

Short Communications

Prevalence and Associated Risk Factors of Gout Among Patients at Khyber Teaching Hospital Peshawar: A Cross-sectional study

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ABSTRACT

Background: Hyperuricemia and gout represent significant global public health challenges with varying prevalence rates across populations. **Objective:** This study aimed to investigate the prevalence and associated risk factors for gout among patients at the Khyber Teaching Hospital, Peshawar, Pakistan. **Methods:** This cross-sectional analytical study was conducted from January to March 2024 and involved 100 patients (57% female, 43% male) aged 18–65 years. Participants were recruited via systematic random sampling from the orthopedic department. Data collection included demographic information, anthropometric measurements, medical history, and serum uric acid levels, which were analyzed via the uricase enzymatic colorimetric method. Qualitative descriptive analysis to identify associated risk factors was used in this study. **Results:** 93% of the patients were between 21 and 60 years old, with 54% reporting a family history of gout. Notably, 95% of the participants presented elevated uric acid levels (>6.8 mg/dL in men, >6.0 mg/dL in women), with 40% falling within the 7.1–8.0 mg/dL range. The major comorbidities included hypertension (72%), thyroid problems (45%), and kidney disease (34%). Protein-rich diet consumption was reported by 84% of the participants, whereas alcohol consumption was reported by 17%. The general health assessment classified 65% of the participants as unhealthy. **Conclusion:** The findings indicate a greater prevalence of gout among females in this population, contradicting traditional patterns, along with significant associations with comorbidities and dietary factors. This study highlights the need for sex-specific screening protocols and comprehensive management approaches that address both primary gout symptoms and associated conditions. These results emphasize the importance of early intervention and lifestyle modification strategies in gout management within the South Asian.

KEYWORDS

Gout, hyperuricemia, uric acid, metabolic disease, comorbidity, noncommunicable diseases

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INTRODUCTION

Uric acid (UA), the final metabolic product of purines in humans, has emerged as a critical biomarker for various metabolic disorders. While its primary role in gout has been well established, recent epidemiological evidence suggests broader implications for public health [1–3]. Strongly conducted epidemiologic research has revealed that an increase in uric acid levels is independently related to gout as well as high risks of obesity, diabetes, and premature death [4–8]. Of particular concern is the alarming trend in the past few decades, where the prevalence of hyperuricemia has rapidly increased globally and its treatment costs have increased [2,9–11].

The growing recognition of hyperuricemia as a significant public health challenge is evidenced by its varying prevalence across populations [12–14]. With recorded rates of 35.1% (men) and 8.7% (women) in Seychelles, 10.6% in Thailand, 7.2% (men) and 0.04% (women) in Scotland and England, 11.2% in the United States of America (USA), and 8.4% in Saudi Arabia, underscores the global nature of this metabolic disorder [2,8,11,15,16]. Age, sex, alcohol use, smoking, and lifestyle were thought to be associated with hyperuricemia in these groups; these characteristics were also associated with risks for gout, CAD, and stroke. Furthermore, anthropometric measurements (weight, height, waist circumference, and hip circumference) and biochemical parameters are significantly correlated with elevated serum uric acid levels, suggesting a complex interplay between multiple factors [17–20].

Recent comprehensive epidemiological investigations have revealed that elevated uric acid levels not only serve as an independent risk factor for gout but are also significantly associated with stroke, diabetes, obesity, hypertension, and premature death. Of particular significance is the emerging evidence linking hyperuricemia to prehypertension, which suggests its potential role in the early pathophysiology of cardiovascular disorders [5,21–23]. Although the exact mechanisms underlying hyperuricemia-induced hypertension remain unknown, current research points to several potential pathways, including endothelial damage, renin-angiotensin system stimulation, and proinflammatory indicators [24].

Understanding the biochemical nature of uric acid is crucial for understanding its pathophysiological effects. Uric acid ($pK_a=5.4$) is present primarily as urate in neutral or pH-based solutions owing to the expulsion of nitrogen at location 3. This chemical property significantly influences its solubility and potential for crystal formation under physiological conditions, leading to its accumulation in soft tissues [3,25,26]. The complexity of uric acid homeostasis is reflected in its multiple determinants, including blood pressure, kidney function, height, body weight, and alcohol consumption. Adults typically have blood uric acid concentrations between 3 and 7 mg/dL, with sex-specific variations, as evidenced by the everyday elimination of uric acid in women being approximately 500–700 mg. The pathological state of hyperuricemia can manifest in various forms, notably through the accumulation of sodium urate crystals in soft tissues, particularly in joints, resulting in gouty arthritis, which excruciates and causes inflammation in the cartilage of joints [27].

Given the increasing global prevalence of hyperuricemia and its significant implications for public health, there is a crucial need to understand its distribution and associated risk factors in different populations. Therefore, this study aimed to investigate the prevalence of gout and hyperuricemia among patients at the Khyber Teaching Hospital, Peshawar, and to identify the key risk factors associated with elevated uric acid levels. By examining various parameters, including demographic characteristics, lifestyle factors, comorbidities, and family history, this study seeks to provide valuable insights for better prevention strategies and management approaches in clinical settings.

MATERIALS AND METHODS

Study design and setting

This cross-sectional analytical study was conducted at the Khyber Teaching Hospital (KTH), Peshawar, from January to March 2024 [28,29]. The hospital serves as a major tertiary care center in the region, providing care to diverse populations from both urban and rural areas. A cross-sectional design was chosen to assess the prevalence of gout and its associated risk factors while

enabling the simultaneous evaluation of multiple variables [30]. The study protocol was approved by the Institutional Review Board of KTH and was conducted in accordance with the Declaration of Helsinki.

Participants and sampling

Using a systematic random sampling technique [29], 100 patients were recruited from the orthopedic department. The sample size was calculated via G'Power 3.1 software, with an effect size of 0.3, an α error probability of 0.05, and a power ($1-\beta$) of 0.80, accounting for a 10% dropout rate. Patients aged 18–65 years with clinically diagnosed gout according to the American College of Rheumatology/European League Against Rheumatism (ACR/EULAR) 2015 classification criteria and serum uric acid levels > 6.8 mg/dL in men and > 6.0 mg/dL in women were included. The exclusion criteria included pregnancy, malignancy, active infection, and the use of uric acid-lowering therapy within the past month.

Data collection procedures

Following written informed consent, blood samples (3 mL) were collected via venipuncture into lithium heparin tubes after an overnight fast (12–14 hours). Samples were collected between 8:00 and 10:00 AM to minimize diurnal variations. The samples were processed within 2 h of collection at the SIAHS Clinical Laboratory, which maintains ISO 15189 accreditation. Centrifugation was performed at 2500 RPM for 10 min at 4°C using a calibrated Beckman Coulter centrifuge (Allegra X-15R). Serum uric acid analysis was performed via the uricase enzymatic colorimetric method with a Roche Cobas c501 analyzer, with regular calibration and quality control measures. The analytical procedure involved mixing 1 mL of uric acid reagent (Roche Diagnostics, Cat. No. 11875426216) with 20 μ L of serum, followed by a 10-minute incubation at 37°C in a temperature-controlled water bath (Memmert WNB14).

Parameters, data collection and data analysis

A standardized case report form was used to collect demographic and clinical data through face-to-face interviews conducted by trained research assistants. The form captured (1) demographic information (age, sex, and socioeconomic status); (2) anthropometric measurements (height, weight, and BMI) via calibrated instruments; (3) medical history, including family history of gout and kidney disease, verified through medical records where available; (4) lifestyle factors assessed via validated questionnaires—dietary patterns through a semiquantitative food frequency questionnaire (FFQ) and alcohol consumption via the AUDIT-C tool; and (5) comorbidities (hypertension, thyroid dysfunction, and kidney disease) confirmed through medical records and current medication review. Statistical analysis was performed via SPSS version 21.5 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies and percentages.

Ethical considerations and data management

The study adhered to the GCP guidelines, with documented informed consent obtained in the participants' preferred language. Patient confidentiality was maintained through coded identifiers, with data stored in password-protected databases accessible only to authorized personnel. Biological samples were handled according to institutional biosafety guidelines and disposed of according to standard protocols for biological waste management.

RESULTS

A cross-sectional study was conducted at the Khyber Teaching Hospital Peshawar to investigate the prevalence and associated risk factors for gout among patients (Table 1). The study revealed significant demographic and health-related patterns among participants ($N=100$). In terms of sex distribution, females constituted a slight majority at 57% ($n=57$) compared with males at 43% ($n=43$). The age distribution revealed that the majority of patients were concentrated in two primary age groups: 21–40 years (46%) and 41–60 years (47%), whereas only a small proportion (7%) were between 10–20 years old. The assessment of general health

conditions yielded concerning results, with 65% of participants classified as unhealthy, 28% maintaining an average health status, and only 7% being categorized as healthy. Notably, more than half of the participants (54%) reported a family history of gout, suggesting a strong genetic component in the prevalence of the disease. An overwhelming majority (84%) of patients regularly consumed protein-rich diets, which emerged as a significant dietary factor.

This study identified several comorbidities and risk factors among the participants. High blood pressure is the most prevalent comorbidity, affecting 72% of patients. Thyroid problems were present in 45% of the patients, whereas 34% reported concurrent kidney disease. A family history of kidney disease was noted in 41% of the participants. Alcohol consumption was reported by 17% of the participants, although it was less prevalent in the study population. The analysis of uric acid levels revealed a distribution pattern. The majority of patients (40%) had uric acid levels between 7.1–8.0 mg/dl, whereas 46% of patients had uric acid levels between 8.1–10.0 mg/dl, which were equally distributed, with 23% in each of the 8.1–9.0 and 9.1–10.0 mg/dl ranges. Only 5% of patients had relatively lower levels (6.1–7.0 mg/dl), whereas 9% exhibited significantly high levels between 10.1–11.0 mg/dl. These findings indicate that most patients presented with moderate to severely elevated uric acid levels, suggesting active gout disease states.

Table 1. Demographic and clinical characteristics of gout patients

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	43	43
Female	57	57
Age (Years old)		
10-20 years old	7	7
21-40 years old	46	46
41-60 years old	47	47
General Health Condition		
Unhealthy	65	65
Average	28	28
Healthy	7	7
Family History of Gout		
Yes	54	54
No	46	46
Taking Protein Rich Diet Usually		
Yes	84	84
No	16	16
Family History of Kidney Disease		
Yes	41	41
No	59	59
Consumption of alcohol		
Yes	17	17
No	83	83
Any Kidney Disease		
Yes	34	34
No	66	66
Problem of High Blood Pressure		
Yes	72	72
No	28	28
Thyroid problems		
Yes	45	45
No	55	55
Uric Acid Level		
6.1-7.0 mg/dl	5	5
7.1-8.0 mg/dl	40	40
8.1-9.0 mg/dl	23	23
9.1-10.0 mg/dl	23	23
10.1-11.0 mg/dl	9	9

DISCUSSIONS

The findings of this cross-sectional study revealed several significant patterns regarding the prevalence and risk factors for gout among patients at the Khyber Teaching Hospital Peshawar. One of the most striking findings is the sex distribution, where females (57%) had a higher prevalence than males did (43%), which contradicts previous studies suggesting male predominance in gout cases [31,32]. This unexpected finding warrants further investigation into the potential regional or demographic factors that might influence sex-specific gout presentation in this population.

The age distribution analysis revealed a trend, with 93% of the cases concentrated in productive age groups (21-60 years), suggesting significant socioeconomic implications. This finding aligns with the research by Dehlin et al. [2] but indicates a potentially earlier onset in this population than global trends. The study also revealed a strong genetic component, with 54% of the participants reporting a family history of gout, supporting the hereditary nature of the condition [25,27]. A particularly alarming finding is the high prevalence of comorbidities, with 72% of the patient experiencing hypertension, 45% having thyroid problems, and 34% presenting with kidney disease. This multimorbidity pattern suggests a complex interplay of metabolic disorders that may need to be addressed comprehensively in treatment approaches [13,33–36]. The study also highlighted the significant role of dietary factors, with 84% of patients regularly consuming protein-rich diets, indicating a potential area for intervention through dietary modification [36].

The analysis of uric acid levels revealed a concerning distribution, with 95% of patients showing levels above the normal range. The concentration of cases (40%) in the 7.1–8.0 mg/dl range, followed by equal distributions (23% each) in the 8.1–9.0 and 9.1–10.0 mg/dl ranges, suggests a need for more aggressive uric acid management strategies. These findings align with those of Song et al. [37], who emphasized the importance of maintaining lower uric acid targets for better clinical outcomes. The study's findings regarding general health conditions are particularly concerning, with 65% of the participants classified as unhealthy. This high percentage, combined with the prevalence of multiple risk factors, indicates the need for a more holistic approach to gout management that addresses both the primary condition and the associated health factors [38–41]. The presence of alcohol consumption in 17% of cases, but lower than that reported in some global studies, still represents a modifiable risk factor that should be addressed in prevention strategies [42–46].

This research suggests several areas for improvement in current clinical practice. First, there is a need for earlier screening and intervention, particularly given the high prevalence in productive age groups. Second, the management of comorbidities should be integrated into gout treatment protocols [47–51]. Third, patient education regarding dietary modifications and lifestyle changes should be emphasized, especially considering the high percentage of patients who consume protein-rich diets. These findings contribute to the growing body of evidence regarding the prevalence of gout and its risk factors, particularly in the South Asian. However, future research should focus on longitudinal studies to better understand disease progression and treatment outcomes in this population. Additionally, investigations of sex-specific risk factors and treatment responses could help explain the unusual sex distributions observed in this study.

Clinical implications

The findings of this study have several significant clinical implications for health care practitioners and policymakers. First, the high prevalence of gout among females (57%) challenges traditional clinical assumptions and suggests the need for sex-specific screening protocols in this population. Healthcare providers should consider implementing routine uric acid screening for both male and female patients, particularly those presenting with the risk factors identified in this study. The strong associations between gout and comorbidities (72% hypertension, 45% thyroid problems, and 34% kidney disease) emphasize the need for an integrated approach to patient care. Clinicians should develop comprehensive management plans that address not only gout symptoms but also associated conditions. This may include coordinated care among rheumatologists, endocrinologists, and nephrologists to optimize patient

outcomes. The significant proportion of patients (84%) consuming protein-rich diets highlights the crucial role of dietary interventions in gout management. Healthcare facilities should consider implementing structured dietary counseling programs and developing culturally appropriate dietary guidelines that account for local food practices and preferences. The development of patient education materials focused on modifiable risk factors, including diet and alcohol consumption, could enhance treatment adherence and outcomes.

Limitations

This study has several limitations that should be considered when interpreting the results. First, the cross-sectional design prevents the establishment of causal relationships between the identified risk factors and gout development. Longitudinal studies are necessary to better understand the temporal sequence of disease progression and the influence of risk factors. Second, the sample size (n=100) and single-center nature of the study may limit the generalizability of the findings to a broader population. The focus of this study on patients at Khyber Teaching Hospital might not fully represent the diversity of gout presentations and risk factors in other geographic or demographic contexts. Third, the reliance on self-reported data for some variables, particularly dietary habits and family history, may have introduced recall bias. Additionally, the timeframe of the study (January to March 2024) may not account for seasonal variations in gout presentations or risk factor exposure. Fourth, the study did not assess certain potentially relevant variables, such as medication history, socioeconomic status, or detailed dietary patterns, which could provide additional insights into gout risk factors and management strategies. The absence of a control group also limited the ability to establish relative risks for the identified factors.

CONCLUSIONS

The findings revealed a pattern of elevated uric acid levels across the study population, with 95% of the patient showing levels above the normal range. The unexpected sex distribution and high prevalence of comorbidities suggest the need for revised clinical approaches to gout screening and management in this population. This study highlights the complex interplay between genetic predispositions (54% family history), dietary habits (84% protein-rich diet consumption), and comorbid conditions in gout development. These findings emphasize the importance of a multifaceted approach to gout management that addresses both direct and indirect risk factors. The results of this study contribute to the growing body of evidence regarding gout epidemiology in South Asia and provide a foundation for improving clinical practice guidelines. Healthcare providers and policymakers can use these findings to develop more effective population-specific approaches for gout prevention and management, ultimately leading to better patient outcomes in this region. Future research should include longitudinal studies to establish causal relationships, investigate sex-specific risk factors, and evaluate targeted intervention strategies. Additionally, larger multicenter studies incorporating more diverse populations would increase the generalizability of the findings and contribute to more effective gout prevention and management strategies.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: IUK, MUK, SK; Methodology: MUK, SK; Software: IUK; Validation: IUK, MUK, SK; Formal analysis: AU, MWK; Investigation: AU, MWK; Resources: IUK, MWK; Data Curation: IUK, AU, MWK; Writing - Original Draft: IUK, WU, MWK; Writing - Review & Editing: IUK, MWK, AU, SK; Visualization: SK, AU; Supervision: WU.

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REFERENCES

- [1] Ahn JK. Epidemiology and treatment-related concerns of gout and hyperuricemia in Korean. *Journal of Rheumatic Diseases* 2023;30:88–98. <https://doi.org/10.4078/jrd.2022.0001>.
- [2] Dehlin M, Jacobsson L, Roddy E. Global epidemiology of gout: prevalence, incidence, treatment patterns and risk factors. *Nat Rev Rheumatol* 2020;16:380–90. <https://doi.org/10.1038/s41584-020-0441-1>.
- [3] Bardin T, Magnat E, Clerson P, Richette P, Rouchon B. Epidemiology of gout and hyperuricemia in New Caledonia. *Joint Bone Spine* 2022;89:105286. <https://doi.org/10.1016/j.jbspin.2021.105286>.
- [4] McCormick N, Rai SK, Lu N, Yokose C, Curhan GC, Choi HK. Estimation of primary prevention of gout in men through modification of obesity and other key lifestyle factors. *JAMA Netw Open* 2020;3:e2027421. <https://doi.org/10.1001/jamanetworkopen.2020.27421>.
- [5] Litwin M, Michałkiewicz J, Niemirska A, Gockowska L, Kubiszewska I, Wierzbicka A, et al. Inflammatory activation in children with primary hypertension. *Pediatr Nephrol* 2010;25:1711–8. <https://doi.org/10.1007/s00467-010-1548-4>.
- [6] Kim JH, Lim JS. The association between C-reactive protein, metabolic syndrome, and prediabetes in Korean children and adolescents. *Ann Pediatr Endocrinol Metab* 2022;27:273–80. <https://doi.org/10.6065/apem.2142226.113>.
- [7] Pan J, Cai X, Chen J, Xu M, Hu J, Mao Y, et al. Association Between high-sensitivity C-reactive protein trajectories and the incidence of metabolic syndrome: A retrospective cohort study. *J Inflamm Res* 2024;17:8501–11. <https://doi.org/10.2147/JIR.S493111>.
- [8] Han T, Chen W, Qiu X, Wang W. Epidemiology of gout – Global burden of disease research from 1990 to 2019 and future trend predictions. *Ther Adv Endocrinol Metab* 2024;15:27295. <https://doi.org/10.1177/20420188241227295>.
- [9] Han Q-X, Zhang D, Zhao Y-L, Liu L, Li J, Zhang F, et al. Risk factors for hyperuricemia in chinese centenarians and near-centenarians. *Clin Interv Aging* 2019;14:2239–47. <https://doi.org/10.2147/CIA.S223048>.
- [10] Guan S, Tang Z, Fang X, Wu X, Liu H, Wang C, et al. Prevalence of hyperuricemia among Beijing post-menopausal women in 10 years. *Arch Gerontol Geriatr* 2016;64:162–6. <https://doi.org/10.1016/j.archger.2016.02.002>.
- [11] Huang J, Ma ZF, Zhang Y, Wan Z, Li Y, Zhou H, et al. Geographical distribution of hyperuricemia in mainland China: a comprehensive systematic review and meta-analysis. *Glob Health Res Policy* 2020;5:52. <https://doi.org/10.1186/s41256-020-00178-9>.
- [12] Latourte A, Dumurgier J, Paquet C, Richette P. Hyperuricemia, Gout, and the Brain—an Update. *Curr Rheumatol Rep* 2021;23:82. <https://doi.org/10.1007/s11926-021-01050-6>.
- [13] Sumpter NA, Saag KG, Reynolds RJ, Merriman TR. Comorbidities in gout and hyperuricemia: causality or epiphenomena? *Curr Opin Rheumatol* 2020;32:126–33. <https://doi.org/10.1097/BOR.0000000000000691>.
- [14] Zhong L, Liu S, Qiu X, Zeng X, Su L, Huang D, et al. High Prevalence of Hyperuricemia and Associated Factors among Zhuang Adults: A Cross-Sectional Study Based on the Ethnic Minority Population Cohort in the Southwestern China. *Int J Environ Res Public Health* 2022;19:16040. <https://doi.org/10.3390/ijerph192316040>.
- [15] Zhang M, Zhu X, Wu J, Huang Z, Zhao Z, Zhang X, et al. Prevalence of Hyperuricemia Among Chinese Adults: Findings From Two Nationally Representative Cross-Sectional Surveys in 2015–16 and 2018–19. *Front Immunol* 2022;12:791983. <https://doi.org/10.3389/fimmu.2021.791983>.
- [16] Song J, Jin C, Shan Z, Teng W, Li J. Prevalence and risk factors of hyperuricemia and gout: a cross-sectional survey from 31 provinces in mainland China. *J Transl Int Med* 2022;10:134–45. <https://doi.org/10.2478/jtim-2022-0031>.

- [17] Zhu Y, Pandya BJ, Choi HK. Comorbidities of Gout and Hyperuricemia in the US General Population: NHANES 2007–2008. *Am J Med* 2012;125:679–87. <https://doi.org/10.1016/j.amjmed.2011.09.033>.
- [18] Zitt E, Fischer A, Lhotta K, Concin H, Nagel G. Sex and age-specific variations, temporal trends and metabolic determinants of serum uric acid concentrations in a large population-based Austrian cohort. *Sci Rep* 2020;10:7578. <https://doi.org/10.1038/s41598-020-64587-z>.
- [19] Tao M, Ma X, Pi X, Shi Y, Tang L, Hu Y, et al. Prevalence and related factors of hyperuricaemia in Shanghai adult women of different ages: a multicentre and cross-sectional study. *BMJ Open* 2021;11:e048405. <https://doi.org/10.1136/bmjopen-2020-048405>.
- [20] Shih Y-L, Lin Y, Chen J-Y. The Association between High-Sensitivity C-Reactive Protein and Metabolic Syndrome in an Elderly Population Aged 50 and Older in a Community Receiving Primary Health Care in Taiwan. *Int J Environ Res Public Health* 2022;19:13111. <https://doi.org/10.3390/ijerph192013111>.
- [21] Bardin T, Richette P. Impact of comorbidities on gout and hyperuricaemia: an update on prevalence and treatment options. *BMC Med* 2017;15:123. <https://doi.org/10.1186/s12916-017-0890-9>.
- [22] Cicero AFG, Fogacci F, Kuwabara M, Borghi C. Therapeutic Strategies for the Treatment of Chronic Hyperuricemia: An Evidence-Based Update. *Medicina (B Aires)* 2021;57:58. <https://doi.org/10.3390/medicina57010058>.
- [23] Pathmanathan K, Robinson PC, Hill CL, Keen HI. The prevalence of gout and hyperuricaemia in Australia: An updated systematic review. *Semin Arthritis Rheum* 2021;51:121–8. <https://doi.org/10.1016/j.semarthrit.2020.12.001>.
- [24] Du L, Zong Y, Li H, Wang Q, Xie L, Yang B, et al. Hyperuricemia and its related diseases: mechanisms and advances in therapy. *Signal Transduct Target Ther* 2024;9:212. <https://doi.org/10.1038/s41392-024-01916-y>.
- [25] Reynolds RJ, Irvin MR, Bridges SL, Kim H, Merriman TR, Arnett DK, et al. Genetic correlations between traits associated with hyperuricemia, gout, and comorbidities. *European Journal of Human Genetics* 2021;29:1438–45. <https://doi.org/10.1038/s41431-021-00830-z>.
- [26] Benn CL, Dua P, Gurrell R, Loudon P, Pike A, Storer RI, et al. Physiology of Hyperuricemia and Urate-Lowering Treatments. *Front Med (Lausanne)* 2018;5:160. <https://doi.org/10.3389/fmed.2018.00160>.
- [27] Butler F, Alghubayshi A, Roman Y. The Epidemiology and Genetics of Hyperuricemia and Gout across Major Racial Groups: A Literature Review and Population Genetics Secondary Database Analysis. *J Pers Med* 2021;11:231. <https://doi.org/10.3390/jpm11030231>.
- [28] Alwi J, Sari MP, Adnyana IMDM, Rustam MuhZA, Rahayu D, Irma, et al. Metode Penelitian Epidemiologi. 1st ed. Bandung: CV Media Sains Indonesia; 2023.
- [29] Adnyana IMDM. Populasi dan Sampel. In: Darwin M, editor. Metode Penelitian Pendekatan Kuantitatif. 1st ed., Bandung: CV. Media Sains Indonesia; 2021, p. 103–16.
- [30] Paulus AY, Sulaeman, Mayasari AC, Ayu JD, Musniati N, Sari MP, et al. Biostatistika Epidemiologi. 1st ed. Bandung: CV. Media Sains Indonesia; 2023.
- [31] Dalbeth N, Gosling AL, Gaffo A, Abhishek A. Gout. *The Lancet* 2021;397:1843–55. [https://doi.org/10.1016/S0140-6736\(21\)00569-9](https://doi.org/10.1016/S0140-6736(21)00569-9).
- [32] Madyaningrum E, Kusumaningrum FM, Wardani RK, Susilaningrum AR, Ramadhani A. Community gout management program needed for adult people in the rural area. *Journal of Community Empowerment for Health* 2021;4:125. <https://doi.org/10.22146/jcoemph.61591>.
- [33] Singh JA, Gaffo A. Gout epidemiology and comorbidities. *Semin Arthritis Rheum* 2020;50:S11–6. <https://doi.org/10.1016/j.semarthrit.2020.04.008>.
- [34] Pathmanathan K, Robinson PC, Hill CL, Keen HI. The prevalence of gout and hyperuricaemia in Australia: An updated systematic review. *Semin Arthritis Rheum* 2021;51:121–8. <https://doi.org/10.1016/j.semarthrit.2020.12.001>.

- [35] Li Q, Li X, Wang J, Liu H, Kwong JS-W, Chen H, et al. Diagnosis and treatment for hyperuricemia and gout: a systematic review of clinical practice guidelines and consensus statements. *BMJ Open* 2019;9:e026677. <https://doi.org/10.1136/bmjopen-2018-026677>.
- [36] Kim KY, Ralph Schumacher H, Hunsche E, Wertheimer AI, Kong SX. A literature review of the epidemiology and treatment of acute gout. *Clin Ther* 2003;25:1593–617. [https://doi.org/10.1016/S0149-2918\(03\)80158-3](https://doi.org/10.1016/S0149-2918(03)80158-3).
- [37] Song P, Wang H, Xia W, Chang X, Wang M, An L. Prevalence and correlates of hyperuricemia in the middle-aged and older adults in China. *Sci Rep* 2018;8:4314. <https://doi.org/10.1038/s41598-018-22570-9>.
- [38] Zhang Q, Gong H, Lin C, Liu Q, Baima Y, Wang Y, et al. The prevalence of gout and hyperuricemia in middle-aged and elderly people in Tibet Autonomous Region, China. *Medicine* 2020;99:e18542. <https://doi.org/10.1097/MD.00000000000018542>.
- [39] Krishnan E, Sokolove J. Uric acid in heart disease: a new C-reactive protein? *Curr Opin Rheumatol* 2011;23:174–7. <https://doi.org/10.1097/BOR.ob013e3283432dd3>.
- [40] Afinogenova Y, Danve A, Neogi T. Update on gout management: what is old and what is new. *Curr Opin Rheumatol* 2022;34:118–24. <https://doi.org/10.1097/BOR.0000000000000861>.
- [41] Al-Meshaweh AF, Jafar Y, Asem M, Akanji AO. Determinants of Blood Uric Acid Levels in a Dyslipidemic Arab Population. *Med Princ Pract* 2012;21:209–16. <https://doi.org/10.1159/000333483>.
- [42] Pathmanathan K, Robinson PC, Hill CL, Keen HI. The prevalence of gout and hyperuricaemia in Australia: An updated systematic review. *Semin Arthritis Rheum* 2021;51:121–8. <https://doi.org/10.1016/j.semarthrit.2020.12.001>.
- [43] Waksman R, Merdler I, Case BC, Waksman O, Porto I. Targeting inflammation in atherosclerosis: overview, strategy and directions. *EuroIntervention* 2024;20:32–44. <https://doi.org/10.4244/EIJ-D-23-00606>.
- [44] Wei T, Liu J, Zhang D, Wang X, Li G, Ma R, et al. The Relationship Between Nutrition and Atherosclerosis. *Front Bioeng Biotechnol* 2021;9:635504. <https://doi.org/10.3389/fbioe.2021.635504>.
- [45] Quilis N, Sivera F, Seoane-Mato D, Pérez-Ruiz F, Sánchez-Piedra C, Díaz-González F, et al. Prevalence of gout in the adult general population in Spain: Estimating the proportion of undiagnosed cases. *Joint Bone Spine* 2022;89:105257. <https://doi.org/10.1016/j.jbspin.2021.105257>.
- [46] Wijnands JMA, Viechtbauer W, Thevissen K, Arts ICW, Dagnelie PC, Stehouwer CDA, et al. Determinants of the prevalence of gout in the general population: a systematic review and meta-regression. *Eur J Epidemiol* 2015;30:19–33. <https://doi.org/10.1007/s10654-014-9927-y>.
- [47] Ratkovic N, Pandrc M, Peric V, Stojanovic M, Rancic N. Relationship between plasma high-sensitivity C-reactive protein and traditional cardiovascular risk factors among active-duty military personnel in the Republic of Serbia. *Vojnosanit Pregl* 2022;79:714–23. <https://doi.org/10.2298/VSP210122030R>.
- [48] Lu X, Li X, Zhao Y, Zheng Z, Guan S, Chan P. Contemporary epidemiology of gout and hyperuricemia in community elderly in Beijing. *Int J Rheum Dis* 2014;17:400–7. <https://doi.org/10.1111/1756-185X.12156>.
- [49] Liu R, Han C, Wu D, Xia X, Gu J, Guan H, et al. Prevalence of hyperuricemia and gout in mainland china from 2000 to 2014: a systematic review and meta-analysis. *Biomed Res Int* 2015;2015:1–12. <https://doi.org/10.1155/2015/762820>.
- [50] Tsoi MF, Chung MH, Cheung BMY, Lau CS, Cheung TT. Epidemiology of gout in Hong Kong: a population-based study from 2006 to 2016. *Arthritis Res Ther* 2020;22:204. <https://doi.org/10.1186/s13075-020-02299-5>.
- [51] Yokose C, McCormick N, Lu N, Tanikella S, Lin K, Joshi AD, et al. Trends in Prevalence of Gout Among US Asian Adults, 2011-2018. *JAMA Netw Open* 2023;6:e239501. <https://doi.org/10.1001/jamanetworkopen.2023.9501>.