Association between Neck Circumference and Asymptomatic Hyperuricemia in Nearly Healthy Adults: A Review of 2019-2020 Cross-Sectional Korean Nationwide Data

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Abstract

Background: Neck circumference (NC) measurement has been recently developed as a simple and time-saving anthropometric method for predicting cardiovascular risk. Asymptomatic hyperuricemia is known as one of the cardiovascular risk factors. This study investigated the association between NC and asymptomatic hyperuricemia among the general population of Korea.

Methods: This cross-sectional study examined data from 7,629 participants in the 2019–2020 Korea National Health and Nutrition Examination Survey. Multivariable logistic regression analysis was used to identify the factors associated with hyperuricemia.

Results: Approximately 10% of participants corresponded to hyperuricemia group who were likely to be male, have more comorbidities, poorer habits, and larger NC. Multivariable regression analysis revealed that NC was significantly associated with hyperuricemia in women (OR 1.17; 95% CI 1.06-1.30), but not in men (OR 1.04; 95% CI 0.96-1.12).

Conclusion: A large NC is independently correlated with hyperuricemia among Korean women.

Keywords: Anthropometric measurement; Central obesity; Hyperuricemia; Neck circumference

Introduction

Uric acid is the product of purine metabolism, and approximately two-thirds of serum uric acid is excreted by the kidneys. An imbalance of uric acid metabolism results in major public health problems. Although hyperuricemia is usually asymptomatic, it is a well-known risk factor for gout, kidney stones, and chronic kidney disease (1). Recent research has examined an emerging relationship between serum uric acid levels and several metabolic disorders, such as hypertension, type 2 diabetes, coronary artery disease, and stroke (2). Therefore, studies on uric acid levels and early detection of asymptomatic hyperuricemia are important for targeted control and prevention of chronic diseases.

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Central obesity, a key component of metabolic syndrome, notably affects serum uric acid levels. In previous studies, several obesity indicators (e.g., body mass index [BMI], waist circumference, and waist-to-height ratio) have been investigated as potential predictors of hyperuricemia (3). Meanwhile, neck circumference (NC) measurement has been recently developed as a simple and timesaving anthropometric method for predicting cardiovascular risk (4). Only a few studies have evaluated the relationship between hyperuricemia and NC; however, their populations have consisted only of female individuals or specific populations (5), or included patients with overt gout (6, 7).

Therefore, we aimed to determine the relationship between asymptomatic hyperuricemia and NC in the general population.

Methods

Design and participants

This cross-sectional study used data from the 2019–2020 Korea National Health Examination and Nutrition Examination Survey (KNHANES), performed annually using multistage probability samples. A three-stage sample design is used. Firstly, the primary sample units (PSUs) are selected from a sampling frame of all consensus blocks or resident registration addresses. And then, all dwelling units in the PSU are listed and 20 households are selected through the field survey for household screening. The final stage of selection occurs in the household, where all members ≥ 1 yr old are selected to participate. Approximately 10,000 persons are sampled in total per year. Detailed information about KNHANES has been previously published (8). A total of 15,469 individuals participated in the 2019–2020 KNHANES. Of these participants, the present study included those who were aged 40 yr or older, as this was the only age group subjected to NC measurement (n=9,296). We excluded participants with missing NC measurements or serum uric acid levels (n=641) as well as those who were diagnosed with gout, myocardial

infarction, stroke, chronic kidney disease, or abnormal kidney function (serum creatinine level > 1.2 mg/dL) (n=1,026). Finally, 7,629 subjects were included in the analysis.

Measurements

NC was measured using a flexible tape (Lufkin W606pm; Lufkin Industries, Inc., Missouri City, TX, USA) with an accuracy of ± 0.1 cm. Trained staff measured NC under each subject's Adam's apple with their neck upright, head parallel to the Frankfort plane, and arms naturally lowered. NC was measured twice for each individual, and average values are presented. The KNHANES operates a quality control program to eliminate, control, and measure various errors. In particular, to reduce measurement errors, the following strategies are employed: periodic staff training and field procedure monitoring by outside experts; certification of examiners; use of a standardized environment; calibration of equipment on a regular basis, and comparison of findings over time.

Demographic and clinical data included age, sex, monthly income, BMI, comorbidities (i.e., obesity, hypertension, and type 2 diabetes), and health-related habits (i.e., smoking status, drinking habits, and regular aerobic exercise). Low income was defined as income less than median household income, and individuals who drank more than twice per week were considered frequent drinkers. Regular aerobic exercise was defined as ≥2.5 h per week of moderate-intensity activities, ≥1.5 h per week of high-intensity activities, or a combination of both. Laboratory results, including serum creatinine and uric acid levels, were also collected.

Statistical analyses

Data are presented as mean and standard deviation (SD) for continuous variables and absolute numbers and percentages for categorical variables. Subject characteristics were analyzed according to uric acid levels through the t-test or Chi-square test. Hyperuricemia was defined as serum uric acid ≥ 7 mg/dL in men and ≥ 6 mg/dL in women (9). Multivariable logistic re-

gression analysis was used to calculate the odds ratios (ORs) and 95% confidence intervals (CIs) for hyperuricemia. *P*-values less than 0.05 were considered to indicate statistically significant differences. All statistical analyses were performed using Stata/MP version 17.0 (StataCorp., College Station, TX, USA).

Ethics approval: The study was approved by the Institutional Review Board of Gachon University Gil Medical Center (GFIRB2022-099). The ethics committee waived the requirement for approval because the database used was managed anonymously at all stages.

Results

Subjects' characteristics according to uric acid levels

Overall, 7,629 subjects including 6,814 with normouricemia and 815 with hyperuricemia, were analyzed. The characteristics of the enrolled subjects are presented in Table 1. The proportions of men and those with low income were significantly higher in the hyperuricemia group. Obesity, hypertension, current smoking, and frequent drinking were more prevalent in the hyperuricemia group than in the normouricemia group. The hyperuricemia group also displayed greater NC than the normouricemia group (36.5±3.3 cm *vs.* 34.7±3.3 cm; *P*<0.001).

Table 1: Subjects' characteristics by serum uric acid level

Variable	Normouricemia (n=6,814)	Hyperuricemia (n=815)	P-value
Serum uric acid (mg/dL)	4.7±1.0	7.2±0.8	<0.001
Demographics			
Age (yr)	59.2±11.6	59.3±12.7	0.819
Male sex	2,636 (38.7)	457 (56.1)	<0.001
Low income†	3,152 (46.5)	410 (50.6)	0.027
Comorbidities			
Obesity	2,368 (34.8)	432 (53.0)	<0.001
Body mass index (kg/m²)	23.9±3.3	25.5±3.3	<0.001
Hypertension	2,030 (29.8)	305 (37.4)	<0.001
Type 2 diabetes	867 (12.7)	90 (11.0)	0.171
Health-related habits			
Current smoking	987 (14.7)	150 (18.8)	0.002
Frequent drinking‡	1,277 (22.2)	261 (37.0)	<0.001
Regular aerobic exercise§	2,503 (39.9)	288 (39.0)	0.636
Neck circumference (cm)	34.7±3.3	36.5±3.3	<0.001

†Less than median household income; ‡More than twice per week; §Defined as ≥2.5 h/week of moderate-intensity activities, ≥1.25 h/week of high-intensity activities, or a combination of both. Data are presented as mean ± standard deviation or number (percentage); *P*-values were from the t-test or Chi-square test

ORs of NCs for hyperuricemia

Multiple logistic regression analysis was performed to identify the factors associated with hyperuricemia for men and women (Table 2). The ORs (95% CIs) for hyperuricemia per 1-cm increase in NC were 1.04 (0.96–1.12) for men and 1.17 (1.06–1.30) for women.

<p align="center">**Table 2:** Factors associated with hyperuricemia</p>

Variable	Men		Women	
	aOR† (95% CI)	*P*-value	aOR†	*P*-value
Age, per 1-year increase	0.97 (0.96–0.99)	<0.001	1.03 (1.01–1.04)	0.001
Low income‡	1.26 (0.99–1.59)	0.057	1.30 (0.97–1.74)	0.081
BMI, per 1-kg/m² increase	1.09 (1.03–1.15)	0.003	1.06 (1.01–1.13)	0.033
Hypertension	1.00 (0.77–1.31)	0.993	1.37 (1.00–1.89)	0.051
Type 2 diabetes	0.53 (0.36–0.78)	0.001	0.69 (0.44–1.08)	0.105
Current smoking	0.76 (0.60–0.97)	0.027	1.26 (0.70–2.29)	0.443
Frequent drinking§	1.75 (1.41–2.18)	<0.001	1.81 (1.24–2.64)	0.002
Regular aerobic exercise¶	0.96 (0.77–1.19)	0.691	1.00 (0.75–1.32)	0.974
NC, per 1-cm increase	1.04 (0.96–1.12)	0.314	1.17 (1.06–1.30)	0.002
Pseudo R²	5.19%		6.86%	

†From the multivariable logistic regression models adjusted for all variables; ‡Less than median household income; §More than twice per week; ¶Defined as ≥2.5 h/week of moderate-intensity activities, ≥1.25 h/week of high-intensity activities, or a combination of both. aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index; NC, neck circumference

Discussion

In this nationally representative study, we found that larger NC was associated with hyperuricemia in women but not in men. To our knowledge, this is the first study investigating the relationship between NC and asymptomatic hyperuricemia in healthy Korean adults.

Hyperuricemia is a component of metabolic syndrome, and several studies have reported an association between hyperuricemia and central obesity (10). Detection and monitoring of hyperuricemia are crucial but not easy without blood testing. NC measurement is a simple and reliable anthropometric indicator that offers a convenient alternative to waist circumference as it is minimally affected by respiration and diet. It does not require patients to expose their abdomen. Previous studies have demonstrated that NC showed a similar association with metabolic syndrome to that of waist circumference (11, 12), and NC has been reported as an indicator of central obesity (13).

Until now, a few studies have reported associations between NC and hyperuricemia. In cross-sectional studies performed in China, NC was significantly related to hyperuricemia in both sexes but was more prominent in women (7), which aligns with our results. One longitudinal study also found that NC was an independent risk factor for hyperuricemia in women (14). The current study found hyperuricemia to be more prevalent

in men, but the relative contribution of NC to hyperuricemia was much higher in women. The negative effect of age in men was notably overwhelming—middle-aged men were highly vulnerable to hyperuricemia compared with older men, consistent with the results of a previous Chinese study (15). This result is probably due to the regularity of social activities among middle-aged men, which frequently leads to group dining, heavy alcohol consumption, and sedentary lifestyles.

Our study has several limitations. First, it was a cross-sectional observational study, so we cannot analyze the causal link between hyperuricemia and NC. Second, NC measurement in KNHANES was performed only in participants who were aged 40 yr or older; it is, therefore, unclear whether our findings would apply to the younger population. Furthermore, our sample is representative of the Korean population; those extrapolating these results to other regions or populations should do so with caution.

Conclusion

NC measurement—an innovative alternative to waist circumference measurement—was positively correlated with serum uric acid levels, though this association was only significant for women. Our findings suggest that NC can help detect asymptomatic hyperuricemia early and determine

the risk of metabolic syndrome in nearly healthy women.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Copur S, Demiray A, Kanbay M (2022). Uric acid in metabolic syndrome: Does uric acid have a definitive role? *Eur J Intern Med*, 103:4–12.
2. Kuwabara M, Kodama T, Ae R, et al (2023). Update in uric acid, hypertension, and cardiovascular diseases. *Hypertens Res*, 46(7):1714-1726.
3. Li DD, Zhao YX, Zhang LF, et al (2023). Association between neck circumference and diabetes mellitus: a systematic review and meta-analysis. *Diabetol Metab Syndr*, 15(1):133.
4. Asil S, Murat E, Taskan H et al (2021). Relationship between Cardiovascular Disease Risk and Neck Circumference Shown in the Systematic Coronary Risk Estimation (SCORE) Risk Model. *Int J Environ Res Public Health*;18(20):10763.
5. Yang H, Liu C, Jin C et al (2021). Neck Circumference Is Associated With Hyperuricemia in Women With Polycystic Ovary Syndrome. *Front Endocrinol (Lausanne)*, 12:712855.
6. Jiang J, Cui J, Yang X et al (2017). Neck Circumference, a Novel Indicator for Hyperuricemia. *Front Physiol*, 8:965.
7. Shen X, Wu S, Xu R et al (2019). Neck circumference is associated with hyperuricemia: a cross-sectional study. *Clin Rheumatol*, 38(9):2373-81.
8. Kweon S, Kim Y, Jang MJ et al (2014). Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). *Int J Epidemiol*, 43(1):69-77.
9. Kim Y, Kang J, Kim GT (2018). Prevalence of hyperuricemia and its associated factors in the general Korean population: an analysis of a population-based nationally representative sample. *Clin Rheumatol*, 37(9):2529-38.
10. Wang HG, Wang LZ, Xie R, et al (2014). Association of Serum Uric Acid with Body Mass Index: A Cross-Sectional Study from Jiangsu Province, China. *Iran J Public Health*, 43(11):1503-9.
11. Vallianou NG, Evangelopoulos AA, Bountziouka V et al (2013). Neck circumference is correlated with triglycerides and inversely related with HDL cholesterol beyond BMI and waist circumference. *Diabetes Metab Res Rev*, 29(1):90-7.
12. Cui T, Yan BH, Liu Z et al (2018). Neck circumference: A valuable anthropometric measurement to detect metabolic syndrome among different age groups in China. *Diabetes Metab Res Rev*, 34(3): 10.1002/dmrr.2966.
13. Zhao L, Huang G, Xia F et al (2018). Neck circumference as an independent indicator of visceral obesity in a Chinese population. *Lipids Health Dis*, 17(1):85.
14. An P, Chen K, Wang A et al (2020). Neck circumference is an independent risk factor for hyperuricemia within 3 years in women: a longitudinal study. *Clin Rheumatol*, 39(12):3757-67.
15. Shan RQ, Ning Y, Ma Y et al (2021). Incidence and Risk Factors of Hyperuricemia among 2.5 Million Chinese Adults during the Years 2017-2018. *Int J Environ Res Public Health*, 18(5):2360.
16. Yeo J, Hwang IC, Suh HS, et al (2023). AB1585 Association between neck circumference and asymptomatic hyperuricemia in nearly healthy adults. *Ann Rheum Dis*, 82:2026.