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The Association between Waist Circumference and Serum Uric Acid among Adults in the United Arab Emirates (UAE): Data from the UAE Healthy Future Study

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Abstract

Background: This cross-sectional study is apart from one of the first and largest population-based prospective cohort studies in the UAE called the United Arab Emirates Healthy Future Study (UAEHFS). The UAEHFS cohort explores and examines the risk factors of the most common chronic diseases among the nationals of the UAE, in particular to cardiovascular disorders. The aim of this study is to investigate the relationship between serum uric acid levels and anthropometric measures (waist circumference (WC), body mass index (BMI), body fat percentage (BFP), and triglycerides (TG)), among Emirati adults.

Methods: Data was used from the baseline data of the UAE Healthy Future Study volunteers. Out of 11,158 participants, 10,603 were included in the statistical analysis after omitting missing values. The study analysis was based on self-reported questionnaires, anthropometric measures, and blood analysis. Multivariate quantile regression models were perfumed to investigate the association between anthropometric measures such as the WC, BMI, BFP and serum uric acid (SUA) adjusted for age, gender, and TG.

Results: There were 5,750 (54%) males included in this study. Males were older than females in this cohort with median of 28 (IQR:23-36), and 24 (IQR:20-34). Statistically significant positive association between uric acid and BMI, BFP, WC was observed for all centiles.

Conclusion: Our result support the positive association between elevated serum uric acid and high BMI, high BFP, increased WC and TG among adult Emiratis. Age was negatively and statistically significantly associated with serum uric acid levels which shows that younger adults had higher serum uric acid. Furthermore, males had more elevated serum uric acid compared to females. The BMI, WC, PFB all reflected similar association to serum uric acid levels.

Key words: waist circumference; serum uric acid; hyperuricemia; BMI, body fat percentage; triglycerides; anthropometric measures.

Background

Chronic diseases have been found to be associated with elevated serum uric acid (SUA) levels and an increased number of the elements which contribute to metabolic syndrome such as obesity, diabetes and hyperlipidemia [1,2].

A number of a previous studies have observed not only the association between serum uric acid, and cardiovascular diseases, but also reflected hyperuricemia as a risk factor which may predict the development of congestive heart failure, coronary artery disease especially with high-risk individuals such as those with those with obesity, hyperlipidemia, diabetes mellitus and hypertension [3,4]. For example, it was observed that congestive heart failure mortality rate increases with individuals who had hyperuricemia [5].

Moreover, numerous studies have observed elevated serum uric acid as a predictor for metabolic syndrome [6,7]. For example, it was evidenced that there is a link between hyperinsulinemia and elevated uric acid absorption in the proximal tubule which increases the risk for development of metabolic syndrome, obesity, and diabetes mellitus [8]. However, the effect of elevated serum uric acid as a predictor of metabolic syndrome and mortality is uncertain in the general population [9,10].

On the other hand, obesity has been widely recognized in literature and clinical practice to be one of the leading causes of chronic diseases and mortality [11,12,13]. For example, in the United States there were about more than 300,000 deaths every year which was related to excess weight and obesity [14]. Several studies have reported that obesity is associated with a wide range of health problems, not only cardiovascular diseases, but also lower quality of life, lower productivity, disturbed mental health, and limited access to quality care. [12,15,16].

Recent studies show a significant correlation between elevated serum uric acid levels and obesity [1,10]. A positive association was indicated between central obesity measured by waist circumference and elevated serum uric acid levels [17,18]. Studies showed that abdominal obesity is a more important risk factor than overall obesity in predicting the development of cardiovascular disease. For example, some studies indicated that measurement of waist circumference is a reliable test to identify individuals at increased risk for type 2 diabetes [18,19]. Moreover, it was reflected that measurement of abdominal obesity can be indicated by triglycerides level and body fat percentage [17,20]. It was evidenced in literature that triglycerides level and body fat percentage play significant roles in predicting the incidence of cardiovascular disease [21]. However, it is unclear to what extent is WC related to elevated triglycerides level and body fat percentage [22].

Some studies have found that increased serum uric acid in relation to central obesity is influenced by age and gender [23,24]. For example, elevated serum uric acid was positively associated with increased risk for cardiovascular disease in males compared to females [25, 26]. On the other hand, some studies have reflected increased risk for metabolic disease when females had higher elevated serum uric acid, but this is far away from certain definition [24,25,26]. Therefore, our study will explore the association between serum uric acid and central obesity after adjusting for age and gender.

The United Arab Emirates (UAE) is a high-income developed country which has undergone a rapid epidemiological transition in different public health aspects [27]. There has been a continues increase in obesity and related morbidity and mortality over the last 10 years. However, among adults in the UAE, little is known about the association between central obesity and elevated serum uric acid and other components such as elevated triglycerides and body fat percentage. In a study conducted in the UAE in 2009 it was found that uric acid seems to be the most reliable biomarker to identify obese subjects with metabolic syndrome [28]. Given this background, the present study sought to clarify the cross-sectional association between waist circumference and serum UA among the UAE Emirati adult population.

Methods

Participant's Eligibility Criteria and Recruitment

Opportunistic recruitment took place in different Emirates of the UAE and at multiple sites including health centers, universities and companies between February 2016 and March 2023 [27]. A cross-sectional analysis of baseline data from the UAEHFS cohort was performed with Emirati nationals aged 18 years and above. All participants were required to read and sign an informed consent. The exclusion criteria were those participants who were pregnant and those who reported any acute infection at the time of recruitment. We obtained the approval of this research by the Abu Dhabi Health Research and Technology Committee (ref. DOH/HQD/2020/516) [27].

Data Collection

A self-questionnaire was completed by all participants who signed the informed consent. Also, physical measurements were done for them by trained and registered nurses as well as a blood sample collection. The self-completed questionnaire also included questions on age and gender and counter checked by their emirate's identity. The subsequent steps of physical assessments included anthropometric measures (BMI, WC, BFP and TG) were performed by the trained nurses based on a standardized protocol. A sample of random venous blood was collected and used for analyzing serum triglycerides and serum uric acid. Only fasting blood samples were used to analyze plasma glucose.

In addition, the self-questionnaire included questions related to confounding factors such as physical activity with different levels (mild, moderate, and intense), 24-hours dietary intake, daily food habits, daily health behaviours, medications intake and presence of underlying diseases. The aim of this paper was to investigate the relationship between serum uric acid levels and anthropometric measures (waist circumference (WC), body mass index (BMI), body fat percentage (BFP), and triglycerides (TG)), among Emirati adults. We consider examining this association having some subjective measures such as physical activity, eating habits, daily health habits and lifestyle in the future once the related data is available for analysis.

Measures

The required demographic measurements such as age and gender were collected by the self-perceived questionnaire and counterchecked by their registered emirate's identity based on the unified system of authority of citizenship and identity in the UAE. Physical measurements such as BMI and BFP were collected by a well-trained and experienced nurse, using Tanita MC-780 MA Segmental Body Composition Analyzer [34]. BMI was categorized in accordance with World Health Organization [24] as underweight (< 18.5 kg/m−2), normal (18.5–24.9 kg/m−2), overweight (25.0–29.9 kg/m−2) and obese (> 30.0 kg/m−2). Central obesity was defined according to the WHO criteria [24]: WC ≥ 94 cm for men and ≥ 80 cm for women [26]. BFP, for people aged 20 to 39, women should aim for 21% to 32% of body fat. Men should have 8% to 19%. For people 40 to 59, women should fall between 23% to 33% and men should fall around 11% to 21%. [30].

The blood sample was obtained by a well-trained nurse for the measurement pf TG level and SUA and was sent immediately to the laboratory of the NYU Abu Dhabi for analysis. The cut-off value for triglycerides used is 150 mg/dl for men and women. [29]. Diagnosis of the elevated serum uric acid was based on the classic cut-off of 6.0 mg/dl for females and 7.0 mg/dl for males. Also, it was based on the newly identified one in the URRAH study that is 5.1 mg/dl for females and 5.6 mg/dl for males [31,32].

Statistical Analysis

Summary statistics were presented by median and interquartile range (IQR) for continues variables and frequency (%) for sex. Quantile regression models were performed to investigate the association between uric acid and BMI, BFP and WC, respectively. The dependent variable was the uric acid level in all fitted multivariate quantile regression models adjusted for age, sex, and TG. The 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th} and 90^{th} centiles were examined to obtain a representative range of uric acid level concentration distribution. This analysis includes nine multivariate quantile regression models for BMI, BFP and WC, adjusted for age, sex and TG, respectively. Effects of BMI, BFP and WC were estimated with 95% confidence intervals (CI). Statistical analyses were conducted using R version 4.2.3. [33].

The sample size was based on power calculation for cardiovascular risk incidence to detect 1.5 hazard ratio over ten years for 80% statistical power and two-sided alpha of 0.05.

Results

Out of 11,153 recruited participants, 10,603 (95.1%) participants were included in the statistical analysis after omitting missing values (figure 1). Table 1 presents summary statistics for age, UA, WC, BMI, and BFP and gender. Table 1 shows that males have a higher uric acid, a higher age, higher BMI, and higher TG compared to females with median (IQR) of 5.9 (5.2-6.7), 28 (23-36), 27 (23.9-30.6), 93 (60-147.5), for males and 4.1 (3.6-4.7) 24 (20-34), 25 (21.4-29.8), 64 (44-98), for females respectively.

Table 2 shows the estimated association between uric acid and BMI, BFP, WC adjusted for age, gender, and TG, in a multivariate quantile regression model for the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th and 90th, centiles levels with corresponding 95% CI. All estimated associations were statistically significant as the 95% confidence intervals don't include zeros. The estimated effects of BMI, BFP, and WC are higher when the centiles of the uric acid increase.

Table 3 shows summary statistics of the serum uric acid level by age group and gender where it is clearly seen males have higher serum uric acid levels as compared to females, however, there was no difference in the serum uric acid levels for males by age group, median (IQR) of 6 (5.3-6.7), 5.9 (5.3-6.8), 5.9 (5.2-6.7), 5.9 (5.2-6.7), for age group 18-20, 21-25, 26-33, 34-74, respectively. Similarly, no difference in the serum uric acid level for females by age group, median (IQR) of 4 (3.5-4.6), 4 (3.5-4.7), 4.2 (3.6-4.8), 4.2 (3.6-5), correspondingly.

Table1: Minimum, 25^{th} quantile, median, 75^{th} quantile and maximum values of the variables included in the statistical analysis.

	age		uric		Waist Circumference		BMI		Body Fat (%)		TG	
Statistic	Woman	Man	Woman	Man	Woman	Man	Woman	Man	Woman	Man	Woman	Man
Min.	18	18	0.8	0.9	45	36	14	13.9	7	3.8	8	11
1st Qu.	20	22	3.6	5.2	69	82	21	23.7	26.9	19.6	43	60
Median	23	27	4.1	5.9	77	90	24.7	26.9	32.5	24.6	63	92
3rd Qu.	32	36	4.7	6.7	87	100	29.5	30.6	38.4	29.3	96	146
Max.	67	74	11.4	13.1	148	193	61.2	65.5	57.6	56	560	3258

Table 2: Estimated the association between uric acid and BMI, BFP, WC adjusted for age, gender, and TG, in a multivariate quantile regression model for the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th and 90th centiles levels with corresponding 95% CI. If the 95% confidence intervals include 0 indicating non statistically significant association.

	BODYFATP	**age**	**Gender/Woman**	**log (TG)**
quantile=0.1	0.031 (0.026, 0.035)	-0.014 (-0.02, -0.009)	-1.742 (-1.825, -1.658)	0.135 (0.072, 0.199)
quantile=0.2	0.041 (0.037, 0.045)	-0.015 (-0.018, -0.011)	-1.965 (-2.037, -1.893)	0.104 (0.052, 0.155)
quantile=0.3	0.04 (0.037, 0.044)	-0.013 (-0.016, -0.009)	-2.009 (-2.075, -1.944)	0.118 (0.071, 0.164)
quantile=0.4	0.046 (0.042, 0.049)	-0.013 (-0.016, -0.009)	-2.144 (-2.208, -2.081)	0.101 (0.054, 0.148)
quantile=0.5	0.048 (0.044, 0.052)	-0.011 (-0.015, -0.008)	-2.171 (-2.236, -2.105)	0.13 (0.083, 0.178)
quantile=0.6	0.05 (0.046, 0.053)	-0.01 (-0.013, -0.006)	-2.237 (-2.301, -2.174)	0.149 (0.103, 0.195)
quantile=0.7	0.049 (0.045, 0.053)	-0.008 (-0.012, -0.004)	-2.287 (-2.36, -2.214)	0.171 (0.119, 0.223)
quantile=0.8	0.052 (0.047, 0.056)	-0.007 (-0.011, -0.002)	-2.368 (-2.454, -2.281)	0.18 (0.116, 0.243)
quantile=0.9	0.057 (0.051, 0.063)	-0.004 (-0.01, 0.001)	-2.525 (-2.633, -2.416)	0.187 (0.11, 0.264)
	BMI	**age**	**Gender/Woman**	**log (TG)**
quantile=0.1	0.046 (0.039, 0.053)	-0.015 (-0.02, -0.011)	-1.432 (-1.507, -1.358)	0.101 (0.038, 0.165)
quantile=0.2	0.056 (0.051, 0.06)	-0.015 (-0.019, -0.011)	-1.52 (-1.579, -1.462)	0.095 (0.044, 0.145)
quantile=0.3	0.057 (0.052, 0.062)	-0.013 (-0.017, -0.01)	-1.605 (-1.66, -1.55)	0.107 (0.06, 0.153)
quantile=0.4	0.059 (0.054, 0.065)	-0.012 (-0.016, -0.009)	-1.67 (-1.727, -1.613)	0.106 (0.058, 0.154)
quantile=0.5	0.063 (0.058, 0.067)	-0.011 (-0.015, -0.008)	-1.697 (-1.751, -1.643)	0.131 (0.084, 0.177)
quantile=0.6	0.064 (0.058, 0.069)	-0.01 (-0.014, -0.006)	-1.73 (-1.788, -1.671)	0.149 (0.1, 0.197)
quantile=0.7	0.068 (0.062, 0.073)	-0.01 (-0.013, -0.006)	-1.803 (-1.863, -1.742)	0.143 (0.092, 0.194)
quantile=0.8	0.073 (0.067, 0.079)	-0.007 (-0.011, -0.003)	-1.84 (-1.909, -1.772)	0.152 (0.093, 0.211)
quantile=0.9	0.076 (0.067, 0.086)	-0.005 (-0.011, -0.0001)	-1.993 (-2.092, -1.894)	0.17 (0.088, 0.252)
	WAIST	**age**	**Gender/Woman**	**log (TG)**
quantile=0.1	0.021 (0.018, 0.023)	-0.018 (-0.022, -0.014)	-1.247 (-1.317, -1.178)	0.109 (0.053, 0.165)
quantile=0.2	0.024 (0.022, 0.027)	-0.017 (-0.021, -0.013)	-1.309 (-1.376, -1.242)	0.093 (0.041, 0.145)
quantile=0.3	0.025 (0.023, 0.027)	-0.017 (-0.02, -0.013)	-1.384 (-1.444, -1.325)	0.097 (0.048, 0.145)
quantile=0.4	0.026 (0.024, 0.028)	-0.015 (-0.018, -0.011)	-1.445 (-1.505, -1.386)	0.105 (0.057, 0.153)
quantile=0.5	0.027 (0.025, 0.029)	-0.014 (-0.017, -0.01)	-1.467 (-1.527, -1.407)	0.106 (0.058, 0.154)
quantile=0.6	0.028 (0.026, 0.03)	-0.013 (-0.017, -0.009)	-1.496 (-1.557, -1.435)	0.137 (0.088, 0.186)
quantile=0.7	0.028 (0.026, 0.031)	-0.011 (-0.015, -0.007)	-1.54 (-1.604, -1.476)	0.14 (0.088, 0.192)
quantile=0.8	0.03 (0.027, 0.032)	-0.009 (-0.013, -0.004)	-1.579 (-1.653, -1.505)	0.156 (0.095, 0.217)
quantile=0.9	0.031 (0.028, 0.035)	-0.008 (-0.014, -0.003)	-1.705 (-1.803, -1.607)	0.18 (0.099, 0.26)

Table 3: Minimum, 25th quantile, median, 75th quantile and maximum values of the serum uric acid by age group and gender.

	Age 18-20		Age 21-25		Age 26-33		Age 34-74	
	Man	**Woman**	**Man**	**Woman**	**Man**	**Woman**	**Man**	**Woman**
Min.	3.2	1.9	3.1	1.7	3	1.9	3	1.6
Q25th	5.3	3.5	5.3	3.5	5.2	3.6	5.2	3.6
Median	6	4	5.9	4	5.9	4.2	5.9	4.2
Q75	6.7	4.6	6.8	4.7	6.7	4.8	6.7	5
Max	8.8	6.2	9	6.5	8.9	6.6	8.9	7.1

Giving all previous observations, it might be the time to apply research trials to examine if the management of hyperuricaemia could play role on the prevention and treatment of development of cardiovascular diseases and metabolic syndrome. Clinicians may consider looking on more focus on serum uric acids levels and its management while dealing with cardiovascular and metabolic cases especially those are at high-risk.

Discussion

Table 3 shows no difference for UA by age group. However, age became negatively associated with UA in Table 2. This is because age is only negatively associated with UA after adjusting for BMI, BFP or WC respectively. This finding supports what is available in the literature in which a significant correlation was reported between hyperuricemia particularly in the elderly age [24].

Moreover, the findings of this study reflected that male had more elevated serum uric acid compared to females (Table 3). This was supported by some literature [25,35], while other literature found to have the opposite, but those studies had smaller sample size [26].

In addition, the association between SUA and anthropometric measures was evidenced to be influenced by the daily food consumption in which some studies found U-Shaped relationship and other study found positive association [36,37]. Therefore, we recommend further research to investigate the significant finding of this study when the full data of 15,000 participants of the UAE is available.

In the UAE, especially after the recent pandemic, there is a huge focus on public health prevention and treatment in particular to the common chronic diseases in the country. So, we believe that, if the results of this study evidence and its connection to the common cardiovascular diseases in the UAE in terms of its morbidity and mortality statistics, is appropriately addressed to the stakeholders of the community and the policy makers, changes will take place in the hidden and visualized efforts. Polices will be applied to provide guidelines or protocols for the daily clinical practice that consider the hyperuricemia effect on metabolic syndrome and cardiovascular disease prevention and treatment.

Moreover, awareness campaigns and programs will be applied through public health centres to the community to address the relation of hyperuricaemia to its factors such as metabolic disease control, dietary intake and healthy lifestyle.

Strength and Limitations

Missing values were omitted due to unavailable age and gender data for 555 participants, but this can be checked in the future when the full data is available for the 15,000 participants of the UAEHFS.

One of the limitations of this study not considering as many as factors which might play role on the nature of the relationship between serum uric acid and anthropometric measures. We basically aimed on measuring objective data at this paper and looking forward considering adequate subjective data to measure the association in a wider range once the subjective data is available.

Although some limitations were found in this study, the findings provide future direction to clinical practice of cardiovascular disease and its risk factors screening and early detection. Further investigation is needed with the full main UAEHFS data to have a better picture of the association between SUA and anthropometric measures with important consideration of the daily food intake.

Conclusion

The findings of this study reflected a significant positive association between elevated serum uric acid and anthropometric measures after adjustment for TG, age and gender among adult Emiratis. The BMI, WC, PFB all reflected similar association to serum uric acid levels. Whilst there was a negative association between age and serum uric acid levels which in which the younger adults the higher serum uric acid. Furthermore, males had more elevated serum uric acid compared to females. These findings provide novel data and could add to the daily clinical practice for early detection of cardiovascular diseases related to hyperuricemia. A recommendation to include the daily food intake in the analysis when the data of the 24 hours food intake of the UAEHFS is available.

Declarations

Ethics Approval and Consent to Participate

This research was approved by the Institutional Review Board(s) at New York University Abu Dhabi (NYUAD), Sheikh Khalifa Medical City (SKMC), Zayed Military Hospital (ZMH), and NYU Langone Medical Center in New York. All methods were performed in accordance with the relevant guidelines and regulations. Written informed consent was obtained from all study participants prior to the start of data collection. Please address all correspondence concerning this manuscript to me at ma4643@nyu.edu

Consent for publication

Not Applicable

Availability of Data and Materials

Data are from the United Arab Emirates Healthy Futures (UAEHFS) study. A de-identified data set can be shared subject to the policies of the approving ethics committees and the data access policy of the UAEHFS. The New York University Abu Dhabi IRB approved informed consent form described how participant data would be shared with other researchers. The consent form states that researchers who are interested in accessing study data will contact the data access/ethics committee to be granted access to the data. Once approved, de-identified data can be made available. Researchers who meet the criteria for access to confidential data may contact the IRB at IRBnyuad@nyu.edu to gain access to the data.

Competing interests

The authors have declared that no competing interests exist.

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Author Contributions

Supervision: Raghib Ali, Amar Ahmad, Fatima Al Maskari.

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