

Postprint of a Meta-Analysis on the Prevalence of Hyperuricemia in Chinese Children and Adolescents

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Abstract

Background Estimating the prevalence of hyperuricemia (HUA) in children and adolescents is crucial for understanding the disease burden of HUA and the rational allocation of corresponding health resources. **Objective** To systematically analyze the prevalence of HUA among children and adolescents in China. **Methods** Relevant studies on the prevalence of HUA among children and adolescents in China published from database inception to September 2024 were searched in CNKI, Wanfang Data Knowledge Service Platform, VIP, PubMed, Embase, Web of Science, and Scopus databases. Literature screening, data extraction, and quality assessment were then performed. All steps were conducted independently by two researchers, with data double-entered and cross-checked. Meta-analysis was performed using Stata 17.0 software, and subgroup analyses of HUA prevalence were conducted according to survey time, survey region, gender, age, BMI, data source, and sample size. **Results** A total of 39 articles were included, with a total sample size of 156,006 cases. The prevalence of HUA among children and adolescents in China was 20.93% (95%CI=17.77%~24.10%). Subgroup analysis results showed that the prevalence of HUA was higher ($P<0.05$) in males (prevalence =24.42%, 95%CI=19.87%~28.97%), those aged 12~19 years (prevalence =32.20%, 95%CI=22.35%~42.06%), those who were overweight / obese (prevalence =38.78%, 95%CI=27.79%~49.78%), those in southern regions (prevalence=31.59%, 95%CI=25.54%~37.64%), and those surveyed during 2017–2023 (prevalence =24.42%, 95%CI=19.87%~28.97%). Analysis results by age group and gender showed that males in the 12~19 age group (prevalence =46.79%, 95%CI=37.51%~56.07%) had a significantly higher prevalence of HUA ($P<0.05$). **Conclusion** The overall prevalence of HUA among children and adolescents in China is relatively high, with an even higher prevalence in post-pubertal males, which warrants attention.

Full Text

The Prevalence of Hyperuricemia among Children and Adolescents in China: A Meta-analysis

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Abstract

Background: Estimating the prevalence of hyperuricemia (HUA) in children and adolescents is crucial for understanding the disease burden and rationally allocating health resources. **Objective:** To systematically analyze the prevalence of HUA among Chinese children and adolescents. **Methods:** We searched CNKI, Wanfang Data, VIP, PubMed, Embase, Web of Science, and Scopus databases for studies on HUA prevalence in Chinese children and adolescents published through September 2024. Two researchers independently conducted literature screening, data extraction, and quality assessment, with dual data entry and cross-checking. Stata 17.0 software was used for meta-analysis, and subgroup analyses were performed by survey time, region, gender, age, BMI, data source, and sample size. **Results:** Thirty-nine studies with a total sample of 156,006 cases were included. The pooled prevalence of HUA in Chinese children and adolescents was 20.93% (95%CI=17.77%-24.10%). Subgroup analyses revealed higher prevalence in males (24.42%, 95%CI=19.87%-28.97%), those aged 12-19 years (32.20%, 95%CI=22.35%-42.06%), overweight/obese individuals (38.78%, 95%CI=27.79%-49.78%), southern regions (31.59%, 95%CI=25.54%-37.64%), and surveys conducted during 2017-2023 (24.42%, 95%CI=19.87%-28.97%) (P<0.05). Analysis by age and gender showed that boys aged 12-19 years had significantly higher HUA prevalence (46.79%, 95%CI=37.51%-56.07%) (P<0.05). **Conclusion:** The overall prevalence of HUA among Chinese children and adolescents is high, with post-pubertal males showing particularly elevated rates, warranting serious attention.

Key words: Hyperuricemia; Child; Adolescent; Prevalence; Meta-analysis

Hyperuricemia (HUA) is a chronic metabolic disorder characterized by abnormally elevated serum uric acid levels and is emerging as a major public health concern [1]. HUA is not only associated with gout but also closely linked to the risk and severity of cardiovascular disease, renal dysfunction, and cancer [2-4]. Historically, HUA in children and adolescents received little attention due

to the lack of typical clinical symptoms. However, recent research has increasingly demonstrated that HUA during childhood and adolescence is associated with heightened risks of cardiovascular and renal diseases in adulthood. The pathophysiological processes begin early in life, and if left uncontrolled, may cause long-term damage to multiple systems and organs [5-6]. Therefore, understanding the current status of HUA among children and adolescents is critically important.

Numerous epidemiological investigations of HUA in Chinese children and adolescents have been conducted, but cross-regional studies remain limited, with reported prevalence rates varying substantially across regions [7-10]. National-level epidemiological data for this population are lacking. Consequently, synthesizing results from multiple regional studies is essential for comprehensively assessing the disease burden of HUA in China. This meta-analysis aims to summarize the current prevalence of HUA among Chinese children and adolescents to provide a scientific basis for public health decision-making and resource allocation.

1. Materials and Methods

This study followed the PRISMA guidelines [11] and was registered with PROSPERO (CRD42024585612).

1.2 Literature Search Strategy

We employed a combination of subject headings and free-text terms to search CNKI, Wanfang Data, VIP, PubMed, Embase, Web of Science, and Scopus databases for studies on HUA prevalence in Chinese children and adolescents, with a search period from database inception to September 2024. Reference lists of relevant reviews were also manually traced. Chinese search terms included: “hyperuricemia,” “uric acid,” “children,” “adolescents,” “middle school students,” “primary school students,” “minors,” “prevalence,” “incidence,” “detection rate,” “epidemiology.” English search terms included: “hyperuricemia,” “teenager,” “teens,” “youth,” “students,” “minors,” “prevalence,” “epidemiology,” “mainland,” “China,” “Chinese.” The PubMed search strategy is detailed in Table 1 .

1.3 Literature Screening and Data Extraction

Two researchers independently screened literature and extracted data according to predefined inclusion and exclusion criteria, with disagreements resolved through consultation with a third researcher. **Inclusion criteria:** (1) Observational studies (using baseline data from longitudinal studies); (2) Study population: children and adolescents (0-19 years) in mainland China; (3) Outcome measure: HUA prevalence or raw data enabling prevalence calculation. **Exclusion criteria:** (1) Studies focused on specific disease populations (e.g.,

hypertension, diabetes); (2) Reviews, conference abstracts, or duplicate publications; (3) Unavailable full text or data; (4) Non-Chinese/English literature; (5) Low-quality studies (score ≤ 4).

A standardized Excel form was created to extract: (1) Basic information (first author, publication year, survey time/region, study design); (2) Data for HUA prevalence calculation; (3) Key information for bias risk assessment. When important data were missing, corresponding authors were contacted for additional details.

1.4 Quality Assessment

Two researchers independently assessed methodological quality using the bias risk assessment tool developed by Hoy et al. [12] for prevalence studies. This 10-item tool covers study design, sample selection, data collection, and analysis, with each item scored as “yes” (1 point) or “no” (0 point). Total scores range from 0-10, with 0-4 indicating low quality, 5-7 moderate quality, and 8-10 high quality.

1.5 Statistical Methods

Statistical analysis was performed using Stata 17.0. Heterogeneity was assessed using I^2 statistics and Q tests. Random-effects models were used for meta-analysis when $I^2 > 50\%$ and $P < 0.1$; otherwise, fixed-effects models were applied. Subgroup analyses or sensitivity analyses were conducted to identify sources of substantial heterogeneity. Publication bias was evaluated using funnel plots and Egger’s test. Statistical significance was set at $P < 0.05$.

2. Results

2.1 Literature Screening Process and Results

The initial search yielded 1,497 articles. After removing duplicates and screening titles/abstracts, 114 articles were retrieved for full-text review. Ultimately, 39 studies [7-10,13-47] were included in the meta-analysis (Figure 1 [Figure 1: see original paper]).

2.2 Characteristics and Quality of Included Studies

The 39 included studies [7-10,13-47] comprised 156,006 participants with 37,498 HUA cases. All studies scored ≥ 6 points, including 23 high-quality studies [8-9,14-16,18,20-23,26-28,30,32-33,35,38-41,43,45] and 16 moderate-quality studies [7,10,13,17,19,24-25,29,31,34,36-37,42,44,46-47]. Detailed characteristics are presented in Table 2 .

2.3 Meta-analysis Results

2.3.1 Prevalence of HUA in Chinese Children and Adolescents Thirty-nine studies [7-10,13-47] reported HUA prevalence. Significant heterogeneity was observed ($I^2=99.6\%$, $P<0.001$), warranting a random-effects model. The pooled prevalence of HUA in Chinese children and adolescents was 20.93% (95%CI=17.77%-24.10%) (Figure 2 [Figure 2: see original paper]).

2.3.2 Subgroup Analysis Subgroup analyses by gender, age, region, BMI, survey period, data source, and sample size revealed higher HUA prevalence in males, those aged 12-19 years, overweight/obese individuals, southern regions, and surveys conducted during 2017-2023 ($P<0.05$). No significant differences were found by data source or sample size ($P>0.05$) (Table 3).

Age- and gender-stratified analysis showed no significant gender difference in the 0-11 age group ($P>0.05$). However, among those aged 12-19 years, males had significantly higher prevalence than females (46.79%, 95%CI=37.51%-56.07% vs. 25.23%, 95%CI=11.89%-38.57%; $P<0.05$) (Table 4).

2.3.3 Sensitivity Analysis and Publication Bias Sensitivity analysis demonstrated robust results, with HUA prevalence ranging from 17%-25% after sequentially removing individual studies. The funnel plot showed slight asymmetry, but Egger' s test ($t=8.01$, $P=0.308$) suggested minimal publication bias (Figure 3 [Figure 3: see original paper]).

Discussion

This meta-analysis synthesized 39 cross-sectional studies from 2010-2023, revealing a pooled HUA prevalence of 20.9% among Chinese children and adolescents. While lower than the 35.4% reported in U.S. youth [48], this rate substantially exceeds those in Asian countries such as South Korea (9.4%) [49] and Japan (2.3%) [50]. These disparities may reflect inadequate healthcare investment, unhealthy dietary patterns (high-fat, high-salt), and limited health awareness in China, highlighting HUA as a prominent health issue requiring urgent attention.

Subgroup analyses demonstrated that prevalence increased with age, remaining relatively low before age 12 but rising substantially thereafter, with significant gender differences emerging post-puberty—consistent with previous findings [16-17]. Several mechanisms may explain this pattern. Puberty involves rapid musculoskeletal growth and accelerated nucleic acid metabolism, increasing purine catabolism and uric acid production [51]. Hormonal changes during adolescence also regulate uric acid metabolism; rising androgen levels suppress uric acid excretion, while estrogen' s protective effects cannot fully compensate for increased production, resulting in higher overall prevalence particularly among males [52-53]. Lifestyle changes after age 12, including reduced physical activity due to academic pressure and unhealthy dietary habits (e.g., increased consumption of sugar-sweetened beverages and high-calorie snacks), may contribute to

obesity and metabolic burden, further elevating uric acid levels [54]. Notably, higher obesity rates among males [55] likely contribute to their elevated HUA prevalence.

Our findings also showed significantly higher HUA prevalence in overweight and obese youth, aligning with domestic and international research [18,56]. Potential mechanisms include: (1) Enhanced lipogenesis and lipolysis with visceral fat accumulation increases free fatty acids and inflammatory factors, providing more substrates for uric acid synthesis [57-58]; (2) Obese children often consume excessive fructose-rich diets, exacerbating insulin resistance. Elevated insulin promotes both lipogenesis and sodium retention, impairing renal uric acid excretion [59]. HUA is a recognized metabolic disorder associated with overweight and obesity [7-8], and weight changes precede alterations in uric acid levels [56]. Given that childhood obesity rates in China reached 15.2% in boys and 7.7% in girls by 2022 [55], weight management is crucial for HUA prevention, emphasizing the need for healthy lifestyle promotion and early screening in overweight youth.

Regional analysis revealed higher HUA prevalence in southern versus northern China, consistent with findings among older adults [60]. This may reflect differences in living environment and dietary patterns. Southern diets feature more high-purine foods (seafood, red meat) and sugar-sweetened beverages, both associated with elevated uric acid [54,61]. Additionally, hot-humid climates correlate with HUA [62-63]; southern weather may cause excessive fluid loss, reducing renal uric acid excretion [2].

Temporal trends show a marked increase in HUA prevalence from 16.84% (2010-2016) to 26.73% (2017-2023), mirroring patterns in adult populations [64]. This likely stems from lifestyle changes accompanying economic growth, including increased intake of high-fat/high-sugar foods and decreased physical activity [54]. Subgroup analyses by data source and sample size showed no significant differences, possibly due to overlap between school- and hospital-based populations and inherent variability in small-sample studies.

Limitations: (1) All included studies were cross-sectional, limiting causal inference; (2) Diagnostic criteria for HUA varied across studies; (3) High heterogeneity persisted for some outcomes; (4) Some subgroups had limited studies, potentially introducing bias.

Conclusion

The prevalence of HUA among Chinese children and adolescents is high, particularly in males, overweight/obese youth, and southern regions. Boys aged ≥ 12 years warrant prioritized screening. The lack of unified diagnostic standards for pediatric HUA necessitates large-scale studies to establish normative reference values. Given the limitations in study number and quality, these findings should be interpreted cautiously and require verification through additional high-quality research.

Author Contributions: XIANG Fengling contributed to conceptualization, data collection, and manuscript drafting. XIANG Fengling and WANG Yuankun performed data extraction and cross-verification. WANG Xiaoyan and HE Shengjie edited and organized tables. GAN Jinhua supervised quality control and took overall responsibility for the manuscript.

Conflict of Interest: The authors declare no conflicts of interest.

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References

- [1] LI Y, SHEN Z Y, ZHU B W, et al. Demographic, regional and temporal trends of hyperuricemia epidemics in mainland China from 2000 to 2019: a systematic review and meta-analysis[J]. *Glob Health Action*, 2021, 14(1): 1874652. DOI:10.1080/16549716.2021.1874652.
- [2] YANAI H, ADACHI H, HAKOSHIMA M, et al. Molecular biological and clinical understanding of the pathophysiology and treatments of hyperuricemia and its association with metabolic syndrome, cardiovascular diseases and chronic kidney disease[J]. *Int J Mol Sci*, 2021, 22(17): 9221. DOI:10.3390/ijms22179221.
- [3] MALLAT S G, AL KATTAR S, TANIOS B Y, et al. Hyperuricemia, hypertension, and chronic kidney disease: an emerging association[J]. *Curr Hypertens Rep*, 2016, 18(10): 74. DOI:10.1007/s11906-016-0684-z.
- [4] XIE Y X, XU P, LIU K, et al. Hyperuricemia and gout are associated with cancer incidence and mortality: a meta-analysis based on cohort studies[J]. *J Cell Physiol*, 2019, 234(8): 14364-14376. DOI:10.1002/jcp.28138.
- [5] KUBOTA M. Hyperuricemia in children and adolescents: present knowledge and future directions[J]. *J Nutr Metab*, 2019, 2019: 3480718. DOI:10.1155/2019/3480718.
- [6] KUO K L, CHEN H M, HSIAO S H, et al. The relationship between anthropometric factors and hyperuricemia in adolescent athletes[J]. *Obes Res Clin Pract*, 2021, 15(4): 375-380. DOI:10.1016/j.orcp.2021.03.012.
- [7] ZHAO Xiaoqian, YANG Liu, ZHAO Min, et al. Association between childhood overweight/obesity, insulin resistance and hyperuricemia[J]. *Chinese Journal of Prevention and Control of Chronic Diseases*, 2023, 31(4): 269-273. DOI:10.16386/j.cjpcd.issn.1004-6194.2023.04.006.
- [8] ZHANG Shuangxia. Correlation between obesity, body fat distribution and hyperuricemia in children and adolescents in Shenzhen[D]. *Shihezi University*, 2023. DOI:10.27332/d.cnki.gshzu.2023.001130.

- [9] LI Lehui, ZHANG Xingguang, FANG Xin, et al. Correlation between serum vitamin D levels and glucose-lipid metabolism in primary and secondary school students in Inner Mongolia[J]. *Chinese Journal of School Health*, 2023, 44(12): 1858-1862. DOI:10.16835/j.cnki.1000-9817.2023.12.021.
- [10] HU Meixin, ZHANG Guowen, XU Xiu, et al. Distribution characteristics of uric acid and dietary recommendations for adolescents in Lvchun County, Honghe Prefecture, Yunnan Province[J]. *Maternal and Child Health Care of China*, 2023, 38(1): 111-114. DOI:10.19829/j.zgfybj.issn.1001-4411.2023.01.030.
- [11] PAGE M J, MCKENZIE J E, BOSSUYT P M, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews[J]. *Int J Surg*, 2021, 88: 105906. DOI:10.1016/j.ijso.2021.105906.
- [12] HOY D, BROOKS P, WOOLF A, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement[J]. *J Clin Epidemiol*, 2012, 65(9): 934-939. DOI:10.1016/j.jclinepi.2011.11.014.
- [13] WANG Lifang, NING Wu, DING Yan, et al. Correlation between blood uric acid and serum 25(OH)D3 levels in middle school students in Shijingshan District, Beijing[J]. *Chinese Journal of Clinicians (Electronic Edition)*, 2023, 17(8): 865-869.
- [14] LIU Yuru, ZHAO Xia, ZHANG Dongran, et al. Comparative analysis of nutritional status of primary and secondary school students in Fangshan District, Beijing in 2015 and 2019[J]. *Capital Journal of Public Health*, 2023, 17(1): 32-36. DOI:10.16760/j.cnki.sdggws.2023.01.010.
- [15] LI Fan, ZHANG Jun, LI Yanyan, et al. Interaction between snoring and hyperuricemia on metabolic syndrome in children and adolescents[J]. *Modern Preventive Medicine*, 2023, 50(20): 3729-3733, 3755. DOI:10.20043/j.cnki.MPM.202306067.
- [16] HU Qifa. Relationship between uric acid levels and cardiovascular disease risk factors in children and adolescents based on quantile regression[D]. *Zunyi Medical University*, 2023.
- [17] GUO Xuemei, XIAO Ningting, JING Xueming, et al. Prevalence and influencing factors of hyperuricemia in children and adolescents aged 6-17 in north-eastern Sichuan[J]. *Chinese Journal of Child Health Care*, 2023, 31(11): 1185-1190.
- [18] SUN Qing, JIANG Ying, ZHANG Yingxiu, et al. Epidemiological status of hyperuricemia in primary and secondary school students in Shandong Province[J]. *Chinese Journal of School Health*, 2022, 43(1): 129-132, 136. DOI:10.16835/j.cnki.1000-9817.2022.01.029.
- [19] LI Zilin. Association between childhood hyperuricemia and target organ damage[D]. *Shandong University*, 2022.
- [20] CHEN Jingrong, LUO Shuquan, XIONG Ying, et al. Analysis of influencing

factors of hyperuricemia in children and adolescents aged 7-17 in Chongqing based on regression and classification tree models[J]. *Journal of Food Hygiene*, 2022, 34(5): 1077-1081.

[21] CAO Ning, LI Lehui, ZHANG Nan, et al. Relationship between high triglyceride waist phenotype and hyperuricemia in children and adolescents in Inner Mongolia[J]. *Chinese Journal of School Health*, 2022, 43(7): 1093-1096. DOI:10.16835/j.cnki.1000-9817.2022.07.022.

[22] TIAN T, WANG Y Y, XIE W, et al. Multilevel analysis of the nutritional and health status among children and adolescents in Eastern China[J]. *Nutrients*, 2022, 14(4): 758. DOI:10.3390/nu14040758.

[23] SHI J, HE L, YU D M, et al. Prevalence and correlates of metabolic syndrome and its components in Chinese children and adolescents aged 7-17: the China national nutrition and health survey of children and lactating mothers from 2016-2017[J]. *Nutrients*, 2022, 14(16): 3348. DOI:10.3390/nu14163348.

[24] CAI R R, DONG Y Y, ZHOU J Y, et al. Association of serum uric acid with cardiovascular risk factors and their clustering among children and adolescents in Yinchuan City[J]. *Journal of Hygiene Research*, 2022, 51(1): 56-67. DOI:10.19813/j.cnki.weishengyanjiu.2022.01.010.

[25] ZHANG Dongmei, YU Lihua, ZHENG Sujie. Distribution characteristics of serum uric acid and its relationship with risk factors in children and adolescents in Qingdao[J]. *Chinese Journal of Social Medicine*, 2021, 38(5): 594-598.

[26] RAO Jiahuan, CHENG Hong, YAN Yinkun, et al. Correlation between visceral fat area and uric acid in school-age children[J]. *Chinese Journal of Child Health Care*, 2021, 29(12): 1276-1280. DOI:10.11852/zgetbjzz2021-1689.

[27] JIANG Nan, WANG Shuang, WU Chang. Analysis of serum uric acid levels and influencing factors in primary and secondary school students in Tongzhou District, Beijing[J]. *Chinese Journal of School Health*, 2021, 42(3): 436-439, 443. DOI:10.16835/j.cnki.1000-9817.2021.03.028.

[28] GUO Dandan, YU Yingjie, YU Xiaohui, et al. Comparative analysis of serum uric acid levels and abnormal uric acid detection rates in primary and secondary school students in Beijing in 2015 and 2019[J]. *Capital Journal of Public Health*, 2021, 15(4): 228-232.

[29] DAI Chengjun. Correlation between childhood hyperuricemia and serum trace elements, blood lipid profile[D]. *Wenzhou Medical University*, 2021.

[30] LEI Yiling, YUAN Zifei, TANG Zhaoxie, et al. Association between uric acid levels and cardiometabolic indicators in school-age children in Guangzhou[J]. *Chinese Journal of School Health*, 2020, 41(11): 1656-1659. DOI:10.16835/j.cnki.1000-9817.2020.11.014.

[31] ZHOU H, MA Z F, LU Y M, et al. Elevated serum uric acid, hyperuricaemia and dietary patterns among adolescents in mainland China[J]. *J Pediatr*

Endocrinol Metab, 2020, 33(4): 487-493. DOI:10.1515/jpem-2019-0265.

[32] LU J, SUN W Y, CUI L L, et al. A cross-sectional study on uric acid levels among Chinese adolescents[J]. *Pediatr Nephrol*, 2020, 35(3): 441-446. DOI:10.1007/s00467-019-04357-w.

[33] ZHAO Jing, XU Jia, WANG Zhi, et al. Serum uric acid levels in primary and secondary school students with different nutritional status in Chaoyang District, Beijing[J]. *Food and Nutrition in China*, 2019, 25(3): 86-89. DOI:10.3969/j.issn.1006-9577.2019.03.021.

[34] WU Qin, ZHOU Xing, ZHOU Beibei, et al. Investigation on uric acid status and related factors in adolescents in Hanjiang District, Yangzhou City, Jiangsu Province[J]. *Chinese Journal of Rheumatology*, 2019, 23(11): 753-757.

[35] LIU Yuru, ZHAO Xia, HUANG Shaoping, et al. Investigation on nutritional status of 532 primary and secondary school students in Fangshan District, Beijing[J]. *Capital Journal of Public Health*, 2019, 13(5): 259-263. DOI:10.16760/j.cnki.sdggws.2019.05.009.

[36] LI Nan, ZHANG Shuang, LENG Junhong, et al. Study on the effect of healthy lifestyle intervention on blood uric acid in preschool children[J]. *Chinese Journal of Child Health Care*, 2019, 27(7): 780-783.

[37] DENG Lu, DU Xueying. Analysis of blood uric acid levels and influencing factors in high school students in urban Guangzhou[J]. *Chinese Journal of School Health*, 2019, 40(9): 1420-1422. DOI:10.16835/j.cnki.1000-9817.2019.09.041.

[38] CHEN Xinchun, KOU Yongmei, GU Xiaona, et al. Distribution characteristics and related risk factors of blood uric acid in children and adolescents in Tangshan area[J]. *Chinese General Practice*, 2019, 22(26): 3227-3232. DOI:10.12114/j.issn.1007-9572.2019.00.082.

[39] GUO Dandan, YU Yingjie, YU Xiaohui, et al. Prevalence and related factors of hyperuricemia in 3566 primary and secondary school students in Beijing[J]. *Capital Journal of Public Health*, 2018, 12(2): 77-80. DOI:10.16760/j.cnki.sdggws.2018.02.006.

[40] CHEN Xudong, WANG Yinhui, BA Lei, et al. Analysis of blood uric acid status and related factors in 557 primary and secondary school students in Chaoyang District[J]. *Chinese Journal of School Health*, 2018, 39(12): 1869-1872.

[41] ZHAO Yinghui, ZHANG Jie. Uric acid levels and related factors in primary and secondary school students aged 6-14 in Miyun District, Beijing[J]. *Occupation and Health*, 2017, 33(22): 3130-3133.

[42] ZHANG Zhihan. Study on nutritional status and intellectual development level of school-age children in rural areas of Hebei Province[D]. *Hebei Medical University*, 2017.

- [43] LI N, ZHANG S, LI W Q, et al. Prevalence of hyperuricemia and its related risk factors among preschool children from China[J]. *Sci Rep*, 2017, 7(1): 9448. DOI:10.1038/s41598-017-09930-2.
- [44] ZHUANG Jingyu, XU Binhua, DUAN Binhong, et al. Correlation analysis between blood uric acid levels and cardiometabolic risk factors in adolescents[J]. *Chinese Journal of School Health*, 2016, 37(3): 425-427, 431. DOI:10.16835/j.cnki.1000-9817.2016.03.031.
- [45] LIU Huiting, WEN Bianzhen, ZHANG Yonghong, et al. Investigation on detection rate and related factors of hyperuricemia in 808 children aged 10-11[J]. *Chinese Journal of Health Management*, 2016, 10(6): 463-466.
- [46] YU Lihua, LIU Ying, WANG Jing. Investigation on incidence of hyperuricemia in children and adolescents aged 7-15 in Qingdao[J]. *Labeled Immunoassays and Clinical Medicine*, 2013, 20(2): 116-117. DOI:10.11748/bjmy.issn.1006-1703.2013.02.021.
- [47] BO Hui, YANG Qingyan, LIU Geli, et al. Investigation and analysis of blood uric acid levels in school-age children[J]. *Journal of Applied Clinical Pediatrics*, 2011, 26(11): 853-855.
- [48] XIE F, WU Z J, FENG J, et al. Association between systemic immune-inflammation index and serum uric acid in U.S. adolescents: a population-based study[J]. *Nutr Metab Cardiovasc Dis*, 2024, 34(1): 206-213. DOI:10.1016/j.numecd.2023.10.008.
- [49] LEE J H. Prevalence of hyperuricemia and its association with metabolic syndrome and cardiometabolic risk factors in Korean children and adolescents: analysis based on the 2016-2017 Korea National Health and Nutrition Examination Survey[J]. *Korean J Pediatr*, 2019, 62(8): 317-323. DOI:10.3345/kjp.2019.00444.
- [50] AOKI Y, SOFUE T, KAWAKAMI R, et al. Prevalence and factors related to hypouricemia and hyperuricemia in schoolchildren: results of a large-scale cross-sectional population-based study conducted in Japan[J]. *Sci Rep*, 2022, 12(1): 17848. DOI:10.1038/s41598-022-19724-1.
- [51] ALVIM R O, SIQUEIRA J H, ZANIQUELI D, et al. Influence of muscle mass on the serum uric acid levels in children and adolescents[J]. *Nutr Metab Cardiovasc Dis*, 2020, 30(2): 300-305. DOI:10.1016/j.numecd.2019.08.019.
- [52] KURAHASHI H, WATANABE M, SUGIMOTO M, et al. Testosterone replacement elevates the serum uric acid levels in patients with female to male gender identity disorder[J]. *Endocr J*, 2013, 60(12): 1321-1327. DOI:10.1507/endocrj.ej13-0203.
- [53] YAHYAOU R, ESTEVA I, HARO-MORA J J, et al. Effect of long-term administration of cross-sex hormone therapy on serum and urinary uric acid in transsexual persons[J]. *J Clin Endocrinol Metab*, 2008, 93(6): 2230-2233. DOI:10.1210/jc.2007-2727.

- [54] CHE Yingjuan, CHEN Yan, CHEN Tingting, et al. Effects of high-fat and high-fat high-fructose diets on hyperuricemia in rats[J]. *Food and Machinery*, 2024, 40(7): 126-131. DOI:10.13652/j.spjx.1003.5788.2024.80361.
- [55] RISK FACTOR COLLABORATION (NCD-RISC) N C D. Worldwide trends in underweight and obesity from 1990 to 2022: a pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults[J]. *Lancet*, 2024, 403(10431): 1027-1050. DOI:10.1016/S0140-6736(23)02750-2.
- [56] YUN M Y, ZHANG T, LI S X, et al. Temporal relationship between body mass index and uric acid and their joint impact on blood pressure in children and adults: the Bogalusa Heart Study[J]. *Int J Obes*, 2021, 45(7): 1457-1463. DOI:10.1038/s41366-021-00810-9.
- [57] TSUSHIMA Y, NISHIZAWA H, TOCHINO Y, et al. Uric acid secretion from adipose tissue and its increase in obesity[J]. *J Biol Chem*, 2013, 288(38): 27138-27149. DOI:10.1074/jbc.M113.485094.
- [58] LEYVA F, WINGROVE C S, GODSLAND I F, et al. The glycolytic pathway to coronary heart disease: a hypothesis[J]. *Metabolism*, 1998, 47(6): 657-662. DOI:10.1016/s0026-0495(98)90026-9.
- [59] WANG Shihan, YUAN Tao. Risk factors, etiology, diagnosis and treatment strategies of hyperuricemia and gout in children and adolescents[J]. *Chinese Journal of Clinical Nutrition*, 2021, 29(3): 184-189.
- [60] WANG Rong, TANG Zhe, SUN Fei, et al. Investigation on prevalence of hyperuricemia among elderly in 7 cities of China[J]. *Chinese Journal of Epidemiology*, 2018, 39(3): 286-288.
- [61] OU G S, WU J L, WANG S Q, et al. Dietary factors and risk of gout: a two-sample mendelian randomization study[J]. *Foods*, 2024, 13(8): 1269. DOI:10.3390/foods13081269.
- [62] SHAN R Q, NING Y, MA Y, et al. Incidence and risk factors of hyperuricemia among 2.5 million Chinese adults during the years of 2017-2018[J]. *Int J Environ Res Public Health*, 2021, 18(5): 2360. DOI:10.3390/ijerph18052360.
- [63] CHENG Yaxin, LI Jia, LIU Mingyu, et al. Study on the effect and mechanism of high temperature and humidity environment on blood uric acid levels in rats[J]. *Acta Laboratorium Animalis Scientia Sinica*, 2023, 31(7): 905-912.
- [64] ZHANG M, ZHU X, WU J, et al. Prevalence of hyperuricemia among Chinese adults: findings from two nationally representative cross-sectional surveys in 2015-16 and 2018-19[J]. *Front Immunol*, 2021, 12: 791983. DOI:10.3389/fimmu.2021.791983.

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