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ORIGINAL RESEARCH

# Knowledge, Attitude, and Practice Toward Hyperuricemia Among Patients Diagnosed with Hyperuricemia

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**Objective:** To investigate the knowledge, attitude, and practice (KAP) of patients diagnosed with hyperuricemia toward hyperuricemia.

**Methods:** This cross-sectional study enrolled patients with hyperuricemia who sought medical care at Taikang Xianlin Drum Tower Hospital between September 15, 2023, and January 11, 2024. A self-administered questionnaire was developed to collect participants' socio-demographic information and KAP scores regarding hyperuricemia. The threshold for sufficient knowledge, positive attitude, and proactive practice was ≥ 70.0% of the total score.

**Results:** This study included 483 non-problematic valid questionnaires, with a mean age of 41.83±14.13 years. The mean knowledge, attitude, and practice scores were 14.65±3.23 (66.59% of the possible maximum of 22), 40.89±4.32 (74.35% of the possible maximum of 55), and 25.66±4.54 (73.31% of the possible maximum of 35). A master's degree or above education (OR=2.555, 95%CU: 1.059–6.164, P=0.037), an income of 10,000–20,000 CNY (OR=2.216, 95% CI: 1.157–4.244, P=0.016), an income of >20,000 CNY (OR=2.237, 95% CI: 1.091–4.586, P=0.028), last uric acid test within the past year (OR=0.583, 95% CI: 0.341–0.997, P=0.049), and not taking uric acid-lowering medication (OR=0.326, 95% CI: 0.204–0.520, P<0.001) were independently associated with knowledge. The knowledge scores (OR=1.181, 95% CI: 1.100–1.269, P<0.001), attitude scores (OR=1.122, 95% CI: 1.063–1.184, P<0.001), age (OR=1.023, 95% CI: 1.005–1.041, P=0.011), current drinker (OR=0.489, 95% CI: 0.301–0.792, P=0.004), last uric acid test within 1 year (OR=0.488, 95% CI: 0.266–0.894, P=0.020), last uric acid test over 1 year ago (OR=0.297, 95% CI: 0.151–0.585, P<0.001), and high uric acid levels at the last test (OR=0.542, 95% CI: 0.299–0.980, P=0.043) were independently associated with practice. The structured equation model showed that knowledge positively influenced attitude (β=0.676, P<0.001) and practice (β=0.494, P=0.002). Attitude positively influenced practice (β=0.624, P<0.001).

**Conclusion:** Patients with hyperuricemia have insufficient knowledge but a positive attitude and proactive practice toward hyperuricemia. Educational and motivational interventions should be designed to improve practice.

**Keywords:** knowledge, attitude, practice, hyperuricemia, self-management, cross-sectional study

## Introduction

Hyperuricemia is the main risk factor for the development and recurrence of gout, a type of inflammatory arthritis resulting from the deposition of monosodium urate crystals in joint fluid and other tissues, but not all patients with hyperuricemia will develop gout.[1,2] There is a rising global trend in the prevalence of hyperuricemia and gout, with an increase in incidence of 63% from 1990 to 2019 and an increase in worldwide prevalence from 22 million in 1990 to 53 million in 2019.[3] Although region-specific data on hyperuricemia in Asia are limited, the increasing prevalence of gout—a clinical manifestation of hyperuricemia—suggests a growing burden across Asian populations.[4,5] Dietary factors



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are associated with an increased risk of hyperuricemia, including the consumption of red meat, seafood, alcohol (especially beer), and sugar-sweetened beverages (as fructose rapidly increases serum urate level)[1,2] and low consumption of dairy products.[6] Other factors associated with hyperuricemia include male sex, ethnicity, some medications, polymorphisms in urate-related genes, age, menopause, overweight, hypertension, and hyperlipidemia, among others.[7,8] Besides pain, arthropathies, and decreased quality of life, hyperuricemia is associated with new-onset CKD, acute kidney injury, and an increased risk of diabetic nephropathy in patients with diabetes mellitus, heart failure, and metabolic syndrome.[7,9] These conditions impose a substantial burden on individuals, families, and society.

Since diet and lifestyle habits play an important role in developing hyperuricemia, self-management is crucial in managing hyperuricemia.[10] Still, proper self-management requires adequate knowledge of the appropriate lifestyle habits, consequences of poor habits, and possible complications, as well as a positive attitude to implement such knowledge.[11,12] Educational and motivational interventions can help improve the knowledge and attitude of the population toward a specific health issue, but the gaps and deficiencies must first be identified. The knowledge, attitude, and practice (KAP) methodology allows the identification of gaps, misconceptions, and misunderstandings that constitute barriers to the correct practice of a given subject in a given population.[13,14] KAP studies provide quantitative and qualitative data and portray the situation. There is a paucity of data on investigations studying KAP among patients diagnosed with hyperuricemia towards hyperuricemia. Still, some studies are available on the KAP toward gout, revealing highly variable KAP levels in various populations and countries,[15–23] but the results could be different in patients with hyperuricemia. Still, it has been shown that patients with asymptomatic hyperuricemia often engage less in active disease management, as the condition is often considered non-pathological, and treatment is generally not recommended unless uric acid levels are very high or there's a risk of complications.[24,25] Furthermore, none of those previous studies on gout were performed in China, where the dietary and lifestyle habits are different from those of other countries, with a focus on flavor and shared meals, a traditional approach to food, and a shift towards Westernized diets in recent years.[26–28] The Westernization of dietary habits in China led to an increase in the prevalence of gout,[29,30] supporting the need to investigate the KAP toward hyperuricemia in China. Poorly managed hyperuricemia can lead to gout development.[24] Although gout is treatable and further attacks can be prevented, it is considered incurable.[31]

Hence, this study aimed to investigate the KAP of patients with hyperuricemia toward hyperuricemia in Nanjing (China), including awareness of risk factors, prevention and management, adherence to prevention and treatment recommendations, or perceived barriers to lifestyle changes.

# Methods

## Study Design and Participants

This cross-sectional study enrolled patients with hyperuricemia who sought medical care at Taikang Xianlin Drum Tower Hospital (Nanjing, China) between September 15, 2023, and January 11, 2024. The study was approved by the ethics committee of the Taikang Xianlin Drum Tower Hospital (approval #LS202319). All participants provided informed consent before completing the questionnaires.

The inclusion criteria were 1) patients diagnosed with hyperuricemia and 2) patients with clear consciousness who could independently complete the questionnaire. The diagnosis of hyperuricemia was made according to the Chinese Guidelines for the Diagnosis and Treatment of Hyperuricemia and Gout (2019).[32] Hyperuricemia was diagnosed in the presence of two fasting blood uric acid measurements (performed on different days) exceeding 420 μmol/L.[32] The exclusion criteria were 1) patients with severe renal insufficiency, malignancies, or any diseases affecting renal function (such patients will have many medical visits that could influence their health literacy in general, and the present study targets patients with hyperuricemia), 2) individuals with secondary hyperuricemia caused by other primary diseases (for the same reasons as in #1), 3) breastfeeding or pregnant women (because hyperuricemia in pregnant women is usually secondary to preeclampsia or altered kidney function[33]), or 4) patients concurrently participating in other clinical trials (as per ethics committee's requirements).

## Questionnaire Design

The questionnaire design was based on the available guidelines: Chinese Guidelines for the Diagnosis and Treatment of Hyperuricemia and Gout (2019)[32] and Practice Guidelines for Patients with Hyperuricemia/Gout.[34] Feedback for refining the questionnaire was provided by two experts: one with 20 years of specialization in endocrinology and metabolic diseases and the other with 15 years of experience in metabolic bone diseases, enhancing the content validity of the questionnaire. A preliminary survey of 35 participants yielded a Cronbach's α coefficient of 0.773, indicating good internal consistency. During the pilot study, participants were asked to give feedback on any unclear or confusing items. No such issues were reported. It confirmed the questionnaire's face validity. Those 35 participants were not included in the main study.

The final questionnaire was in Chinese and encompassed four dimensions: demographic information, knowledge dimension, attitude dimension, and practice dimension. Demographic data such as gender, age, education level, average monthly family income, marital status, smoking and drinking habits, height, weight, blood uric acid level at the last test, timing of the last uric acid test, medication usage, and comorbidities were collected. Uric acid levels were classified as normal (240–420 μmol/L), high (> 420 μmol/L), and low (< 240 μmol/L). The knowledge dimension comprised 22 items, scoring 1 for correct answers and 0 for unclear or incorrect answers, with a score range of 0–22. The attitude dimension consisted of 11 questions scored using a 5-point Likert scale, with values ranging from strongly agree to strongly disagree scored 5–1, yielding a score range of 11–55. The practice dimension included seven questions, with values ranging from never to always scored 1–5, resulting in a score range of 7–35. The threshold for good knowledge, positive attitude, and proactive practice was ≥ 70.0% of the total score.[35]

## Questionnaire Distribution

The questionnaire was distributed to the participants through an online platform. The electronic questionnaire was created using Questionnaire Star, and a QR code for the electronic questionnaire was generated. The participants scanned the QR code sent via WeChat to log in and complete the questionnaire. The QR codes were distributed to patients with hyperuricemia in outpatient clinics or the medical examination center. To ensure the quality and completeness of the questionnaire results, each IP address was restricted to one submission, and answering all items was mandatory to submit the questionnaire. The research team members reviewed all submitted questionnaires' integrity, internal coherence, and reasonability. The participants were guaranteed anonymity in their responses. The IP addresses were kept only during the data collection period to prevent duplicate participation but were deleted after the database lock.

## Sample Size

The formula

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta}\right)^2 \times p \times (1-p)$$

was used to calculate the sample size of this cross-sectional survey. In the formula, $n$ represents the sample size for each group, $\alpha$ represents the type I error (which is typically set at 0.05), $Z_{1-\alpha/2}$=1.96, $\delta$ represents the allowable error (typically set at 0.05), and $p$ is set at 0.5 (as setting it at 0.5 maximizes the value and ensures a sufficiently large sample size). Hence, the calculated sample size was 384. Considering an estimated questionnaire response rate of 80%, a minimum of 480 valid questionnaires were needed.

## Statistical Analysis

SPSS 26.0 (IBM, Armonk, NY, USA) and AMOS 24.0 (IBM, Armonk, NY, USA) were used for the analysis. The normal distribution of continuous data was checked using the Kolmogorov–Smirnov test. The continuous variables were described as means ± standard deviations and analyzed using Student's *t*-test or ANOVA. The categorical variables were described as n (%) and analyzed using the chi-squared test. The Pearson correlation analysis was used to determine the correlations among KAP dimensions. Univariable and multivariable logistic regression analyses were used to analyze the knowledge and practice scores using 70% of the total score as the cutoff value. The variables with P-values <0.05 in

the univariable analyses were included in the multivariable analysis. Multicollinearity was verified using the variance inflation factor (VIF). A VIF of 1 generally indicates no multicollinearity, while a VIF of 5–10 suggests potential multicollinearity and a VIF of >10 indicates serious multicollinearity.[36] A structural equation modeling (SEM) analysis was conducted to test the hypotheses that (H1) knowledge directly affects attitude, (H2) knowledge directly affects practice, and (H3) knowledge indirectly affects practice through attitude.

# Results

## Characteristics of the Participants

This study included 483 non-problematic questionnaires. The mean age was 41.83±14.13 years. For each variable, the majority of the participants were seen in males (89.65%), overweight (46.38%), living in urban areas (81.37%), with college/undergraduate education (53.62%), with health insurance (98.34%), an income of 5000–10,000 CNY (33.33%), married (74.95%), never smoked (58.59%), current drinkers (45.76%), last uric acid test in the past 6 months (28.36%), high uric acid levels (81.57%), not taking uric acid-lowering medication (75.57%), without hypertension (71.01%), without diabetes (78.67%), and without hyperlipidemia (67.29%) (Table 1).

**Table 1** Characteristics of the Participants

| N=483 | | Knowledge | P-values | Attitude | P-values | Practice | P-values |
|---|---|---|---|---|---|---|---|
| **Total score** | | 14.65±3.23 | | 40.89±4.32 | | 25.66±4.54 | |
| **Gender** | | | 0.012 | | 0.217 | | 0.859 |
| Male | 433 (89.65) | 14.77±3.34 | | 40.82±4.36 | | 25.66±4.60 | |
| Female | 50 (10.35) | 13.62±3.03 | | 41.54±3.90 | | 25.64±4.07 | |
| **Age (years)** | 41.83±14.13 | | | | | | |
| **Body mass index (kg/m$^2$)** | | | 0.456 | | 0.591 | | 0.085 |
| Underweight (<18.5) | 4 (0.83) | 14.25±3.59 | | 38.50±2.38 | | 27.25±3.86 | |
| Normal weight (18.5–23.9) | 134 (27.74) | 14.96±3.16 | | 40.85±4.37 | | 26.43±4.62 | |
| Overweight (24–27.9) | 224 (46.38) | 14.51±3.46 | | 40.85±4.29 | | 25.65±4.44 | |
| Obese (≥28) | 121 (25.05) | 14.59±3.25 | | 41.09±4.37 | | 24.78±4.55 | |
| **Residence** | | | 0.078 | | 0.327 | | 0.889 |
| Rural | 47 (9.73) | 14.28±2.38 | | 41.32±5.04 | | 26.09±4.61 | |
| Urban | 393 (81.37) | 14.80±3.37 | | 40.75±4.23 | | 25.63±4.55 | |
| Suburban | 43 (8.90) | 13.72±3.65 | | 41.74±4.29 | | 25.49±4.47 | |
| **Education** | | | 0.002 | | 0.835 | | 0.386 |
| Junior high school and below | 45 (9.32) | 13.18±3.68 | | 40.91±4.04 | | 25.38±5.00 | |
| High school/technical school | 63 (13.04) | 13.92±3.58 | | 41.14±4.44 | | 25.76±4.38 | |
| College/undergraduate | 259 (53.62) | 14.83±3.09 | | 40.97±4.23 | | 25.40±4.53 | |
| Master's and above | 116 (24.02) | 15.22±3.34 | | 40.59±4.58 | | 26.29±4.46 | |
| **Health insurance coverage** | | | 0.836 | | 0.337 | | 0.123 |
| Yes | 475 (98.34) | 14.67±3.31 | | 40.91±4.31 | | 25.71±4.53 | |
| No | 8 (1.66) | 13.88±4.39 | | 40.00±5.21 | | 22.75±4.80 | |
| **Family monthly income (CNY)** | | | 0.003 | | 0.005 | | 0.607 |
| <5000 | 90 (18.63) | 13.74±3.11 | | 41.54±4.24 | | 25.66±4.81 | |
| 5000–10,000 | 161 (33.33) | 14.40±3.59 | | 40.90±4.49 | | 25.59±4.41 | |
| 10,000–20,000 | 141 (29.19) | 15.29±2.96 | | 41.28±4.28 | | 25.99±4.69 | |
| >20,000 | 91 (18.84) | 15.00±3.37 | | 39.64±3.95 | | 25.26±4.31 | |
| **Marital status** | | | 0.908 | | 0.581 | | 0.731 |
| Married | 362 (74.95) | 14.64±3.36 | | 40.91±4.25 | | 25.71±4.50 | |
| Unmarried | 121 (25.05) | 14.69±3.22 | | 40.83±4.54 | | 25.50±4.69 | |
| **Smoking status** | | | 0.683 | | 0.634 | | 0.501 |
| Never smoked | 283 (58.59) | 14.59±3.24 | | 40.78±4.33 | | 25.73±4.51 | |
| Former smoker, currently quit | 62 (12.84) | 14.76±3.26 | | 40.89±3.62 | | 26.19±4.92 | |
| Current smoker | 138 (28.57) | 14.74±3.54 | | 41.13±4.60 | | 25.27±4.44 | |

(*Continued*)

**Table 1** (Continued).

| N=483 | | Knowledge | P-values | Attitude | P-values | Practice | P-values |
|---|---|---|---|---|---|---|---|
| **Alcohol consumption** | | | 0.502 | | 0.052 | | 0.002 |
| Never drank alcohol | 179 (37.06) | 14.61±3.38 | | 40.65±4.55 | | 26.09±4.73 | |
| Former drinker, currently quit | 83 (17.18) | 14.96±3.07 | | 41.82±4.03 | | 26.63±4.47 | |
| Current drinker | 221 (45.76) | 14.57±3.38 | | 40.74±4.20 | | 24.95±4.32 | |
| **Time since the last uric acid test** | | | 0.009 | | 0.007 | | <0.001 |
| Within 1 month | 132 (27.33) | 15.26±3.48 | | 41.71±4.73 | | 27.12±4.89 | |
| Within 6 months | 137 (28.36) | 14.61±3.54 | | 41.20±4.21 | | 26.69±3.85 | |
| Within 1 year | 132 (27.33) | 14.55±2.74 | | 40.52±3.96 | | 24.70±4.29 | |
| One year or above | 82 (16.98) | 13.91±3.42 | | 39.66±4.09 | | 23.12±4.04 | |
| **Uric acid level in the last test** | | | 0.252 | | 0.495 | | <0.001 |
| Normal (240–420 μmol/L) | 87 (18.01) | 14.78±3.54 | | 40.70±4.58 | | 27.26±4.43 | |
| High (> 420 μmol/L) | 394 (81.57) | 14.65±3.24 | | 40.94±4.26 | | 25.33±4.49 | |
| Low (< 240 μmol/L) | 2 (0.41) | 9.00±7.07 | | 39.50±6.36 | | 20.50±0.71 | |
| **Currently taking uric acid-lowering medication** | | | <0.001 | | 0.248 | | <0.001 |
| Yes | 118 (24.43) | 16.25±2.90 | | 41.29±4.18 | | 27.87±4.27 | |
| No | 365 (75.57) | 14.14±3.29 | | 40.76±4.36 | | 24.94±4.40 | |
| **Hypertension** | | | 0.633 | | 0.790 | | 0.042 |
| Yes | 140 (28.99) | 14.81±2.93 | | 41.04±4.40 | | 26.21±4.27 | |
| No | 343 (71.01) | 14.59±3.47 | | 40.83±4.29 | | 25.43±4.64 | |
| **Diabetes** | | | 0.194 | | 0.404 | | 0.026 |
| Yes | 103 (21.33) | 14.10±3.85 | | 41.27±4.59 | | 26.49±4.70 | |
| No | 380 (78.67) | 14.80±3.15 | | 40.79±4.24 | | 25.43±4.48 | |
| **Hyperlipidemia** | | | 0.008 | | 0.978 | | 0.991 |
| Yes | 158 (32.71) | 15.24±2.93 | | 40.85±4.19 | | 25.61±4.26 | |
| No | 325 (67.29) | 14.37±3.47 | | 40.91±4.39 | | 25.68±4.68 | |

**Note**: P-values were considered significant at P < 0.05.

## Knowledge

The mean knowledge score was 14.65±3.23 (66.59% of the possible maximum of 22). Differences in knowledge scores were seen according to gender (P=0.012), education (P=0.002), income (P=0.003), time since last uric acid test (P=0.009), taking uric acid-lowering medication (P<0.001), and hyperlipidemia (P=0.008) (Table 1). The knowledge item with the highest score was K9 (97.31% correct; "Prolonged hyperuricemia can lead to gout".), while the lowest score was seen for K14.3 (10.14% correct; "The phenylbutazone can be used to alleviate acute gout attacks".) (Supplementary Table 1).

## Attitude

The mean attitude score was 40.89±4.32 (74.35% of the possible maximum of 55). Differences in attitude scores were observed according to income (P=0.005) and time since the last uric acid test (P=0.007) (Table 1). The attitude item with the highest score was A3 (98.34% positive; "I believe that maintaining a healthy diet and regular exercise are essential for treating hyperuricemia".), while the lowest score was for A7 (32.09% positive; "I believe that once my uric acid levels return to normal, I can stop taking medication".) (Supplementary Table 2).

## Practice

The mean practice score was 25.66±4.54 (73.31% of the possible maximum of 35). Differences in practice scores were observed according to alcohol consumption (P=0.002), time since the last uric acid test (P<0.001), uric acid level in the last test (P<0.001), taking uric acid-lowering medication (P<0.001), hypertension (P=0.042, and diabetes (P=0.026) (Table 1). The practice item with the highest score was P4 (84.06% proactive; "I usually pay attention to drinking plenty of water".). The lowest score was for P1 (40.78% proactive; "I regularly go to the hospital for uric acid check-ups".) (Supplementary Table 3).

## Correlation

As shown in Table 2, the knowledge score was correlated to the attitude (r=0.172, P<0.001) and practice (r=0.331, P<0.001) scores, while the attitude score was correlated to the practice score (r=0.258, P<0.001).

## Multivariable Analysis

A master's degree or above education (OR=2.555, 95%CU: 1.059–6.164, P=0.037), an income of 10,000–20,000 CNY (OR=2.216, 95% CI: 1.157–4.244, P=0.016), an income of >20,000 CNY (OR=2.237, 95% CI: 1.091–4.586, P=0.028), last uric acid test within the past year (OR=0.583, 95% CI: 0.341–0.997, P=0.049), and not taking uric acid-lowering medication (OR=0.326, 95% CI: 0.204–0.520, P<0.001) were independently associated with the knowledge score (Table 3). The multicollinearity analysis showed no multicollinearity for the knowledge multivariable analysis, with all VIFs near 1 (Supplementary Table 4).

**Table 2** Correlation Analyses Between KAP Dimension Scores

| | Knowledge | Attitude | Practice |
|---|---|---|---|
| Knowledge | 1 | | |
| Attitude | 0.172 (P<0.001) | 1 | |
| Practice | 0.331 (P<0.001) | 0.258 (P<0.001) | 1 |

**Note**: P-values were considered significant at P < 0.05.

**Table 3** Univariable and Multivariable Regression Analysis of Knowledge Dimension

| Knowledge Dimension | Univariable Logistic Regression | | Multivariable Logistic Regression | |
|---|---|---|---|---|
| | OR (95% CI) | P-values | OR (95% CI) | P-values |
| **Gender** | | | | |
| Male | 1.615 (0.866–3.015) | 0.132 | | |
| Female | Ref | | | |
| **Age** | 1.002 (0.990–1.015) | 0.728 | | |
| **Body mass index (kg/m$^2$)** | | | | |
| Underweight and normal weight (<23.9) | Ref | | | |
| Overweight (24–27.9) | 0.735 (0.478–1.132) | 0.162 | | |
| Obese (≥28) | 1.092 (0.669–1.782) | 0.725 | | |
| **Residence** | | | | |
| Rural | Ref | | | |
| Urban | 1.626 (0.853–3.100) | 0.139 | | |
| Suburban | 1.536 (0.649–3.637) | 0.329 | | |
| **Education** | | | | |
| Junior high school and below | Ref | | Ref | |
| High school/technical school | 1.902 (0.814–4.446) | 0.138 | 2.154 (0.868–5.344) | 0.098 |
| College/undergraduate | 2.282 (1.107–4.703) | 0.025 | 1.998 (0.895–4.464) | 0.091 |
| Master's and above | 3.091 (1.429–6.683) | 0.004 | 2.555 (1.059–6.164) | 0.037 |
| **Family monthly income (CNY)** | | | | |
| <5000 | Ref | | Ref | |
| 5000–10,000 | 1.582 (0.908–2.756) | 0.105 | 1.578 (0.855–2.915) | 0.145 |
| 10,000–20,000 | 2.359 (1.344–4.142) | 0.003 | 2.216 (1.157–4.244) | 0.016 |
| >20,000 | 2.408 (1.304–4.448) | 0.005 | 2.237 (1.091–4.586) | 0.028 |
| **Marital status** | | | | |
| Married | Ref | | | |
| Unmarried | 0.962 (0.634–1.461) | 0.856 | | |

(*Continued*)

**Table 3** (Continued).

| Knowledge Dimension | Univariable Logistic Regression | | Multivariable Logistic Regression | |
|---|---|---|---|---|
| | OR (95% CI) | P-values | OR (95% CI) | P-values |
| **Smoking status** | | | | |
| Never smoked | Ref | | | |
| Former smoker, currently quit | 1.550 (0.892–2.691) | 0.120 | | |
| Current smoker | 1.228 (0.813–1.854) | 0.329 | | |
| **Alcohol consumption** | | | | |
| Never drank alcohol | Ref | | | |
| Former drinker, currently quit | 1.382 (0.819–2.335) | 0.226 | | |
| Current drinker | 1.040 (0.696–1.554) | 0.847 | | |
| **Time since the last uric acid test** | | | | |
| Within 1 month | Ref | | Ref | |
| Within 6 months | 0.691 (0.427–1.118) | 0.132 | 0.638 (0.380–1.069) | 0.088 |
| Within 1 year | 0.556 (0.340–0.908) | 0.019 | 0.583 (0.341–0.997) | 0.049 |
| One year or above | 0.488 (0.276–0.863) | 0.014 | 0.549 (0.294–1.023) | 0.059 |
| **Uric acid level in the last test** | | | | |
| Normal or low | Ref | | | |
| High | 0.914 (0.575–1.454) | 0.705 | | |
| **Currently taking uric acid-lowering medication** | | | | |
| Yes | Ref | | Ref | |
| No | 0.325 (0.211–0.500) | <0.001 | 0.326 (0.204–0.520) | <0.001 |
| **Hypertension** | | | | |
| Yes | Ref | | | |
| No | 0.809 (0.544–1.203) | 0.295 | | |
| **Diabetes** | | | | |
| Yes | Ref | | | |
| No | 1.246 (0.797–1.948) | 0.335 | | |
| **Hyperlipidemia** | | | | |
| Yes | Ref | | Ref | |
| No | 0.641 (0.437–0.941) | 0.023 | 0.673 (0.446–1.015) | 0.059 |

**Note**: P-values were considered significant at P < 0.05.

The knowledge scores (OR=1.181, 95% CI: 1.100–1.269, P<0.001), the attitude scores (OR=1.122, 95% CI: 1.063–1.184, P<0.001), age (OR=1.023, 95% CI: 1.005–1.041, P=0.011), current drinker (OR=0.489, 95% CI: 0.301–0.792, P=0.004), last uric acid test within 1 year (OR=0.488, 95% CI: 0.266–0.894, P=0.020), last uric acid test over 1 year ago (OR=0.297, 95% CI: 0.151–0.585, P<0.001), and high uric acid levels at the last test (OR=0.542, 95% CI: 0.299–0.980, P=0.043) were independently associated with the practice score (Table 4). The multicollinearity

**Table 4** Univariable and Multivariable Regression Analysis of Practice Dimension

| Practice Dimension | Univariable Logistic Regression | | Multivariable Logistic Regression | |
|---|---|---|---|---|
| | OR (95% CI) | P-values | OR (95% CI) | P-values |
| **Knowledge dimension** | 1.197 (1.125–1.273) | <0.001 | 1.181 (1.100–1.269) | <0.001 |
| **Attitude dimension** | 1.139 (1.085–1.196) | <0.001 | 1.122 (1.063–1.184) | <0.001 |
| **Gender** | | | | |
| Male | 1.072 (0.590–1.950) | 0.819 | | |
| Female | Ref | | | |
| **Age** | 1.019 (1.005–1.033) | 0.006 | 1.023 (1.005–1.041) | 0.011 |

(*Continued*)

**Table 4** (Continued).

| Practice Dimension | Univariable Logistic Regression | | Multivariable Logistic Regression | |
|---|---|---|---|---|
| | **OR (95% CI)** | **P-values** | **OR (95% CI)** | **P-values** |
| **Body mass index (kg/m$^2$)** | | | | |
| Underweight and normal weight (<23.9) | Ref | | | |
| Overweight (24–27.9) | 0.851 (0.548–1.321) | 0.472 | | |
| Obese (≥28) | 0.809 (0.489–1.338) | 0.409 | | |
| **Residence** | | | | |
| Rural | Ref | | | |
| Urban | 0.984 (0.528–1.833) | 0.960 | | |
| Suburban | 1.047 (0.446–2.459) | 0.915 | | |
| **Education** | | | | |
| Junior high school and below | Ref | | | |
| High school/technical school | 1.103 (0.494–2.466) | 0.810 | | |
| College/undergraduate | 0.784 (0.406–1.514) | 0.468 | | |
| Master's and above | 0.972 (0.474–1.994) | 0.938 | | |
| **Family monthly income (CNY)** | | | | |
| <5000 | Ref | | | |
| 5000–10,000 | 0.839 (0.490–1.437) | 0.523 | | |
| 10,000–20,000 | 0.872 (0.502–1.516) | 0.628 | | |
| >20,000 | 0.670 (0.368–1.221) | 0.191 | | |
| **Marital status** | | | | |
| Married | Ref | | | |
| Unmarried | 1.028 (0.673–1.571) | 0.898 | | |
| **Smoking status** | | | | |
| Never smoked | Ref | | | |
| Former smoker, currently quit | 1.139 (0.642–2.019) | 0.656 | | |
| Current smoker | 0.945 (0.623–1.434) | 0.791 | | |
| **Alcohol consumption** | | | | |
| Never drank alcohol | Ref | | Ref | |
| Former drinker, currently quit | 1.398 (0.784–2.492) | 0.256 | 0.798 (0.408–1.558) | 0.508 |
| Current drinker | 0.567 (0.377–0.853) | 0.006 | 0.489 (0.301–0.792) | 0.004 |
| **Time since the last uric acid test** | | | | |
| Within one month | Ref | | Ref | |
| Within six months | 0.868 (0.504–1.495) | 0.611 | 1.036 (0.555–1.934) | 0.911 |
| Within one year | 0.354 (0.210–0.596) | <0.001 | 0.488 (0.266–0.894) | 0.020 |
| One year or above | 0.203 (0.112–0.367) | <0.001 | 0.297 (0.151–0.585) | <0.001 |
| **Uric acid level in the last test** | | | | |
| Normal or low | Ref | | Ref | |
| High | 0.529 (0.318–0.880) | 0.014 | 0.542 (0.299–0.980) | 0.043 |
| **Currently taking uric acid-lowering medication** | | | | |
| Yes | Ref | | Ref | |
| No | 0.281 (0.169–0.466) | <0.001 | 0.631 (0.325–1.129) | 0.121 |
| **Hypertension** | | | | |
| Yes | Ref | | Ref | |
| No | 0.566 (0.371–0.863) | 0.008 | 0.732 (0.438–1.223) | 0.234 |
| **Diabetes** | | | | |
| Yes | Ref | | Ref | |
| No | 0.557 (0.346–0.895) | 0.016 | 0.850 (0.477–1.513) | 0.580 |
| **Hyperlipidemia** | | | | |
| Yes | Ref | | | |
| No | 0.824 (0.555–1.222) | 0.335 | | |

**Note**: P-values were considered significant at $P < 0.05$.

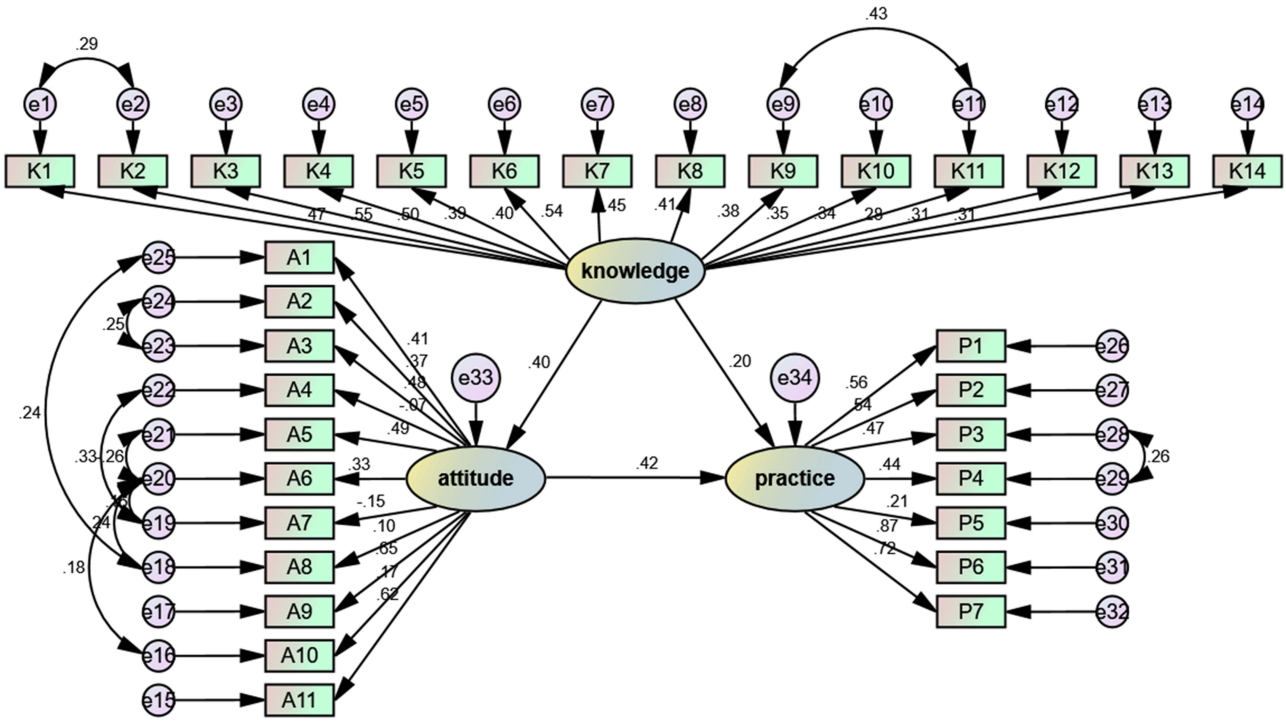


**Figure 1** Structural equation modeling.

analysis showed no multicollinearity for the practice multivariable analysis, with all VIFs near 1 (Supplementary Table 5).

## Structural Equation Modeling Analysis

The SEM is shown in Figure 1. Most fit indexes indicated a good model fit (Table 5). The results showed that knowledge positively influenced attitude (β=0.676, P<0.001) and practice (β=0.494, P=0.002). Attitude positively influenced practice (β=0.624, P<0.001) (Supplementary Table 6).

**Table 5** Fit Indexes of the Structural Equation Model

| Model | Reference | Measured Results |
|---|---|---|
| **CMIN/DF** | 1–3 is excellent, 3–5 is good | 2.441 |
| **RMSEA** | <0.08 is good | 0.055 |
| **GFI** | >0.8 is good | 0.863 |
| **AGFI** | >0.8 is good | 0.840 |

**Abbreviations**: CMIN/DF, minimum discrepancy divided by its degrees of freedom; RMSEA, root mean square error of approximation; GFI, goodness-of-fit index; AGFI, adjusted goodness-of-fit index.


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## Discussion

The results of this study suggested that patients with hyperuricemia have moderate KAP toward hyperuricemia. Educational and motivational interventions should be designed to improve practice.

The present study revealed moderate KAP toward hyperuricemia among patients with the condition. It is of clinical significance since the management of hyperuricemia relies on the patients' self-management regarding adopting proper lifestyle habits.[2,23] To the best of our knowledge, no previous studies focused specifically on the KAP toward hyperuricemia in patients with hyperuricemia. KAP data are available for gout,[15–23] which is the direct consequence of hyperuricemia.[37,38] A study in Saudi Arabia showed that patients with gout had a satisfactory KAP toward gout and were satisfied with their treatments and life in general.[15] Singh reported that patients recognizing the need to take uric acid-lowering drugs to prevent gout flares, manage pain, and have less restrictive dietary restrictions had better adherence to treatment.[20] On the other hand, Harrold et al reported that patients with gout in Worcester (USA) experienced significant challenges in gout management, leading to voluntary non-adherence to treatments.[16] The same authors, in a similar participant population, revealed significant gaps in dietary triggers and chronic medications to manage gout, emphasizing the need for self-management.[17] Martini et al reported that patients with gout in New Zealand had substantial deficits in the causes and management of gout.[18] A meta-analysis of 20 studies suggested a lack of proper patient education about the causes and treatments of gout.[19] Similar results were reported in the United Kingdom and The Netherlands.[21,22] On the other hand, the present study was performed in patients with hyperuricemia, without gout symptoms, and they may be less inclined to take self-management actions due to the "silence" of their condition, as previously reported.[24,25] Still, the present study's participants appear to consider their condition adequately since their attitude and practice levels were relatively high. Since poorly managed hyperuricemia can lead to gout,[24] being serious about its management is important.

Although the male participant proportion was a little high in the present study, at about 90% (or 9:1), available epidemiological data suggest that the male-to-female ratio of hyperuricemia prevalence can reach 80% (or 4:1).[24,39] The difference is due to the protective effect of the female sex on urate levels.[40] Better socioeconomic characteristics were associated with higher knowledge and practice scores. Socioeconomic status is well-known as a major determinant of health literacy.[41] Not taking medication and not being tested recently for uricemia, potentially indicating a less severe condition, were also independently associated with poor knowledge and practice. Increasing age was independently associated with higher practice scores, possibly because of the knowledge that advancing age is associated with comorbidities and a will to avoid them. Current drinkers had a poorer practice. Alcohol is an addictive substance that is associated with the risk of gout, but breaking the habit is difficult.[42]

In China, cultural factors like dietary shifts towards purine-rich foods and alcohol consumption, alongside socio-economic changes, contributed to the increasing prevalence of gout and hyperuricemia. Increased alcohol consumption, particularly liquor, is a significant risk factor for hyperuricemia and gout, and this trend is observed in China. China's population growth and aging, along with lifestyle and income changes, have also contributed to the rise in hyperuricemia and gout prevalence.[5,43] There are variations in hyperuricemia and gout prevalence across different regions and ethnic groups in China, influenced by local dietary habits, lifestyles, and socioeconomic factors.[30] Cultural beliefs and perceptions about health and disease can also influence hyperuricemia and gout management and adherence to treatment recommendations.[44] Hyperuricemia and gout have long been seen as self-inflicted diseases through excessive food consumption, but although dietary-based management approaches are useful in hyperuricemia management, diet is not the only factor involved in hyperuricemia. Still, those beliefs resulted in poor adherence to management.[44] In China, traditional Chinese medicine (TCM) emphasizes the balance of Yin and Yang and the importance of diet and lifestyle in maintaining health. This framework can influence how individuals perceive and manage hyperuricemia. Certain foods are believed to be "hot" or "cold" in TCM, and these beliefs can impact dietary choices, potentially influencing uric acid levels. For example, some may avoid foods believed to be "hot" or "wet" to prevent or manage hyperuricemia. Health decisions are often made within a family or community context in China, and cultural norms can shape attitudes and practices related to health. Chinese culture often emphasizes prevention and maintaining health through lifestyle choices rather than solely relying on medication. Many Chinese individuals use herbal remedies and other traditional treatments

for various health conditions, including hyperuricemia.[45] Still, the present study did not specifically examine the cultural factors influencing the KAP toward hyperuricemia. It should be included in future studies.

The present study showed that knowledge about the causes of hyperuricemia, the non-gout complications of hyperuricemia, the need to manage asymptomatic hyperuricemia, and management during acute gout attacks should be improved, including the knowledge of drugs used to manage hyperuricemia and gout. The SEM and multivariable analyses showed that knowledge influenced attitude and practice and that attitude influenced practice. It is in accordance with the KAP theory,[13,14] and improving knowledge should ultimately translate into better practice. The present study suggests that educational and motivational interventions should be designed to improve practice toward hyperuricemia. Such interventions could translate into better prevention and management of hyperuricemia. Those interventions could include lectures, websites, videos, podcasts, and pamphlets and should cover the pathophysiology of gout and its prevention and management. Interventions should also be targeted primarily to patients with a lower income, alcohol drinkers, or those who have not been tested recently. Additional studies are necessary to design and test such interventions. Furthermore, physicians are primary sources of reliable health-related knowledge for patients.[46,47] Physicians generally appear to have adequate KAP toward hyperuricemia,[16,48,49] although it is not a unanimous finding.[19,21] Hence, future studies should also investigate the physicians in Nanjing to determine whether they disseminate appropriate information to their patients.

This study had limitations. The participants were from a single center and, hence, from the same geographical area, limiting the generalizability of the results. The sample size was also limited, considering the high frequency of hyperuricemia. Using an online questionnaire through a WeChat QR code is convenient, but it may introduce a response bias since tech-savvy patients may be overrepresented, and older patients with lower comfort with electronic devices may be underrepresented. The questionnaire was completed anonymously. The QR code was distributed at outpatient clinics, and the instructions indicated that only patients with hyperuricemia should complete the questionnaire, but there is no guarantee that this was the case. The participants self-reported the data about uric acid levels. It was not required to report the specific values but only to indicate whether there was an abnormal increase. The results were considered relatively reliable since the patients were handed the QR code during an outpatient visit during which they were told their blood examination results. Therefore, the information was fresh in their mind. The exact data about diet and exercise were not collected nor analyzed. The cross-sectional design prevented the analysis of causality or the analysis of the changes in KAP over time in relation to the blood uric acid levels. An SEM analysis was performed as a surrogate of causality, but it must be remembered that causality was statistically inferred using a mathematical model instead of actually being observed.[50–52] All KAP studies are at risk of social desirability bias. Indeed, participants can be tempted to answer what they know they should think or do instead of what they are actually thinking or doing.[53,54] The social desirability can be mitigated for studies completed in person with data collectors,[53] but those methods are not applicable for online research, except for guaranteeing the anonymity of the responses, which was done in the present study.

## Conclusion

In conclusion, patients with hyperuricemia in Nanjing have moderate KAP toward hyperuricemia. The study found that higher education, income, and past uric acid testing were associated with better knowledge and practice scores. The results should be used to design educational and motivational interventions to improve practice related to hyperuricemia, which will be done in future studies. Future studies should also examine the patients longitudinally to observe the changes in KAP over time and with interventions. Public health policies should be adjusted to emphasize the need for better education of patients with hyperuricemia toward their condition.

## Abbreviations

KAP, knowledge, attitude, and practice; SEM, structural equation modeling.

## Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

## Ethics Approval and Consent to Participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the ethics committee Taikang Xianlin Drum Tower Hospital (Approved number: LS202319) and with the 1964 helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent before completing the questionnaires. All methods were performed in accordance with the relevant guidelines and regulations.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare that they have no competing interests in this work.

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