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Article

Body mass index-related hyperuricemia: age-sex heterogeneity among at-risk oncological screening populations, a psycho-oncological perspective

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Abstract: Objective: To examine age- and gender-based heterogeneity in the correlation between body mass index (BMI) and hyperuricemia within a large physical examination cohort of at-risk oncological screening populations. **Methods:** This retrospective cross-sectional study recruited 82,195 at-risk oncological screening population. Linear regression and multivariate binary logistic regression were used to quantify the independent association between graded BMI and hyperuricemia risk, with stratified subgroup analyses conducted by age and gender to identify metabolically high-risk subgroups. **Results:** A positive linear correlation between BMI and serum uric acid persisted in both sexes after adjusting for confounders. Overweight and obesity independently raised hyperuricemia risk. Obese females showed significantly higher susceptibility than obese males (OR = 5.50 vs 3.92, $P < 0.001$). Participants younger than 40 years displayed the strongest BMI-hyperuricemia correlation; obese females aged 30–39 formed the highest-risk metabolic subgroup. Sensitivity analysis validated the robustness of all statistical outputs. **Conclusions:** BMI-associated hyperuricemia presents distinct age-gender heterogeneity among at-risk oncological screening populations. Overweight and obese females under 40 constitute the most metabolically vulnerable subgroup. These population-level metabolic patterns can guide combined metabolic and psychological risk stratification, enabling personalized mind-body interventions to ease tumor-related anxiety and persistent psychological distress.

Keywords: hyperuricemia; obesity; body mass index; age-sex heterogeneity; at-risk oncological screening populations; mind-body integrated prevention

1. Introduction

Hyperuricemia arises from sustained serum urate overaccumulation and drives chronic low-grade systemic inflammation that impairs multiple organ function [1]. Elevated BMI is a well-established modifiable risk factor for hyperuricemia, and concurrent overweight and hyperuricemia have become a widespread public health burden across all age groups [2-5]. Population epidemiological studies consistently document age and gender disparities in the prevalence of these two metabolic disorders, yet existing research mostly restricts analysis to physical metabolic phenotypes in general residents, rarely linking metabolic subgroup differences to psychological outcomes among individuals with abnormal oncological screening results.

Routine physical examinations capture a broad spectrum of at-risk oncological screening populations, divided into three clear subgroups: individuals with elevated tumor biomarkers or indeterminate nodules on ultrasound or CT without malignant pathological confirmation; participants with fully negative tumor screening and no history of neoplastic lesions; and postoperative patients with pathologically confirmed

benign neoplasms or localized early malignancies who did not receive adjuvant radiotherapy or chemotherapy. Even non-malignant abnormal screening signals and minor tumor resection histories induce long-term psychological strain, including persistent fear of lesion progression, recurrent anxiety about potential recurrence, and altered self-perception, core research topics covered by Psycho-Oncologie [6- 8]. Unlike patients with advanced malignancies receiving continuous systemic anti-tumor treatment, this group lacks standardized long-term psychological follow-up in routine clinical workflows, though concurrent chronic metabolic comorbidities continuously amplify mild to moderate psychological distress over years. Adiposity and hyperuricemia-derived inflammation disrupt central neurotransmitter balance, heightening emotional irritability and reducing adherence to regular re-examination and mental self-regulation [9-12]. When chronic physical discomfort overlaps with tumor screening-related psychological stress, individuals frequently avoid follow-up visits, report reduced daily quality of life, and struggle to restore stable long-term mental status [13,14].

Psycho-oncology research has expanded rapidly over the past decade, with consistent evidence validating the clinical value of integrated mind-body management for all tumor-related populations [14-17]. Identifying subgroups facing concurrent high metabolic risk and psychological vulnerability has become a core translational demand for modern psycho-oncology, alongside efforts to translate epidemiological evidence into standardized preventive care protocols.

Current psycho-oncological preventive frameworks advocate holistic mind-body management, yet routine physical examination workflows seldom integrate metabolic risk stratification into standardized psychological screening for at-risk oncological screening populations. Universal one-size-fits-all psychological guidance fails to address distinct metabolic and emotional vulnerability across demographic subgroups. Large-sample population data quantifying combined obesity and hyperuricemia risk across stratified age and gender groups remain scarce, leaving clinicians without objective quantitative references to identify individuals with tumor screening abnormalities facing compound physical and psychological threats. To fill this clinical research gap, the present cross-sectional study of 82,195 at-risk oncological screening populations characterizes heterogeneous correlations between graded BMI and hyperuricemia risk, with all data interpretation and clinical extrapolation oriented toward targeted psychological risk prevention and holistic mind-body health management for at-risk oncological screening populations.

2. Materials and methods

2.1 Study population

This retrospective cross-sectional analysis targeted solely the at-risk oncological screening population. All subjects underwent standardized routine physical examinations. Rigorous uniform inclusion and exclusion criteria were implemented for participant screening, resulting in a final analytical cohort of 82,195 individuals who all met the diagnostic criteria for the at-risk oncological screening population:

1. Abnormal oncological screening results without histopathologic confirmation of invasive carcinoma, including elevated serum tumor biomarkers, indeterminate nodules on ultrasound or CT, abnormal cervical screening (positive human papillomavirus infection with atypical ThinPrep cytologic test results), and suspicious gastrointestinal mucosal lesions identified by gastroscopy or colonoscopy

2. Normal full-spectrum oncological screening results, positive family history of

malignant neoplasms, and absence of personal neoplastic lesions

3. Curative resection of benign neoplasms or localized in situ malignancies, with no history of postoperative adjuvant radiotherapy or chemotherapy

Unified exclusion criteria: incomplete physical or biochemical test data, patients receiving standardized long-term gout treatment, severe uncontrolled chronic organ complications, advanced malignant tumors requiring systematic anti-tumor therapy, and participants aged younger than 18 or older than 90 years. For participants with multiple physical examination records during the study period, only the latest complete valid dataset was included for analysis. The research protocol obtained ethical approval from the Ethics Committee of the Second Hospital of Shandong University, and all participants provided written informed consent before data collection. The full research procedure complied with the Declaration of Helsinki and followed STROBE reporting guidelines for observational epidemiological studies.

2.2 Data collection

All physical and biochemical indicators were tested per unified standardized laboratory operating specifications. After 15 minutes of quiet rest, blood pressure was measured twice using calibrated electronic sphygmomanometers, and average values were recorded. Height and weight were measured via fully automatic body composition analyzers under consistent environmental conditions; BMI was calculated as weight (kg) divided by height squared (m). Fasting venous blood samples were collected after an 8-hour overnight fast to test serum uric acid, fasting blood glucose, serum lipid profiles, and other routine biochemical markers. Electronic medical records were systematically reviewed to extract historical information including hypertension, diabetes, chronic kidney disease, gout, tumor marker results, imaging nodule reports, and tumor surgical history to control confounding bias in subsequent regression models.

2.3 Variable definition

Participants were stratified according to the Chinese BMI criteria into underweight (BMI < 18.5 kg/m2), normal weight (18.5-23.9 kg/m2), overweight (24.0-27.9 kg/m2) and obese (≥ 28 kg/m2) groups [18].

Participants were also stratified according to the WHO criteria into underweight (BMI < 18.5 kg/m2), normal weight (18.5-24.9 kg/m2), overweight (25.0-29.9 kg/m2) and obese (≥ 30 kg/m2) groups [19].

Hyperuricemia diagnostic thresholds followed international uniform clinical standards: fasting serum uric acid > 416 μmol/L for males and > 357 μmol/L for females [20].

2.4 Statistical analysis

Normally distributed continuous variables were expressed as mean ± standard deviation; categorical variables were described using case numbers and constituent ratios. Intergroup comparisons of continuous variables adopted the Mann-Whitney U test, while categorical variable comparisons used the Chi-square test. Age stratification was implemented by 10-year intervals for subgroup analysis. Simple linear regression analyzed linear correlations between continuous BMI and serum uric acid. Multivariate binary logistic regression adjusted for age, smoking status, alcohol consumption, and chronic comorbidities to calculate odds ratios (OR) and corresponding 95% confidence intervals (CI) of hyperuricemia across BMI subgroups. All statistical analyses used SPSS 23.0 software, with $P < 0.05$ defined as the threshold for statistical significance.

3. Results

3.1 Baseline characteristics of participants

A total of 82195 participants (47774 men and 34421 women) were included in this study. The mean age of men and women was 44.46 ± 13.22 and 44.30 ± 13.26 years, respectively ($p = 0.061$). BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), FPG, TG, and LDL were higher in men than in women ($p < 0.001$). The serum UA levels were significantly higher in men than in women (368.24±80.36 μmol/L vs. 269.46±62.15 μmol/L, $p < 0.001$). Moreover, male smokers and alcohol drinkers had significantly higher UA levels than their female counterparts. However, men had lower high-density lipoprotein cholesterol levels compared with women ($p < 0.001$) (**Table 1**).

Table 1. Characteristics of the study participants

Total(*n* = 82195)	**Male(*n* = 47774)**	**Women (*n* = 34421)**	***P* value**
Age(years)	44.46±13.22	44.30±13.26	0.061
BMI(kg/m^2)	26.03±3.52	23.73±3.56	< 0.001
SBP(mmHg)	134.48±17.90	124.04±19.36	< 0.001
DBP(mmHg)	85.58±12.56	76.70±11.75	< 0.001
FPG(mmol/L)	5.44±15.49	5.13±1.20	< 0.001
TG(mmol/L)	1.68±1.49	1.17±0.85	< 0.001
TC(mmol/L)	4.72±0.90	4.72±0.94	< 0.001
HDL-C(mmol/L)	1.27±0.32	1.51±0.35	< 0.001
LDL-C(mmol/L)	2.75±0.77	2.65±0.80	< 0.001
Serum uric acid(μmol/L)	368.24±80.36	269.46±62.15	< 0.001
Current smoker	48.32	2.56	< 0.001
Alcohol consumption	43.46	20.13	< 0.001

SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; TG, triglycerides; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.

Data are expressed as the mean ± standard deviations or percent.

The difference between males and females was analyzed using the Mann–Whitney U test for continuous variables and Chi-Square test for categorical variables.

3.2 Correlation between serum uric acid and BMI

The BMI was significantly correlated with serum uric acid for both genders ($\beta = 6.66$, $P < 0.001$ for men; $\beta = 5.47$, $P < 0.001$ for women). After adjustment for age, smoking status and alcohol consumption, a significant positive association between serum uric acid and total BMI remained ($\beta = 6.84$, $P < 0.001$ for men; $\beta = 5.30$, $P < 0.001$ for women). In both genders, normal weight, overweight and obese were positively correlated with serum uric acid even after adjusting for age, smoking status and alcohol consumption (**Table 2**).

Table 2. Univariable and multivariable linear regression were used to analyze the relationship between uric acid and BMI groups

	Univariable				Multivariable[a]			
	Men		Women		Men		Women	
	β	*P* value	*β*	*p* value	*β*	*p* value	*β*	*p* value
Total	6.66	< 0.001	5.47	< 0.001	6.84	< 0.001	5.30	< 0.001
Underweight	7.60	0.064	0.89	0.592	6.22	0.111	1.18	0.476
Normal weight	6.72	< 0.001	4.833	< 0.001	8.01	< 0.001	4.69	< 0.001
Overweight	6.55	< 0.001	6.26	< 0.001	6.94	< 0.001	5.97	< 0.001
Obese	5.19	< 0.001	4.58	< 0.001	3.91	< 0.001	4.61	< 0.001

BMI: body mass index.

[a]Adjusted for age, smoking status and alcohol consumption, hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease.

BMI category were stratified according to Chinese criteria.

3.3 Prevalence distribution of hyperuricemia

The prevalence of hyperuricemia increased with increased BMI, with higher prevalence in men than in women. The prevalence of hyperuricemia in the obese group was the highest (39.5% in men and 21.6% in women) ($P < 0.05$) (**Figure. 1A**).

In all age groups, the prevalence of HUA in men was higher than in women, with the highest prevalence in the 19-29 age group (33.7%). The prevalence in males gradually decreased with age. However, the incidence of HUA in females initially increased and then decreased with age. The lowest incidence was in the 40-49 age group (5.8%), and the highest incidence was in the 70-89 age group (16.8%) ($P < 0.001$) (**Figure. 1B**).

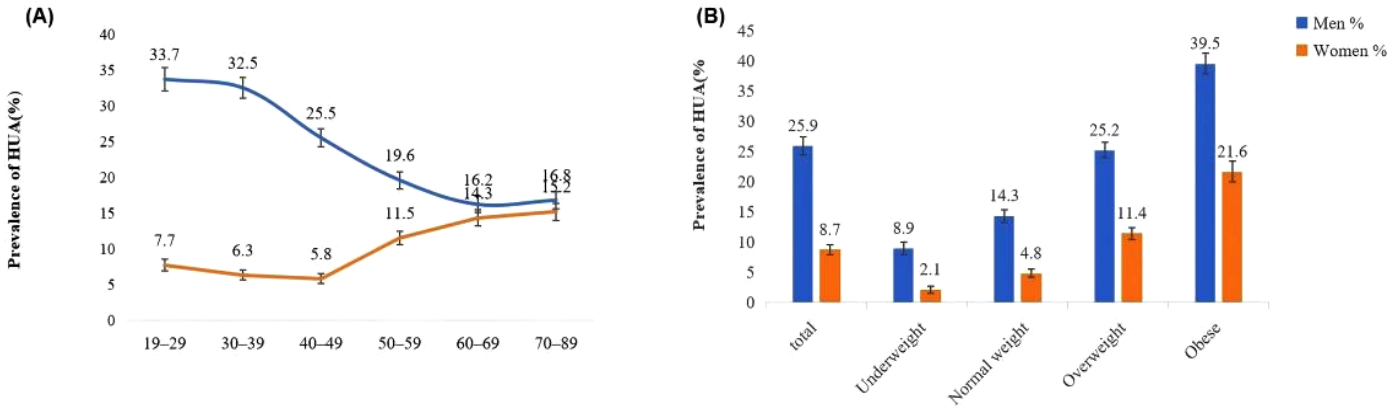


Figure 1. Prevalence of hyperuricemia (HUA) stratified by sex across age groups (A) and BMI categories (B) among the at-risk oncological screening population.

(A) Sex-specific prevalence of HUA in different age subgroups. (B) Sex-specific prevalence of HUA for the total population and four BMI subgroups: underweight, normal weight, overweight, and obesity. Vertical error bars represent 95% confidence intervals of prevalence. BMI, body mass index; HUA, hyperuricemia.

3.4 Risk association between graded BMI and hyperuricemia

Compared with normal-weight participants, an increased BMI was associated with increased risk of hyperuricemia, especially in obese (OR: 5.50, 95% CI: 5.07-6.08, $P < 0.001$ for women; OR: 3.92, 95%CI: 3.69-4.17, $P < 0.001$ for men; **Table 3**) and overweight (OR: 2.56, 95%CI: 2.33-2.80, $P < 0.001$ for women; OR: 2.63, 95%CI: 2.15-2.93, $P < 0.001$ for men; **Table 3**) female participants. Moreover, the risk of hyperuricemia was higher in the 19-29 (OR: 6.63, 95%CI: 5.72-7.69, $P < 0.001$ for obese men; OR: 8.91, 95%CI: 6.46-12.29, $P < 0.001$ for obese women; **Table 4**) and 30-39 (OR: 5.48, 95%CI: 4.87-6.15, $P < 0.001$ for obese men; OR: 9.54, 95%CI: 7.66-11.88, $P < 0.001$ for obese women; **Table 4**) age groups.

Meanwhile, being underweight was a protective factor against hyperuricemia compared to normal body weight, (OR: 0.59, 95%CI: 0.43-0.80, $P = 0.010$ for men and OR: 0.44, 95%CI: 0.31-0.62, $P < 0.001$ for women) (**Table 3**).

During subgroup analysis and sensitivity analyses, it was found that the above relationship between hyperuricemia and BMI existed in participants below 70 (below 70 years old groups $P < 0.05$; 70-89 age group $P > 0.05$; **Table 4**, **Table 5**).

Table 3. Association between hyperuricemia with different BMI groups of different sexes was analyzed by binary logistic regression

	Men		Women	
	OR(95% CI)	*P* value	OR(95% CI)	*P* value
Normal weight	1		1	
Underweight	0.59(0.43, 0.80)	0.010	0.44(0.31, 0.62)	< 0.001
Overweight	2.63(2.15, 2.93)	< 0.001	2.56(2.33, 2.80)	< 0.001
Obese	3.92(3.69, 4.17)	< 0.001	5.50(5.07, 6.08)	< 0.001

BMI, body mass index; OR, odds ratio; CI, confidence interval.
Adjusted for age, smoking status and alcohol consumption, hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease.

Table 4. Relationship between hyperuricemia with different BMI groups of different sexes and ages was analyzed by binary logistic regression

	Total		Underweight		Overweight		Obese	
	OR(95% CI)	*P* value	OR(95% CI)	*P* value	OR(95% CI)	*P* value	OR(95% CI)	*P* value
Men(y)								
19-29	1.22(1.12, 1.29)	< 0.001	0.60(0.40, 0.91)	0.016	2.50(2.20, 2.85)	< 0.001	6.63(5.72, 7.69)	< 0.001
30-39	1.19(1.17, 1.20)	< 0.001	0.42(0.22, 0.81)	0.009	2.65(2.37, 2.96)	< 0.001	5.48(4.87, 6.15)	< 0.001
40-49	1.15(1.13, 1.16)	< 0.001	0.78(0.31, 2.00)	0.612	2.06(1.82, 2.34)	< 0.001	3.46(3.04, 3.94)	< 0.001
50-59	1.14(1.12, 1.15)	< 0.001	0.48(0.11, 2.01)	0.314	1.82(1.58, 2.10)	< 0.001	2.95 (2.53, 3.43)	< 0.001
60-69	1.13(1.10, 1.17)	< 0.001	0.00(-----)	0.998	2.40(1.91, 3.02)	< 0.001	3.85(3.01, 4.93)	< 0.001
70-89	1.17(1.12, 1.22)	< 0.001	0.00(-----)	0.998	1.30(0.92, 1.83)	0.132	2.98(2.63, 4.29)	0.056

Continuation Table:

	Total		Underweight		Overweight		Obese	
	OR(95% CI)	*P* value	OR(95% CI)	*P* value	OR(95% CI)	*P* value	OR(95% CI)	*P* value
Women(y)								
19-29	1.25(1.22, 1.29)	< 0.001	0.49(0.30, 0.79)	0.004	3.30(2.54, 4.29)	< 0.001	8.91(6.46, 12.29)	< 0.001
30-39	1.27(1.24, 1.30)	< 0.001	0.49(0.27, 0.91)	0.024	2.92(2.39, 3.57)	< 0.001	9.54(7.66, 11.88)	< 0.001
40-49	1.19(1.16, 1.22)	< 0.001	0.68(0.22, 2.17)	0.519	2.22(1.77, 2.79)	< 0.001	5.49(4.27, 7.06)	< 0.001
50-59	1.17(1.15, 1.20)	< 0.001	0.16(0.02, 1.16)	0.070	1.95(1.63, 2.34)	< 0.001	3.60(2.94, 4.40)	< 0.001
60-69	1.14(1.12, 1.17)	< 0.001	0.00(-----)	0.997	2.15(1.69, 2.73)	< 0.001	3.16(2.43, 4.12)	< 0.001
70-89	1.12(1.07, 1.17)	< 0.001	0.00(-----)	0.998	1.46(0.97, 2.18)	0.066	2.28(1.50, 3.45)	0.051

BMI, body mass index; OR, odds ratio; CI, confidence interval.
Adjusted for age, smoking status and alcohol consumption, hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease.
Footnote: --- indicates no hyperuricemia cases were observed in this subgroup; OR could not be estimated.

Table 5. Sensitivity analyses for association between hyperuricemia with different BMI groups of different sexes and ages was analyzed by binary logistic regression according to WHO criteria

	Underweight		Overweight		Obese	
	OR(95% CI)	*P* value	OR(95% CI)	*P* value	OR(95% CI)	*P* value
Men(y)						
19-29	0.53(0.35, 0.80)	0.002	2.91(2.58, 3.28)	< 0.001	7.73(6.48, 9.23)	< 0.001
30-39	0.33(0.18, 0.64)	0.001	2.67(2.43, 2.92)	< 0.001	4.99(4.43, 5.62)	< 0.001
40-49	0.64(0.25, 1.63)	0.349	1.94(1.76, 2.15)	< 0.001	3.47(3.05, 3.96)	< 0.001
50-59	0.42(0.10, 1.76)	0.236	1.85(1.65, 2.08)	< 0.001	3.23 (2.75, 3.79)	< 0.001
60-69	0.00(-----)	0.998	2.02(1.69, 2.42)	< 0.001	3.20 (2.45, 4.18)	< 0.001
70-89	0.00(-----)	0.998	1.64(1.22, 2.20)	0.083	4.05(2.62, 6.27)	0.213
Women(y)						
19-29	0.45(0.28, 0.73)	0.001	4.13(3.18, 5.36)	< 0.001	9.69(6.46, 14.54)	< 0.001
30-39	0.47(0.25, 0.84)	0.012	4.04(3.35, 4.87)	< 0.001	11.33(8.69,14.77)	< 0.001
40-49	0.60(0.19, 1.90)	0.384	2.58(2.10, 3.17)	< 0.001	5.36(4.09, 7.21)	< 0.001
50-59	0.14(0.02, 1.00)	0.050	1.99(1.69, 2.33)	< 0.001	3.91(3.08, 4.96)	< 0.001
60-69	0.00(-----)	0.997	2.07(1.69, 2.54)	< 0.001	3.12(2.36, 4.14)	< 0.001
70-89	0.00(-----)	0.998	1.63(1.15, 2.33)	0.076	2.34(1.46, 3.75)	0.436

BMI, body mass index; OR, odds ratio; CI, confidence interval.
Adjusted for age, smoking status and alcohol consumption, hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease.
BMI category were stratified according to WHO criteria.
Footnote: --- indicates no hyperuricemia cases were observed in this subgroup; OR could not be estimated.

4. Discussion

Accumulating evidence has established a close bidirectional link between metabolic disorders-including obesity and hyperuricemia-and psychological distress, particularly among individuals facing oncological concerns [6,7]. Within at-risk oncological screening populations, concurrent chronic metabolic comorbidities continuously amplify tumor-related anxiety and depressive symptoms, underscoring the need for integrated metabolic-psychological risk assessment [8]. This retrospective cross-sectional analysis enrolled 82,195 at-risk oncological screening participants and systematically clarified graded, age- and gender-specific links between BMI stratification, hyperuricemia (HUA), and psychological vulnerability. Baseline metabolic divergence existed by sex: men exhibited significantly higher serum uric acid (UA), BMI, blood pressure and lipid profiles, alongside lower HDL-C. Linear regression confirmed stable positive correlations between BMI and UA in both sexes after adjusting for confounders (men: $\beta = 6.84$; women: $\beta = 5.30$, all $P < 0.001$). Hyperuricemia prevalence rose stepwise across normal weight–overweight–obesity strata, with obese women carrying an HUA odds ratio of 5.50 (95%CI 5.07–6.08, $P < 0.001$) and obese men 3.92 (95%CI 3.69–4.17, $P < 0.001$). Age-stratified models further highlighted the strongest BMI-HUA synergy among participants aged 19–39 years, especially obese young women (OR = 9.54, 95%CI 7.66–11.88, $P < 0.001$), while this metabolic correlation vanished in adults aged ≥ 70 years. The obvious metabolic differences across age and gender subgroups further account for varying levels of psychological vulnerability in this at-risk oncological screening population. Young women with elevated BMI and UA represent the subgroup facing the greatest mental health burden during tumour risk evaluation.

Prior psycho-oncological and metabolic cohort studies have separately reported correlations between adiposity, serum urate and anxiety among general attendees or confirmed cancer patients [21-26]. Most published work also neglects the amplified occupational and childcare stress unique to young females as a critical modifier of the metabolism-mental health relationship. The present work delivers two notable innovations. First, the analytical cohort exclusively comprises three mutually exclusive subgroups of at-risk oncological screening individuals, covering abnormal imaging/cytology, malignant family history and post-curative resection benign/in situ tumours, which better mirrors real-world tumour prevention screening scenarios than general population cohorts. Second, we quantified gradient effects of BMI stratification on hyperuricemia and further mapped how age-gender metabolic heterogeneity translates to divergent psychological vulnerability. The extreme metabolic risk observed in obese females aged 19–39 provides novel stratified epidemiological evidence unavailable from homogeneous population analyses, laying a quantitative foundation for tiered psychological intervention targeting metabolically high-risk screening participants.

This gradient metabolic-psychological disparity can be interpreted via social psychological, neuroendocrine and inflammatory signalling pathways. From a social psychological perspective, young women in this at-risk screening population simultaneously undertake full-time employment and primary childcare responsibilities, resulting in chronic sleep deprivation and irregular dietary patterns [27,28]. Neuroendocrine mechanisms further drive a bidirectional vicious cycle between chronic stress and metabolic dysfunction [29,30]. Persistent psychosocial stress increases circulating cortisol levels, inhibits the renal tubular expression of urate transporter 1 (URAT1) and glucose transporter 9 (GLUT9),

thereby elevating serum uric acid and reducing the fractional excretion of urate [31,32]. Consistently, our linear regression analysis confirmed a steady positive correlation between BMI and serum uric acid in both sexes. Excessive visceral fat deposition further stimulates hepatic purine synthesis and aggravates hyperuricemia. When these metabolically abnormal young women receive ambiguous tumour screening results, accumulated metabolic stress drastically lowers psychological resilience. At the molecular inflammatory level, paired plasma and cerebrospinal fluid testing verifies that adipose-derived TNF-α, IL-1β and IL-6 penetrate the blood–brain barrier, lower central serotonin concentrations and disrupt mood regulation [33,34]. Uric acid crystals induce excessive activation of the NLRP3 inflammasome in microglia, upregulating NLRP3 protein expression and increasing IL-6 concentrations [35,36]. Cyclic estrogen fluctuations in premenopausal women amplify microglial inflammatory response during estrogen peaks, magnifying the metabolic-anxiety association [37,38]. Conversely, testosterone inhibits NLRP3 signaling in males, which may mitigate psychological distress even when BMI and uric acid levels are similarly raised [39,40]. Consistent with our age-stratified results, older adults aged ≥ 70 experience attenuated caregiving pressure and long-term physiological adaptation, eliminating the BMI-HUA correlated psychological vulnerability observed in younger subgroups. This multi-layer quantitative framework directly accounts for stratified psychological vulnerability shaped by graded BMI-hyperuricemia phenotypes within at-risk oncological screening populations.

Several limitations of this study should be acknowledged. First, the cross-sectional design cannot confirm causal relationships between elevated BMI and hyperuricemia. Second, partial historical medical information relied on participant self-report, which may introduce minor information bias. Third, detailed body fat distribution and refined lifestyle data were not collected, limiting further exploration of potential influencing mechanisms. Future longitudinal prospective studies combined with professional psychological scale evaluation are required to further clarify the interactive relationship between metabolic status and psychological health in at-risk oncological screening participants.

5. Conclusion

Hyperuricemia risk increases with elevated BMI, with significant age-gender population heterogeneity. Overweight and obese females aged 40 years and below are the highest-risk subgroup for BMI-related hyperuricemia. This study provides novel stratified physical risk evidence for psycho-oncological clinical practice, supporting precise psychological intervention, metabolic regulation and individualized mind-body rehabilitation management to improve long-term holistic health outcomes of at-risk oncological screening participants.

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Informed consent statement: Informed consent was obtained from all subjects

involved in the study.

Data availability statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of interest: The authors declare no conflict of interest.

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