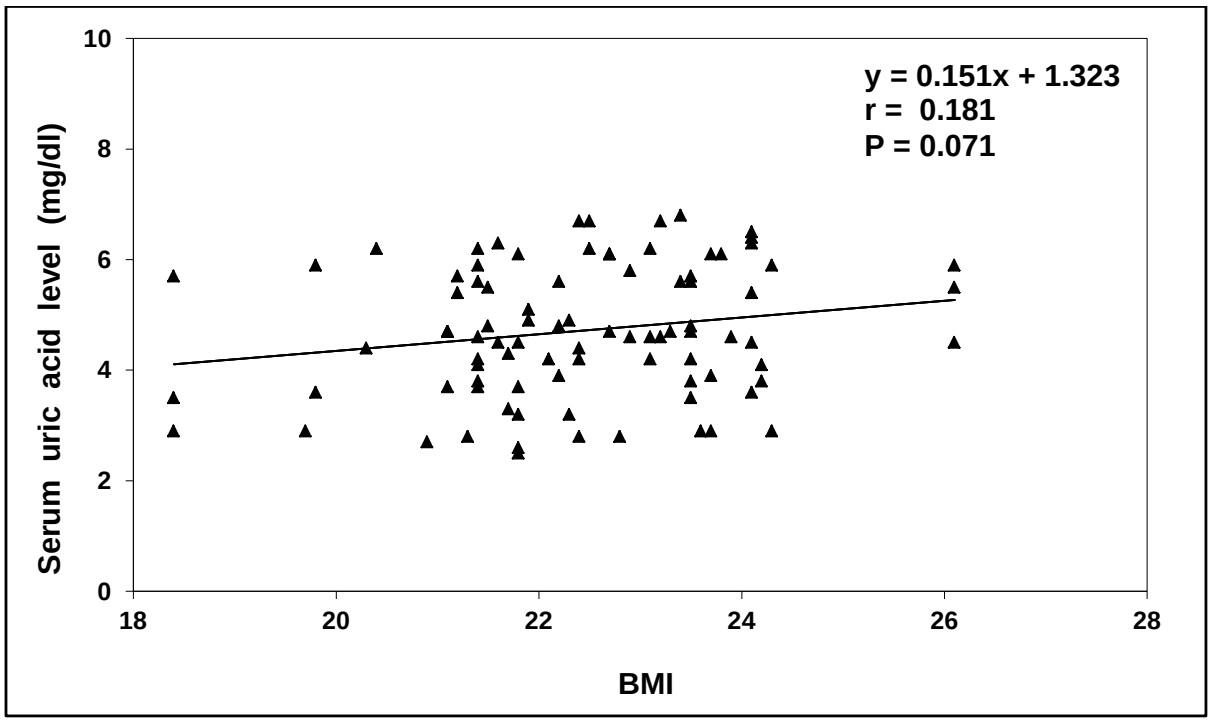


Figure (3) Correlation between serum uric acid and BMI in medical college volunteers.

There was no correlation between BMI and serum uric acid in non medical college volunteers (r = 0.026). Fig(4)

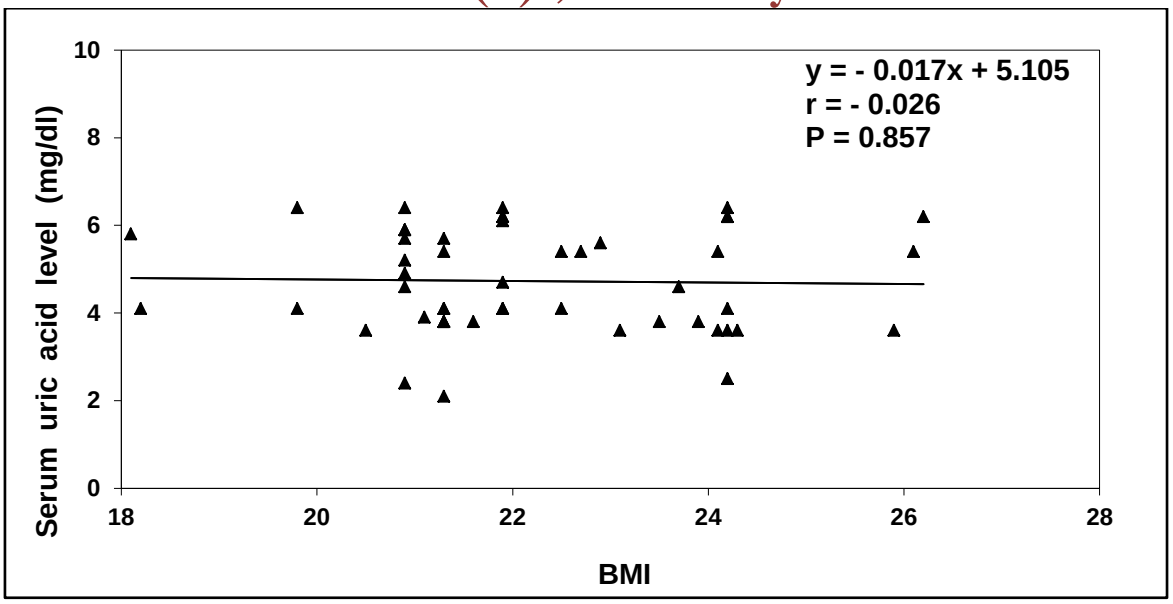


Figure (4): Correlation between BMI and serum uric acid in non medical college volunteers

The IQ and serum uric acid level was significantly higher in medical group than in non medical group (p value = 0.000). Table (5).

Table (5): Intelligence quotient (IQ) for medical and non medical college volunteers in comparison to their serum uric acid level.

Intelligence quotient (IQ).	Medical college Volunteers (n=100)		Non medical college Volunteers (n=50)		P*-value
	No. (%)	Serum uric acid level(mg\dl)	No. (%)	Serum uric acid level(mg\dl)	
90-	60(60.0)	3.96 ± 0.70	43(86.0)	3.48 ± 1.06	0.004
110-	25(25.0)	5.62 ± 0.35	7(14.0)	4.27 ± 0.13	0.000
120-140	15(15.0)	6.40 ± 0.26	0 (0.0)	---------	-------
Total	**100(100.0)**	**4.74 ±1.15**	**50 (100.0)**	**3.73 ± 1.17**	**0.952**

* Independent t – test was used.

In comparison of male and female IQ in medical group; the male percentage was more in gifted group (IQ = 120-140) ; while the female percentage was more in average group (IQ = 90 – 109). Table (6)

Table (6): Comparison of male and female IQ in medical college volunteers .

Intelligence quotient (IQ).	Medical college Volunteers (n=100)		P*-value
	Male No. (%)	Female No. (%)	
90-	14 (26.9)	46 (95.8)	0.000
110-	25 (48.1)	0 (0.0)	0.000
120-140	13 (25.0)	2 (4.2)	0.004
Total	52 (100.0)	48 (100.0)	0.000

* Chi-square test was used.

In comparison of male and female IQ in non medical group; the male percentage was significantly higher in super average group (IQ = 110 -119) than female (p-value= 0.33) while in average group (IQ= 90- 110) no significant difference. Table (7).

Table (7): Comparison of male and female IQ in non medical college volunteers .

Intelligence quotient (IQ).	Non medical college Volunteers (n=50)		P*-value
	Male No. (%)	Female No. (%)	
90-	23 (76.7)	20 (100.0)	0.033
110-	7 (23.3)	0 (0.0)	
120-140	0 (0.0)	0 (0.0)	------
Total	30 (100.0)	20 (100.0)	------

* Fisher exact test was used.

In comparison of male and female IQ in both medical and non medical volunteers; male percentage were higher in gifted and super fertile group while female percentage was higher in average group of IQ. Table (8).

Table (8): Comparison between male and female IQ in medical and non medical volunteers .

Intelligence quotient	Male	Female	P*-value

(IQ).	No. (%)	No. (%)	
90-	37 (45.1)	66 (97.1)	0.000
110-	32 (39.0)	0 (0.0)	0.000
120-140	13 (15.9)	2 (2.9)	0.009
Total	**82 (100.0)**	**68 (100.0)**	0.000

* Chi-square test was used.

Male percentage was higher in gifted group while female percentage was higher in average group (r = 0.570). Figure (5)

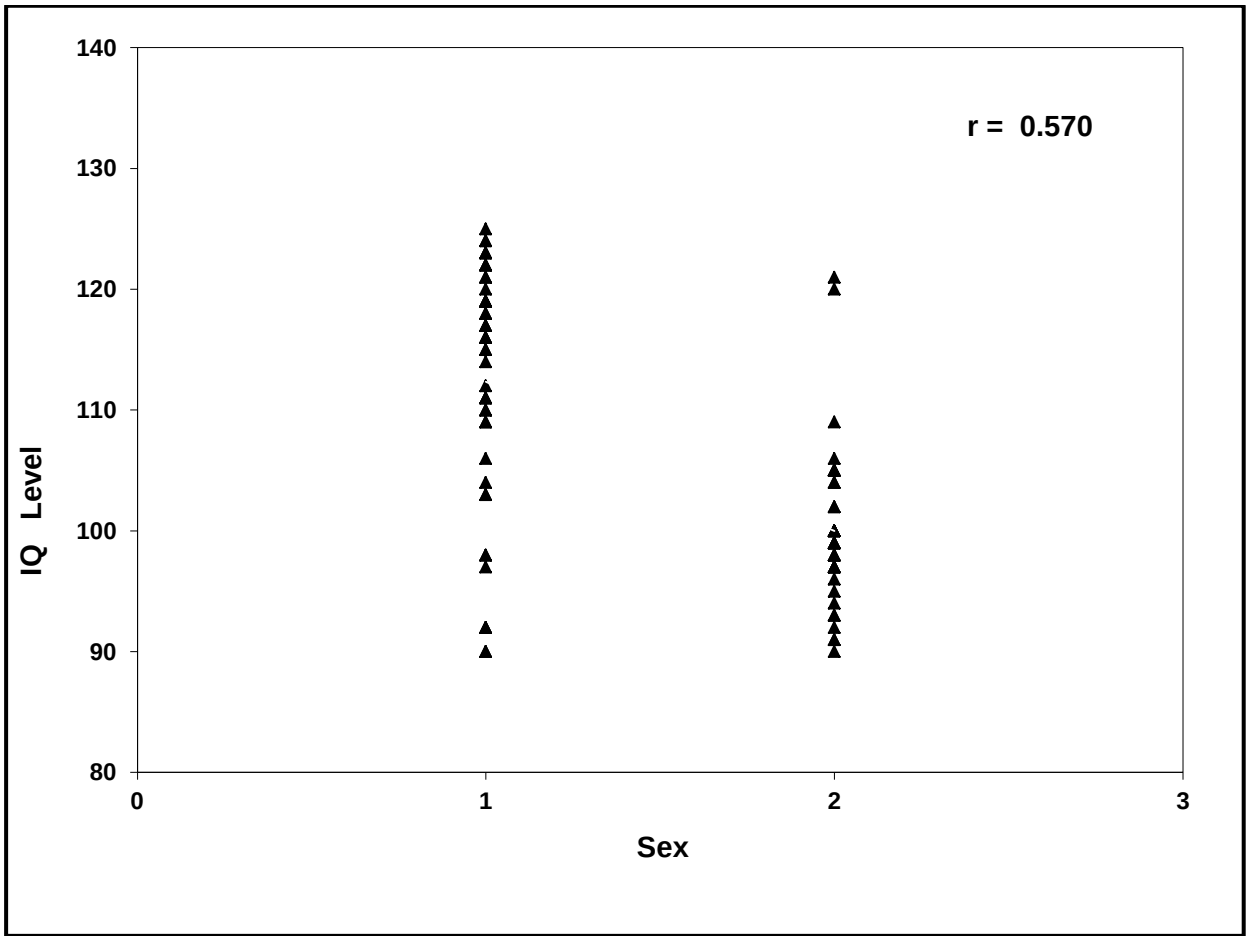


Figure (5): Male (1) and female (2) IQ in both medical and non medical college volunteers.

Discussion:

In man, cerebral cortex is well developed, having enormous growth and convolutions of cortex and also frontal prominence which is considered to be the seat of higher intelligence,

which is absent in lower animals because of presence of uricase enzyme. There is a considerable relationship between a person's degree of intelligence and range of activities, level of achievement and the depth of understanding. Gout is one of the oldest recorded diseases of mankind. Uric acid having similar structure to that of caffeine and the obromine acts as a cerebral stimulant and thought to be responsible for better development of brain and more intelligence, also they found that uric acid may increase dopamine levels (a neurotransmitter) in the brain. (Usha et al., 2013, p. 64-66), (Guerreiro et al., 2009, p.1118–28), (Florkin & Duchateau, 1973, p.298)

Our study consist of (100) medical college volunteers; 52 male (52%); there mean age (21.13 ±1.46); and 48 female (48%); their mean age (21.60 ± 1.54). The non medical college volunteers was (50); 30 male (60%); their mean age (20.53 ± 1.36); and 20 female (40%), their mean age (20.50 ± 1.23).

The study reveals that: The IQ and the serum uric acid level was significantly high in medical college volunteers; (p value = 0.000); and this is mimic other study. (Usha et al., 2013, p. 64-66). In non medical group; higher serum uric acid level found in those with higher IQ ; but there was no one in gifted group.

Our study show that: There was no significant difference in serum uric acid level, and the body mass index (BMI) among the medical volunteers; and the same thing found among the non medical volunteers; this is not mimic the other studies. (Wang et al., 2014, p. 1503-9), (Yue et al., 2012,p. 595-600). this may be due to that, there are few number of student who are overweight and no one of them who are obese in this study.

Our study reveals that: The male IQ among the medical college volunteers and their serum uric acid level is significant higher than that for the female; the same thing is found among the male in non medical college volunteers in comparison to female; this difference is highly significant (P - Value = 0.000), and this is mimic the other study. (Usha et al., 2013, p. 64-66).

The IQ for the medical college volunteers and their serum uric acid level are more than that for the non medical college volunteers, and this difference is highly significant, (P – Value = 0.000), and this is mimic other studies. (Usha et al., 2013, p 64-66), (Kasal, 1970,p. 1291 – 99), (Stetton & Hearson ,1959, p. 17-37).

Conclusions :

There is a positive correlation between the IQ and serum uric acid level among the medical college volunteers (p- value = 0.000); the same thing was found among the non medical volunteers (p –value = 0.000). There was no correlation between BMI and serum uric acid level in medical college volunteers; the same thing was found among the non medical volunteers. There is significant difference in Intelligence Quotient (IQ) and serum uric acid level between male and female among the medical college students volunteers (p value=0.000); the same thing was found among the non medical volunteers (p value=0.000). There is significant difference in Intelligence Quotient (IQ) and serum uric acid level between medical and non medical college volunteers (p value=0.000).

Recommendations:

- In future study we suggest to increase the number of medical and non medical volunteers (such as 200 volunteers from medical college and 100 volunteers from non medical college); and to take equal number of male and female from both groups.
- Also we recommend to concentrated on the other parameters such as; eating habit (vegetarian or non vegetarian) and socioeconomic level (high, mid or low socioeconomic level).

References:

- Abramovich F., Bailey T .C. & Sapatinas T. (2000). "Wavelet analysis and its statistical applications". Journal of the Royal Statistical Society Series D-The Statistician. 49:1–29
- Acheson,R.M. (1970). "Epidemiology of serum uric acid and gout: an example of the complexities of multifactorial causation". Proc. R. Soc. Med. v 63(2): 193–197.
- Acheson, R.M. (1969) "Social class gradients and serum uric acid in males and females". Br. Med. J. 4:65–67

- Bilker W. B., Hansen J. A., Brensinger C. M., Richard J., Gur R. E., Gur, R. C. (2012) "Development of abbreviated nine-item forms of the Raven's standard progressive matrices test". Assessment. 19 (3): 354–369.
- Canadian Guidelines for Body Weight Classification in Adults (2003). Health Canada. Ottawa
- Chaudhari K. & Khanzode S.(2010) "clinical correlation of endogenous antioxidant – uric acid level in major depressive disorder". Indian Journal of Clinical Biochemistry. 25 (1): 77-81
- Dell' Aquila R. & Ronchetti E.M. (2004) Introduction to Robust Statistics with Economic and Financial Applications. Wiley
- Ellis, H. (1963) A study of British genius. Hurst and Blackett. London
- Eunjeong K., Seung - sik Hwang, Dong Ki Kim.(2017) "Sex-specific Relationship of serum uric acid with all-cause mortality in adults with normal kidney function: An observational study". Journal of Rheumatology. January: 34-46
- Florkin & Duchateau (1973) Comparative animal physiology.3rd edition
- .press of W.B. Saunder's company. USA
- Gardner M. D. & Scott R., (1980) "Age- and sex-related reference ranges for eight plasma constituents derived from randomly selected adults in a Scottish new town". Journal of Clinical Pathology. 33 (4): 380–385
- George W. Brooks, & Ernst, Mueller.(1966) "Serum urate concentrations among university professors; Relation to Drive, Achievement, and Leadership". JAMA. 195 (6): 415-418
- Guerreiro S, Ponceau A, Toulorge D, et al.(2009) "Protection of midbrain dopaminergic neurons by the end-product of purine metabolism uric acid: potentiation by low-level depolarization". Journal of neurochemistry.109: 1118–28
- Hochberg J. et al. (2008) Tumor lysis syndrome: Current perspective. Haematologica.
- Javier Nieto F., Carlos Iribarren, Myron D. Gross. (2000) Uric acid and serum antioxidant capacity: a reaction to atherosclerosis? Elsevier Science Ireland Ltd.
- Kanbay M, et al. (2010) Uric acid in hypertension and renal disease: The chicken or the egg? Blood Purification.

- Kasal S. V. (1970) "Serum uric acid and cholesterol in achievement, behaviour and motivations". JAMA . 213(8) : 1291 – 99
- Kim SY, et al. (2010) "Hyperuricemia and coronary heart disease: A systematic review and meta-analysis". Arthritis Care & Research.62 (170-172)
- Maleki A., Samandari S., Almeida O., Jafarian K. S. R, Abdolvand M, et (2014) "Correlation between hypertension, c-reactive protein and serum uric acid with psychological well-being". Iran Red Crescent Med J.16(7):172-190
- Obesity in Canada. (2011) Public Health Agency of Canada. Canadian Institute for Health Information. Ottawa
- Ohno, I. (2011) "Relationship between hyperuricemia and chronic kidney disease". Nucleosides, Nucleotides and Nucleic Acids.30:1039
- Ozcan ME, Gulec M, Ozerol E, Polat R, Akyol O. (2004) "Antioxidant enzyme activities and oxidative stress in affective disorders". Int Clin Psychopharmacol. 19(2): 89-95.
- Raven, J. C. (1963). Mental tests used in genetic studies: The performance of related individuals on tests mainly educative and mainly reproductive, MSc Thesis. University of London
- Sen CK. (1995) "Oxygen toxicity and antioxidants: state of the art". Ind J Physiol Pharmacol. 39 (3): 177-96
- Singh RP, Sharad S, Kapur S. (2004) Free radicals and oxidative stress in neurodegenerative diseases: relevance of dietary antioxidants". JIACM. 5 (3):218-25
- Stetton D. & Hearson JZ. (1959) "Intellectual level measured by army classification battery and serum uric acid concentration", Science, 129:17-37
- Talat F. , Nishi , Shamim K. A. and Ajit K. Ch. (2016) "normal reference ranges for serum uric acid in population of north Bihar". ISSN: 2320-5407 Int. J. Adv. Res. 5(5): 682-686
- Tovchiga O. V. &. Shtrygol S. Yu. (2014) "Uric acid and central nervous system functioning (a literature review)". Biology Bulletin Reviews.4. Issue 3: 210–221
- Usha, P., Sandhya, D., Surekha V., Ruikar, V.M (2013) "Study of serum uric acid and its correlation with Intelligence Quotient and other parameters in normal healthy

adults". International Journal of Recent Trends in Science And Technology 6. Issue 2: 64-66

- Vidula, B., et al. (2010) "High Uric Acid Levels Raise Diabetes Risk". American Journal of Medicine. 123: 957–961.
- Waring, W. Stephen; J. Webb, David; R. J. Maxwell, S. (2001) "Systemic Uric Acid Administration Increases Serum Antioxidant Capacity in Healthy Volunteers". Journal of Cardiovascular Pharmacology.38 .Issue 3:365–371
- Wang H., Wang L., Xie R. (2014) "Association of serum uric acid with body mass index: A cross-sectional study from jiangsu province", China. Iran J Public Health. 43(11):1503-9
- Yanyan Z., Bhavik J., Pandya, & Hyon K. (2007) Prevalence of gout and hyperuricaemia in the US general population.The National Health and Nutrition Examination Survey.
- Yue JR, Huang CQ, Dong BR. (2012) "Association of serum uric acid with body mass index among long-lived Chinese". Exp Gerontol . 47 (8): 595-600