http://dx.doi.org/10.14500/aro.12380

Uric Acid Dynamics in Young Women: Associations with Radiation Exposure, Blood Groups, and Biochemical Markers

Ahmed H. Ahmed†

Department of Biology, College of Science, Salahaddin University-Erbil,
Kurdistan Region – F.R. Iraq

***Abstract*—A growing body of evidence implicates uric acid to play central roles in various disease complications. However, the delineation between causative and coincidental roles remains poorly elucidated. This study aimed to evaluating uric acid in young women considering variables such as disease types, body mass index, blood groups, radiation exposure, and to assess the relationship between uric acid levels and certain subclinical biomarkers. A cohort of 178 young women, between 18 and 39 years, (comprising 100 cases and 78 healthy controls) was included in this investigation. Diagnosed subjects with common diseases, renal, cardiovascular, blood, joints, diabetes, gastrointestinal diseases, were selected according to stringent criteria. Subjects were categorized based on disease types, blood groups, and exposure history to ionizing radiation including mammography and body or leg X-ray. Serum levels of uric acid and biochemical tests were analyzed by unpaired comparison tests and correlation coefficient tests. Subjects with hematological disorders exhibited lower uric acid concentrations when compared to healthy women. Uric acid concentrations in individuals with repeated exposure to X-ray radiation showed a high significant difference ($p<0.01$) compared to unexposed individuals. In Spearman correlation analyses, positive correlations ($p < 0.001$) are identified between uric acid and iron, calcium, prolactin, and body mass index. In healthy young women, uric acid levels fluctuated both within and beyond physiological ranges, independent of disease status, weight indexes, and blood types. Assessment of uric acid in young women, based on a history of radiation exposure, subclinical blood parameters might guide for better medical decision and treatment**

***Index Terms*—Hyperuricemia, Metabolic syndrome, Metabolism, Purine, Urate.**

I. Introduction

Under physiological conditions, uric acid is produced as an end product of purine catabolism that originating from nucleic acids and proteins. In human beings, uric acid is synthesized predominantly in the liver and intestines, with secondary synthesis occurring in vascular endothelium, kidneys, and musculature as a reservoir of purines (Goldberg, et al., 2021) arising from the degradation of nucleic acids, specifically adenines and guanines, in damaged cells. In physiological circumstances, the excretion of uric acid from the organism transpires continuously in substantial amounts through the kidneys (70%) and to a lesser extent through the liver (30%) (Yang, et al., 2019). The levels of circulating uric acid in the bloodstream are maintained within homeostatic ranges by various metabolic enzymes and transporter proteins located in the liver and kidneys, respectively (Grossman, Grossman and Goldbourt, 2019; Goldberg, et al., 2021). Notably, heightened concentrations of uric acid have raised concerns in clinical investigations, particularly as uric acid has been associated with gout (Mei, et al., 2022) and malaria (Gomes, et al., 2019), both of which represent significant global public health challenges for centuries; consequently, uric acid has increasingly garnered attention beyond its physiological limits in conditions such as chronic kidney diseases (Hsieh, et al., 2017), cardiovascular dysfunction, non-alcoholic liver diseases (Song, et al., 2019) metabolic disorders (Liu, et al., 2023), and even cognitive impairments (El Ridi and Tallima, 2017). Conversely, the protective roles of uric acid in neurovegetative disorders, oxidative stress, acid-base equilibrium, immune dysregulation, inflammation, and parasitic infections (Du, et al., 2016) have been extensively documented. Presently, uric acid has emerged as one of the most frequently conducted laboratory tests and is incorporated into routine health screenings for both afflicted and healthy individuals, in addition to the recurrent clinical alerts issued by healthcare professionals regarding the risks associated with elevated uric acid levels, which have significantly concerned the public. Intriguingly, a cursory examination of the existing literature and a critical analysis of sampling methodologies, data interpretation, and analytical frameworks may further obscure the comprehension of uric acid's physiological behavior, particularly given that the majority of uric acid association studies have revealed U-shaped or J-shaped correlations (Crawley, et al., 2022; Zheng, et al., 2022) rather than linear associations. Moreover, the widely accepted threshold for hyperuricemia (>7 mg/dL,

ARO-The Scientific Journal of Koya University
Vol. XIII, No. 2 (2025), Article ID: ARO.12380. 7 pages
DOI: 10.14500/aro.12380
Received: 25 June 2025; Accepted: 21 August 2025
Regular research paper; Published: 11 October 2025
†Corresponding author's e-mail: ahmed.h.ahmed@su.edu.krd

irrespective of gender differences) has faced criticism, as this benchmark appears to be inaccurately estimated across various countries or regions (Konta, et al., 2020). A crucial point of clarification is the reason behind numerous studies indicating severe complications associated with uric acid, even at considerable distances from the established threshold. This observation underscores the necessity of re-evaluating this critical value while incorporating significant anthropological data from diverse populations, representing an urgent step towards a precise clinical assessment of elevated uric acid levels and mitigating unnecessary medical interventions or dietary modifications. Nevertheless, the potential aberrant fluctuations of uric acid, even among asymptomatic individuals, have been widely observed in women, particularly among younger women, despite the absence of clinical manifestations of any diseases. By taking into account the accessible published evidence, investigating the association of uric acid with other coincident biomarkers in health and disease, in relation to clinical history, cultural dietary practices, physical activity, radiation exposure history, and genetic factors, may provide valuable insights into the genuine triggers of uric acid elevation. To address some of these conceptual correlations between various subclinical markers and uric acid, this study aims to evaluate uric acid levels in healthy and diseased women concerning disease type, blood groups and body mass index, in addition to examining the nature of the association between uric acid and serum iron, magnesium, estradiol E2, Vitamin D3 and lipid profiles in young women.

II. Methods

This investigation focused on young women aged 18–39 years, for whom categorical data were meticulously extracted from clinical examination reports spanning the preceding 6 months, along with blood samples that were subsequently collected and analyzed in biochemical laboratories. The criteria established for the selection of participants were as follows: Chronic controlled conditions, encompassing arthritis (n = 17) (characterized by joint pain, stiffness, and swelling persisting for over 6 weeks in three to four distinct joints or more, with morning stiffness extending beyond 30 min) (Zhang, et al., 2025), hypertension (n = 19) (with a diagnostic threshold for hypertension set at 140/90 mmHg in clinical blood pressure assessments) (Jones, et al., 2020), Type II diabetes mellitus (n = 32) (defined as having a blood glucose level of 126 mg/dL (7 mmol/L) or above) (Fina Lubaki, Omole and Francis, 2022), renal impairment (n = 9) (evidenced by a glomerular filtration rate of less than 60 mL/min/1.73 m² or the presence of albuminuria ≥30 mg within a 24-h period) (Tsur, et al., 2024), and gastrointestinal disorders (n = 12) (including but not limited to bacterial or parasitic infections, celiac disease, lactose intolerance, unidentified etiology of diarrhea, and hepatic diseases) (Ashfaq, Hayee and Muhammad, 2023), blood diseases (n = 11) newly diagnosed with anemia were the sole conditions included, with stringent conditional periodic monitoring supported by clinical documentation. In addition, for possible influence of ionizing radiation on cellular metabolism and damage, the history of X-ray exposure (n = 41) (ionizing radiations, mammography, body or legs X-ray) during past 6 months (Borzoueisileh, et al., 2020) was included in the study. Excluded from the study were individuals with uncontrolled chronic diseases accompanied by various complications, those recently diagnosed with new ailments, patients who had undergone recent surgical interventions, smokers, individuals with extreme body mass indices, subjects adhering to ketogenic diets or undergoing hormonal therapies, those with extensive body tattoos (exceeding 300 cm^2) (Lehner, et al., 2011), and consumers of alcoholic beverages (Fukui, et al., 2023). Ultimately, a cohort comprising 78 healthy and 100 diseased young women was successfully included. Blood samples underwent comprehensive analyses, including assessments of complete blood count, serum uric acid, estradiol E2, Vitamin D3, prolactin levels, lipid profiles, liver function tests, as well as evaluations of magnesium, calcium, iron, and ferritin concentrations. The research received ethical approval from the Human Ethics Committee at the College of Science under reference number 45/364, 2024.

III. Statistical Analysis

The determination of the sample size was executed utilizing the sample size calculator software G-power v3, incorporating a significance level (α) of 0.05, a statistical power (β) of 0.80, and an effect size (d) of 0.45, derived from previous studies evaluating the correlation coefficient disparities between diseased and non-diseased young female populations. The data sets that conformed to the normality assumptions were subjected to analysis through parametric statistical tests, whereas those that failed to exhibit a normal distribution were assessed through non-parametric tests without undergoing transformation. For the purpose of examining associations, either Pearson's correlation coefficient or Spearman's rank correlation coefficient tests were implemented. Comparative analyses among the study groups were conducted using the unpaired T-test or Mann–Whitney U test, alongside simple one-way analysis of variance complemented by *post hoc* comparison tests.

IV. Results

In Fig. 1, the research delineated a thorough overview of the empirical findings across four distinct panels, each emphasizing varying facets of the investigation. Panel (a) indicated no significant disparities in serum uric acid levels between diseased and healthy women. Panel (b) elaborated on the types of diseases and their respective influences on serum uric acid concentrations. The classification of "Healthy" was utilized as the control cohort, followed by six disease categories: Blood Diseases, Rheumatic Diseases, Gastrointestinal Tract Disorders, Diabetes Mellitus Type 2, and Cardiovascular Diseases. As noted in the comparative analysis, only blood diseases exhibited significantly lower uric acid levels with substantial statistical differences,

http://dx.doi.org/10.14500/aro.12380

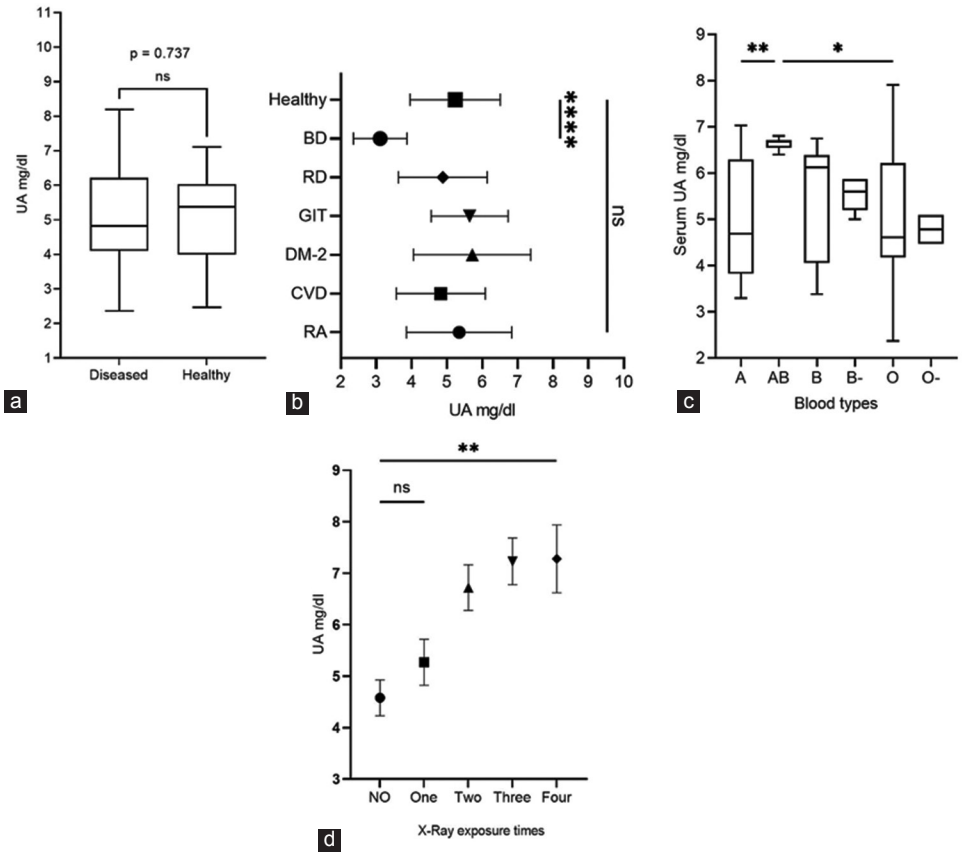

Fig. 1. Numerical and categorical data distributions across four panels: (a) Serum uric acid concentration in mg\dL for diseased and healthy subjects; (b) serum uric acid in healthy and different disease types; BD; blood diseases, RD; renal diseases, GIT; gastrointestinal tract diseases, DM-2; diabetes mellitus-type 2, CVD; cardiovascular diseases, RA; Rheumatic Arthritis; (c) Serum uric acid levels in different blood types, (d) mean differences between subjects with no X-ray exposure and subjects with different exposure times ("One" to "Four") within last 6 months. Asterisks represent statistical differences; *represents $p < 0.05$, **; <0.01, ****; $p < 0.0001$.

whereas the other conditions did not demonstrate any notable statistical variations, taking into account the non-parametric nature of the data, which may occasionally obscure even at marginal statistical changes. Panel (c) integrated quantitative biochemical data with information regarding blood type. This panel presented serum uric acid values in mg/dL in conjunction with ABO blood group variants (AB, B, B-, O, O-). The comparative analysis conspicuously illustrated the statistical differences between blood type AB, which exhibited the highest uric acid levels, and the other blood types ($p < 0.001$ in relation to blood type A and $p < 0.05$ concerning other blood types). Notably, Panel (d) concentrated on diagnostic imaging parameters, specifically exposure to mammography and X-rays, and categorized ordinal X-ray exposure durations (One through Four). The mean uric acid values (4.5–7.3 mg/dL) corresponded to the frequency of imaging procedures performed. This study reveals an evident that subjects subjected to repeated radiation exposure were more inclined to present elevated uric acid levels compared to those with a lower incidence of exposure or no exposure history over the preceding 6 months, achieving a level of significance at $p < 0.01$ when exposure durations were doubled or more. In the current analysis, the correlation investigation yielded diverse correlation characteristics of uric acid with biochemical assessments in the selected subjects. Fig. 2 illustrated a comprehensive correlation analysis across eight panels (A-H), revealing significant associations between uric acid and various blood markers. Four panels exhibited moderate positive correlations: Panel a ($r = 0.45$, $p < 0.0001$), Panel b ($r = 0.42$, $p < 0.0001$), Panel d ($r = 0.48$, $p < 0.0001$), and Panel h ($r = 0.42$, $p < 0.005$). Panel h specifically scrutinized the relationship between serum uric acid (mg/dL) and prolactin levels (ng/ml), implying a potential pathophysiological connection between purine metabolism and endocrine functionality. Three panels demonstrated significant negative correlations: Panel c presented a moderate inverse relationship ($r = -0.51$, $p < 0.0001$), followed by Panel e ($r = -0.49$, $p < 0.0001$) and Panel f ($r = -0.44$, $p < 0.0001$).

This null finding holds considerable significance as it indicates that these lipid parameters exhibit independent variability within the context of the study, thereby potentially excluding certain metabolic interactions. On the other hand, many blood and serum parameters listed in Table I show no significant correlations between uric acid and complete blood count, creatinine levels, blood urea nitrogen, serum ferritin, fasting blood glucose, C-reactive protein, erythrocyte sedimentation rate, as well as other

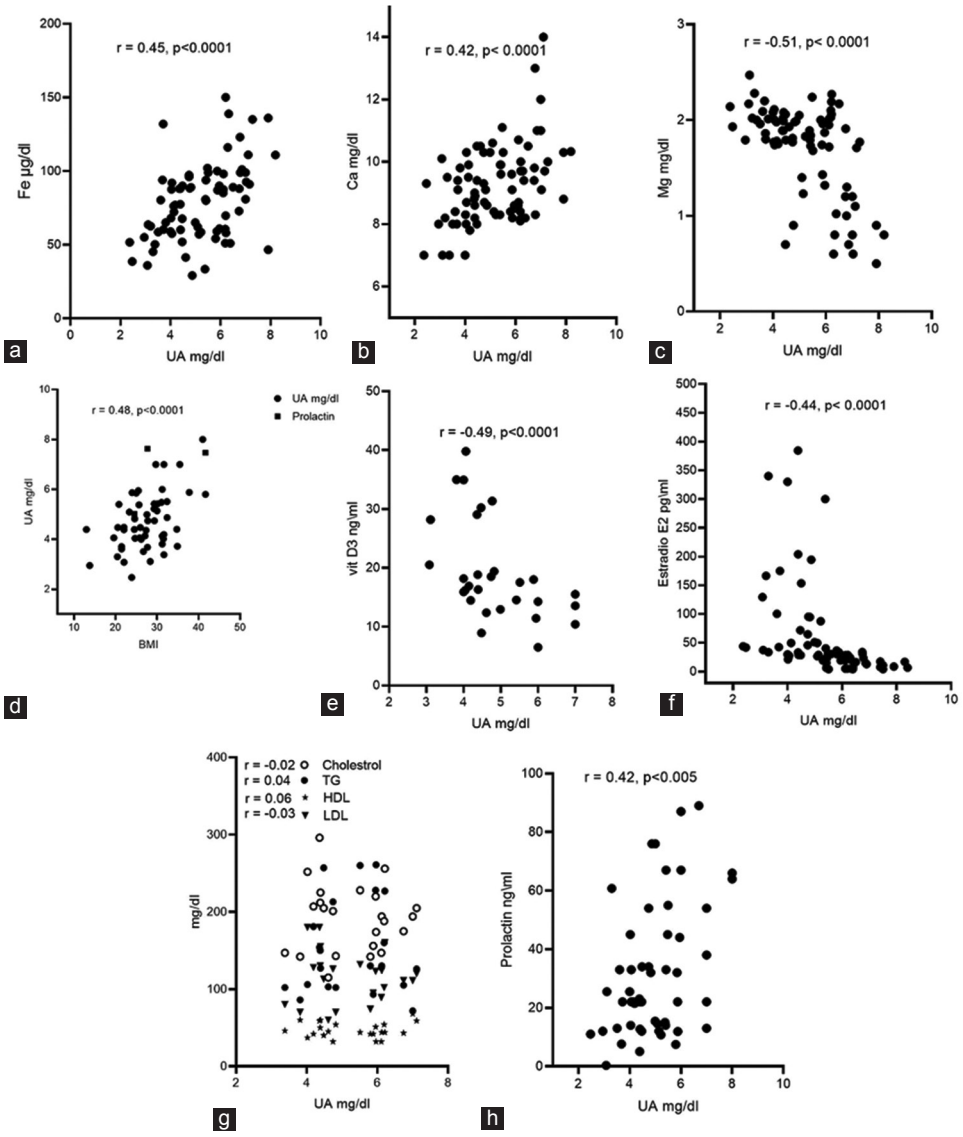

Fig. 2. Correlation analysis results across eight panels (a-h) showing Pearson correlation coefficients (r) and their statistical significance (p-values). Panels (a-d) demonstrate significant, but slightly moderate, positive (a: r = 0.45; b: r = 0.42; d: r = 0.48) and negative (c: r = −0.51) correlations with $p < 0.0001$). Panel (e-f) reveal additional negative correlations (e: r = -0.49; f: r = −0.44, both $p < 0.0001$), while panel (g) shows a negligible correlation (r = −0.02) between serum uric acid lipid profiles; Cholesterol, TG; triglycerides, HDL; high-density lipoproteins, LDL; low-density lipoproteins. Panel (h) confirms a positive correlation (r = 0.42, $p < 0.005$) between serum uric acid and prolactin.

female hormones.

V. Discussion

This investigation addressed a contentious subject pertaining to the implications of uric acid in the advancement and manifestation of various diseases, or at the very least, its concomitant occurrence with subclinical indicators, particularly among young women, as burgeoning evidence has indicated that women in this ages are increasingly susceptible to subclinical diseases attributable to a combination of biological, hormonal, and sociocultural factors (Okoth, et al., 2020). Furthermore, the urgency of reassessing these parameters was exacerbated by international reports and scientific findings that increasingly highlighted the global risks associated with uric acid, prompting numerous countries and urban areas to revise their cutoff values for hyperuricemia. A study conducted in China by (Zhang, et al., 2022) established the threshold for hyperuricemia to be 420 µmol/L (4.7 mg/dL) irrespective of gender distinctions. Conversely, in the Japanese population, as noted by (Kuwabara, et al., 2024), the threshold for hyperuricemia was delineated at >7 mg/dL for both sexes, while in Brazil, the thresholds were set at >9.2 mg/dL for males and >6.9 mg/dL for females (Gomes, et al., 2019), in Sweden; >6.8 mg/dL (34), in black African populations; >7 mg/dL for males and >5.6 mg/dL for females (Molla, et al., 2021), and in certain eastern European nations; >6.8 mg/dL for males and >6 mg/dL for females (Winder, et al., 2021). These data, in conjunction with the internationally accepted definition of hyperuricemia, which is

http://dx.doi.org/10.14500/aro.12380

TABLE I
Correlation Analysis of Serum Uric Acid Levels with Biochemical and Subclinical Parameters in Young Women (n=178)

Parameters	r	95% CI	p-value
Creatinine	0.077	0.049–0.093	<0.3401
ESR	−0.093	−0.097–−0.08	<0.1201
CRP	0.078	0.041–0.090	<0.301
Estradiol (E2)	−0.44	0.235–0.639	<0.0001
Urea	0.01	0.009–0.026	0.0932
Vit D3	0.49	0.294–0.644	<0.001
TG	0.04	−0.012–0.394	0.9602
LDL	−0.03	−0.016–0.439	0.8408
HDL	0.06	−0.029–0.462	0.7806
Cholesterol	0.02	−0.013–0.188	0.8626
HbA1c	−0.09	−0.436–0.286	0.6413
Ferritin	−0.037	−0.586–−0.095	0.0076
GUE (crystals)	−0.07	−0.342–0.216	0.6299
Bilirubin total	0.13	0.035–0.877	0.323
LH	0.01	0.003–0.087	0.34
LSH	−0.11	−0.412–0.394	0.3602
Prolactin	0.42	−0.365–0.590	<0.005
BS	0.02	−0.359–0.062	0.4806
wbc	−0.019	−0.241–0.205	0.8687
rbc	0.069	−0.157–0.288	0.552
hb	−0.027	−0.249–0.197	0.8137
hct	−0.022	−0.244–0.203	0.8512
mcv	−0.111	−0.327–0.115	0.3358
mch	−0.144	−0.356–0.082	0.2104
mchc	−0.139	−0.352–0.087	0.2266
plt	0.050	−0.175–0.271	0.6652
lym%	0.038	−0.187–0.259	0.7432
mid%	−0.071	−0.290–0.155	0.5397
neut%	−0.012	−0.235–0.212	0.9199
lym	0.009	−0.215–0.232	0.9373
mxd	−0.080	−0.2991–0.14	0.4866
neut	−0.013	−0.237–0.211	0.9074
rdw-cv	0.082	−0.145–0.300	0.4805
rdw-sd	0.150	−0.0760–0.362	0.1924
pdws	0.027	−0.198–0.249	0.8144
mpv	−0.072	−0.291–0.154	0.5329

Values represent Pearson's correlation coefficient (r), 95% confidence intervals (CI), and corresponding p-values. Strong positive correlations were observed with creatinine (r=0.77, p<0.0001), CRP (r=0.78, p<0.0001), and estradiol (r=0.62, p=0.0033), while a strong negative correlation was found with ESR (r = −0.93, p<0.0001). Vitamin D3 showed a significant positive association (r=0.71, p<0.0001), whereas ferritin demonstrated a moderate negative correlation (r = −0.37, p=0.0076). No significant correlations were detected for urea, lipid profiles (TG, LDL, HDL, cholesterol), HbA1c, iron, GUE crystals, bilirubin, or hormonal markers (LH, LSH, prolactin, BS) (all p>0.05). GUE: General urine examination; BS: Blood sugar; ESR: Erythrocyte sedimentation rate; CRP: C-reactive protein; TG: Triglycerides; LDL/HDL: Low-/High-density lipoprotein; LH/LSH: Luteinizing hormone, LSH: Luteinizing-stimulating hormone

established at >7 mg/dL without regard for gender differences (Konta, et al., 2020), underpin the substantial role of uric acid in the etiology and progression of a multitude of diseases (Jung, et al., 2018; Crawley, et al., 2022). An atypical observation in the current study is depicted in (Fig. 1a), which reveals that in females with diseases, uric acid levels were noted to be significantly below (as median) the threshold, accompanied by a relatively uniform interquartile range, in contrast to non-diseased subjects, thereby contradicting the widely held belief regarding uric acid elevation in the context of disease (Verma, et al., 2020) with a proportional exposure ratio or mean differences not less than 0.5 (Sah and Qing, 2015). A plausible explanation for this uric acid behavior could be its capacity to exhibit high concentration peaks under both physiological and pathophysiological conditions. While the latter scenario has been substantiated in existing literature, the former necessitates further clarification. Some reports have indicated that elevated uric acid levels in otherwise healthy individuals are associated with subclinical organ damage or atherosclerosis (Kuwabara, et al., 2024) and, at times, occur independently of other hematological markers (Beberashvili, et al., 2015). Although the elevation of uric acid levels in chronic diseases has been extensively documented, the current findings, with the adequate sample size, did not reveal any significant impact of disease on uric acid levels, with the exception of the blood diseased group, where certain therapeutic interventions may have contributed to a notable reduction in uric acid levels. Nevertheless, for the remaining diseased cohorts, the lack of significant median differences, compounded by the absence of baseline uric acid concentrations before the onset of subclinical alterations, necessitates further elucidative evidence. Moreover, clinical associations with conditions such as cardiovascular disease, Type 2 diabetes mellitus, and rheumatoid arthritis further underscore the role of uric acid in exacerbating insulin resistance, endothelial damage, and NLRP3-driven inflammation (Wang, et al., 2020). For example, the activity of xanthine oxidase induced by uric acid produces reactive oxygen species, which aggravates cardiovascular remodeling and contributes to the pathogenesis of these conditions (44). Notably, when blood groups were incorporated into this investigation, the variations observed in the results led to the documentation of blood type-related hemostatic and biochemical distinctions (Khan and Pujari 2018). More significantly, the disparities in uric acid concentrations across different blood groups appeared to be inadequately addressed, yet they may be critical when reevaluating the uric acid threshold in studies incorporating diverse gender variables. Another salient observation in this research was the mean differences observed between graded X-ray exposure durations (e.g., "One" to "Four"), which reflected cumulative damage resulting from radiation exposure (Chauhan and Wilkins, 2019); this, in turn, caused damage to nucleic bases and increased uric acid levels (Wang, et al., 2020). Regrettably, the recurrent consequences of radiation exposure remain underestimated within patient histories, which appear to significantly contribute to elevated uric acid levels, potentially elucidating why even asymptomatic individuals may exhibit elevated uric acid levels following multiple exposures to diagnostic radiation, particularly those subjected to narrow exposure timeframes. Another notable aspect of the current study was the coincidental appearance of various blood markers alongside uric acid in healthy young women. With a moderate correlation of uric acid with iron, calcium, and prolactin, alongside a negative correlation with estradiol E2 and Vitamin D3 or magnesium, one can surmise the necessity for a systematic blood screening schedule at regular intervals, given that these parameters may fluctuate independently without clinical symptoms, yet exhibit statistically significant associations without meaningful

clinical cause-and-effect implications. Although uric acid has been repeatedly reported to correlate with the aforementioned parameters in pathological subjects (Wang et al., 2020), the emergence of moderate associations in healthy subjects in the present study raises questions regarding the potentially deleterious roles of these parameters even in the context of disease progression. In addition, the results presented elucidated significant associations between serum uric acid levels, body mass index, and various metabolic and subclinical parameters, thereby offering insights into the intricate interplay of obesity, purine metabolism, and early disease markers. The associations depicted in Table I underscored the misleading roles of uric acid in metabolic dysregulation, potentially mediated through pathways such as insulin resistance and chronic inflammation. Moreover, the comparatively weaker correlations with lipid profiles (e.g., HDL: r = 0.06) imply that body mass index alone may not adequately encapsulate lipid abnormalities, necessitating the inclusion of additional markers such as uric acid for a comprehensive risk assessment (Zhang, et al., 2022). Another unexpected outcome in this study was hematological and lipid profile indices that have not seen to be influenced by coincidental increase or decrease, even moderately, of above-mentioned parameters with uric acid that emphasize the believe that many blood circulating markers might fluctuate independently from other markers and, in turn, obliterate the cause and effect impacts of uric acid on appearance of other subclinical markers, at least in the selected ages of women.

VI. Conclusion

The current study highlighted the levels of uric acid in different studied groups in young women, and some other blood parameters were coincidentally appeared in positive or negative association. Exposure to diagnosing radiation seemed to participate in uric acid elevation. We suggest that overestimation of uric acid is not necessarily been addressed as a causative role in disease progression.

References

Ashfaq, F., Hayee, S., and Muhammad, S.W., 2023. A study on association of stress related problems with gastrointestinal disorders in University students: Association of stress related problems with GIT disorders. *The Journal of Zoology*, 4(1), pp.21-26.

Beberashvili, I., Sinuani, I., Azar, A., Shapiro, G., Feldman, L., Stav, K., Sandbank, J., and Averbukh, Z., 2015. Serum uric acid as a clinically useful nutritional marker and predictor of outcome in maintenance hemodialysis patients. *Nutrition*, 31(1), pp.138-147.

Borzoueisileh, S., Shabestani Monfared, A., Ghorbani, H., Mortazavi, S.M.J., Zabihi, E., Pouramir, M., Doustimotlagh, A.H., Shafiee, M., and Niksirat, F., 2020. Assessment of function, histopathological changes, and oxidative stress in liver tissue due to ionizing and non-ionizing radiations. *Caspian Journal of Internal Medicine*, 11(3), pp.315-323.

Chauhan, V., and Wilkins, R.C., 2019. A comprehensive review of the literature on the biological effects from dental X-ray exposures. *International Journal of Radiation Biology*, 95(2), pp.107-119.

Crawley, W.T., Jungels, C.G., Stenmark, K.R., and Fini, M.A., 2022. U-shaped association of uric acid to overall-cause mortality and its impact on clinical management of hyperuricemia. *Redox Biology*, 51, p.102271.

Du, N., Xu, D., Hou, X., Song, X., Liu, C., Chen, Y., Wang, Y., and Li, X., 2016. Inverse association between serum uric acid levels and Alzheimer's disease risk. *Molecular Neurobiology*, 53, pp.2594-2599.

El Ridi, R., and Tallima, H., 2017. Physiological functions and pathogenic potential of uric acid: A review. *Journal of Advanced Research*, 8(5), pp.487-493.

Fina Lubaki, J.P., Omole, O.B., and Francis, J.M., 2022. Glycaemic control among type 2 diabetes patients in sub-Saharan Africa from 2012 to 2022: A systematic review and meta-analysis. *Diabetology and Metabolic Syndrome*, 14(1), p.134.

Fukui, S., Okada, M., Rahman, M., Matsui, H., Shiraishi, A., Nakai, T., Tamaki, H., Kishimoto, M., Hasegawa, H., and Matsuda, T., 2023. Differences in the association between alcoholic beverage type and serum urate levels using standardized ethanol content. *JAMA Network Open*, 6(3), pp.e233398-e233398.

Goldberg, A., Garcia-Arroyo, F., Sasai, F., Rodriguez-Iturbe, B., Sanchez-Lozada, L.G., Lanaspa, M.A., and Johnson, R.J., 2021. Mini review: Reappraisal of uric acid in chronic kidney disease. *American Journal of Nephrology*, 52(10-11), pp.837-844.

Gomes, L.T., Bellei, A.K., Andrade, D.I.D., Gotardo, P.Z., Nery, A.F., and Fontes, C.J.F., 2019. Decreased uric acid levels in the acute phase of *Plasmodium vivax* malaria. *Revista da Sociedade Brasileira de Medicina Tropical*, 52, p.e20170412.

Grossman, C., Grossman, E., and Goldbourt, U., 2019. Uric acid variability at midlife as an independent predictor of coronary heart disease and all-cause mortality. *PLoS One,* 14(8), p.e0220532.

Hsieh, Y.P., Chang, C.C., Yang, Y., Wen, Y.K., Chiu, P.F., and Lin, C.C., 2017. The role of uric acid in chronic kidney disease patients. *Nephrology*, 22(6), pp.441-448.

Jones, N.R., McCormack, T., Constanti, M., and McManus, R.J., 2020. Diagnosis and management of hypertension in adults: NICE guideline update 2019. *The British Journal of General Practice*, 70(691), p.90.

Jung, J.H., Song, G.G., Lee, Y.H., Kim, J.H., Hyun, M.H., and Choi, S.J., 2018. Serum uric acid levels and hormone therapy type: A retrospective cohort study of postmenopausal women. *Menopause*, 25(1), pp.77-81.

Khan, A.D.Y., and Pujari, A.D., 2018. A comparative study of the variation in coagulation profile between different blood groups in ischemic heart disease patients and normal subjects. *National Journal of Physiology, Pharmacy and Pharmacology*, 8(11), pp.1496–1496.

Konta, T., Ichikawa, K., Kawasaki, R., Fujimoto, S., Iseki, K., Moriyama, T., Yamagata, K., Tsuruya, K., Narita, I., and Kondo, M., 2020. Association between serum uric acid levels and mortality: A nationwide community-based cohort study. *Scientific Reports*, 10(1), p.6066.

Kuwabara, M., Ae, R., Kosami, K., Kanbay, M., Andres-Hernando, A., Hisatome, I., and Lanaspa, M.A., 2024. Current updates and future perspectives in uric acid research, 2024. *Hypertension Research*, 48, pp.867-873.

Lehner, K., Santarelli, F., Penning, R., Vasold, R., Engel, E., Maisch, T., Gastl, K., König, B., Landthaler, M., and Bäumler, W., 2011. The decrease of pigment concentration in red tattooed skin years after tattooing. *Journal of the European Academy of Dermatology and Venereology,* 25(11), pp.1340-1345.

Liu, Q., Peng, M., Yang, T., and Si, G., 2023. Uric acid levels and risk of cognitive impairment: Dose-response meta-analysis of prospective cohort studies. *PLoS One*, 18(11), p.e0293832.

Mei, Y., Dong, B., Geng, Z., and Xu, L., 2022. Excess uric acid induces gouty nephropathy through crystal formation: A review of recent insights. *Frontiers in Endocrinology*, 13, p.911968.

Molla, M.D., Bekele, A., Melka, D.S., Teklemariam, M.D., Challa, F.,

Ayelign, B., Shibabaw, T., Akalu, Y., and Geto, Z., 2021. Hyperuricemia and its associated factors among adult staff members of the Ethiopian public health institute, Ethiopia. *International Journal of General Medicine*, 14, p.1437-1447.

Okoth, K., Chandan, J.S., Marshall, T., Thangaratinam, S., Thomas, G.N., Nirantharakumar, K., and Adderley, N.J., 2020. Association between the reproductive health of young women and cardiovascular disease in later life: Umbrella review. *BMJ*, 371, p.m3502.

Sah, O.S.P., and Qing, Y.X., 2015. Associations between hyperuricemia and chronic kidney disease: A review. Nephrourology Monthly, 7(3), p.e27233.

Song, Y., Tang, L., Han, J., Gao, Y., Tang, B., Shao, M., Yuan, W., Ge, W., Huang, X., and Yao, T., 2019. Uric acid provides protective role in red blood cells by antioxidant defense: A hypothetical analysis. *Oxidative Medicine and Cellular Longevity*, 2019(1), p.3435174.

Tsur, A.M., Akavian, I., Landau, R., Derazne, E., Tzur, D., Vivante, A., Grossman, E., Rotem, RS., Fishman, B., and Pinhas-Hamiel, O., 2024. Adolescent body mass index and early chronic kidney disease in young adulthood. *JAMA Pediatrics*, 178(2), pp.142-150.

Verma, S., Ji, Q., Bhatt, D.L., Mazer, C.D., Al-Omran, M., Inzucchi, S.E., Wanner, C., Ofstad, A.P., Zwiener, I., George, J.T., Zinman, B., and Fitchett, D., 2020. Association between uric acid levels and cardio-renal outcomes and death in patients with type 2 diabetes: A subanalysis of EMPA-REG outcome. *Diabetes, Obesity and Metabolism,* 22(7), pp.1207-1214.

Wang, Y., Yang, Z., Wu, J., Xie, D., Yang, T., Li, H., and Xiong, Y., 2020. Associations of serum iron and ferritin with hyperuricemia and serum uric acid. *Clinical Rheumatology*, 39, pp.3777-3785.

Wang, Z., Lv, M.Y., and Huang, Y.X., 2020. Effects of low-dose X-ray on cell growth, membrane permeability, DNA damage and gene transfer efficiency. *Dose-Response*, 18(4), p.1-9.

Winder, M., Owczarek, A.J., Mossakowska, M., Broczek, K., Grodzicki, T., Wierucki, Ł., and Chudek, J., 2021. Prevalence of hyperuricemia and the use of allopurinol in older poles-results from a population-based PolSenior study. *International Journal of Environmental Research and Public Health*, 18(2), p.387.

Yang, Y., Zhou, W., Wang, Y., and Zhou, R., 2019. Gender-specific association between uric acid level and chronic kidney disease in the elderly health checkup population in China. *Renal Failure*, 41(1), pp.197-203.

Zhang, J., Sun, N., Zhang, W., Yue, W., Qu, X., Li, Z., and Xu, G., 2025. The impact of uric acid on musculoskeletal diseases: Clinical associations and underlying mechanisms. *Frontiers in Endocrinology*, 16, p.1515176.

Zhang, M., Zhu, X., Wu, J., Huang, Z., Zhao, Z., Zhang, X., Xue, Y., Wan, W., Li, C., and Zhang, W., 2022. Prevalence of hyperuricemia among Chinese adults: Findings from two nationally representative cross-sectional surveys in 2015-16 and 2018-19. *Frontiers in Immunology*, 12, p.791983.

Zheng, Y., Ou, J., Huang, D., Zhou, Z., Dong, X., Chen, J., Liang, D., Liu, J., Liu, Y., and Chen, J., 2022. The U-shaped relationship between serum uric acid and long-term all-cause mortality in coronary artery disease patients: A cohort study of 33,034 patients. *Frontiers in Cardiovascular Medicine*, 9, p.858889.