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性、年齢、BMI、腹囲、体型に関連した高尿酸血症の検討: 私立大学における特定健康診断結果の調査

Examining Hyperuricemia as Associated with Gender, Age, BMI Waist **Circumference, and Body Type: Survey of Data Obtained in Specific Health Checkups at a Private University**

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抄録

[目的] 特定健康診断結果における性,年齢,体格指数 (BMI),腹囲および体型に伴う高尿酸血症の発症状 況を検討した。[方法]対象者は服薬のない大阪府内の私立大学教職員(男性350人,女性402人)であった。 高尿酸血症は血清中濃度が7mg/dL超と定義されている。高尿酸血症者の割合を性、年齢、BMI、腹囲およ びBMIと腹囲の組み合わせによる体型区分に基づくカテゴリーにおいて年齢群間(2013年において40歳未 満,40歳以上)で比較した。各カテゴリーにおける高尿酸血症者の百分率を年齢群,BMI区分(<18.5,≥ 18.5 and <25, ≥25kg/m²), 腹囲区分(男性<85, ≥85cm), 体型区分において比較した。[結果] 女性のサ ンプルサイズが小さかったので男性のみ分析した。高尿酸血症はいずれの年齢群においても10%以上発症し、 いずれの年齢群においても腹囲が85cm以上の腹部肥満の男性の25%以上に発症していた。BMIが25kg/m² 以上かつ腹囲が85cm以上の30%以上の男性が両年齢群とも高尿酸血症であった。[結論]高尿酸血症は成 人男性(特に腹部肥満の男性)には一般的に発症していた。

Abstract

Objective: This study explored the current status of hyperuricemia according to gender, age, body mass index (BMI), waist circumference (WC) and body type as determined by specific heath checkups. Methods: Participants included faculty and staff members (350 men, 402 women) at a private university in Osaka, Japan, who were not taking any medications. Hyperuricemia is defined as a serum uric acid concentration of >7 mg/ dL. The frequency of hyperuricemia based on categories of gender, BMI, WC, and body type (combination of

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BMI and WC) was compared across age groups (<40 years or \geq 40 years in 2013). Percentages of those with hyperuricemia in the various categories were compared by age group, BMI (<18.5, \geq 18.5 and <25 and, \geq 25 kg/m²), WC division (<85, \geq 85 cm), and body type. **Results:** Due to the small sample size of women, only the data from men were analyzed for the following items. Hyperuricemia was noted in more than 10% of men in each age group (<40 years and \geq 40 years), and in more than 25% of abdominally obese men with WC \geq 85 cm had hyperuricemia. **Conclusion:** Hyperuricemia developed commonly in adult men (in particular, abdominally obese men).

I. Introduction

Metabolic syndrome (MetS) is defined by cutoff values for waist circumference (WC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C), glucose (Glu) and blood pressure (BP) (Medicine Committee of the Japanese Association of Medical Sciences, 2005). Participants with MetS require health guidance following health checkups, which also evaluate blood parameters such as serum uric acid (UA) and liver enzymes as a way to screen for lifestyle diseases. Subjects with abnormal results must meet with a health expert to learn about specific lifestyle modifications that are required to address their health issues (Ministry of Health, Labour and Welfare, 2015). In this context, UA is considered one relevant item, because if left untreated, hyperuricemia can result in an abrupt gout attack. Furthermore, even without symptoms, hyperuricemia frequently increases the risk of severe complications such as heart attack and renal failure. Levels of UA have been documented to correlate closely with obesity and visceral fat (Takahashi et al., 1997), as well as MetS (Nagahama et al., 2014). However, while the importance of measuring UA in addition to obesity and MetS is known, few reports have examined the ideal way to assess a combination of these three parameters at specific health checkups (SHC). The present study examined recent trends in hyperuricemia across the various categories of gender, age, BMI, WC, and body type, all of which were evaluated in the SHC (Ministry of Health, Labor and Welfare, 2007).

I. Participants and Methods

1. Participants

Our participants were faculty and staff members at a private university in Osaka, Japan. Their work comprised primarily sedentary tasks, and all employees were required by the industrial safety and health law to undergo an SHC. A self-administered questionnaire was provided to 423 men and 430 women, and those who requested total body composition analysis were included in this study. Of the participants who completed the questionnaire, 350 men and 402 women were not taking any medications for hypertension, hyperlipidemia, or diabetes mellitus. These participants were categorized according to gender and age group (<40 years or \geq 40 years in 2013). Ultimately, the study population comprised 158 men <40 (mean, 30.8 ± 4.7) years and 192 (51.2 \pm 8.4) men \geq 40 (51.2 \pm 8.4) years old, as well as 151 women <40 (30.5 ± 5.1) years and 251 women \ge 40 (48.7 ± 6.4) years old.

2. Clinical Data

Blood levels of UA were measured by the uricase peroxidase method, respectively. Participants wore light weight clothes for body weight measurements, from which 1 kg was subtracted to account for the clothing weight. WC was measured as the minimum circumference at the level of the umbilicus to the nearest 0.5 cm at the end of normal expiration.

3. Definition of hyperuricemia

Hyperuricemia was defined as a serum UA concentration of >7 mg/dL in both genders and age groups of the Japanese participants, based on chemical characteristics of saturated solubility of sodium urate (Kagami, 1996).

4. Division of WC

Cutoff values for abdominal obesity were WC \geq 85 cm in men and \geq 90 cm in women. According to Japanese diagnostic criteria, a WC of 85 cm in men is equivalent to a visceral fat area of 100 cm² as determined by computed tomography. WC cutoff values suggest the circumference beyond which excess visceral fat accumulation is assumed.

5. Definition of Body mass index (BMI)

BMI was calculated as weight in kilograms divided by the square of height in meters. BMI <18.5, \geq 18.5 and <25, and ≥ 25 were defined as thin, healthy, and obese, respectively.

6. Classification of body type

Body shape was defined as one of the following obesity types: non-obese (NO) type (BMI <25 kg/m² and WC <85 cm), apple-shaped (A) type (BMI \geq 25 kg/m² and WC <85 cm), pear-shaped (P) type (BMI <25 kg/m² and WC \geq 85 cm), and (A&P) type (BMI \geq 25 kg/m² and WC \geq 85 cm).

7. Statistical Analysis

The number of participants of each gender, BMI, WC, and body type was determined and compared by age group. Percentages of those with hyperuricemia were also compared by age group, BMI, WC division, and body type. Pearson's χ^2 test was used to analyze categorical variables. Binary logistic regression analysis was performed to compare the prediction of hyperuricemia between BMI, WC and body type. Statistical analysis was performed using SPSS[®] 12.0 J software (SPSS Inc., Chicago, IL), with statistical significance defined as p<0.05.

8. Ethical Considerations

This study was approved by the Ethics Committee of Osaka Medical College (No. 1080). Both written and oral explanations of the study methods and objectives were provided, and informed consent was obtained from all participants. Anonymity was ensured to protect personal information.

II. Results

Table 1 shows the number of participants with hyperuricemia by gender and age group. More than 10% of men in both age groups had hyperuricemia, with no significant difference noted between the two groups. There were only two women with hyperuricemia in total age groups. Due to the small sample size of women, only the data from men were analyzed for the following items. Figure 1 shows the percentages of those with hyperuricemia by BMI and age group. In each age group, roughly 30% of obese men had hyperuricemia, with no significant differences between age groups. A significant difference was noted between BMI categories. Figure 2 shows the number of individuals with hyperuricemia by WC group. More than 25% of abdominally

 Table 1
 Distribution of participants not on any medication according to serum concentrations of uric acid (UA) by gender and age group

	Men			Women		
Serum UA (mg/dL)	≤7	>7	Total	≤7	>7	Total
<40 years old	89.2% (141)	10.8% (17)	100% (158)	151% (151)	0% (0)	100% (151)
≥ 40 years old	84.9% (163)	15.1% (29)	100% (192)	99.2% (249)	0.8% (2)	100% (251)

Hyperuricemia is defined as a serum UA concentration \geq 7 mg/dL. N.S. differences between age groups according to Pearson's chi-squared test.

obese men in each age group had hyperuricemia, with no significant differences between age groups. A significant difference was noted between WC groups. Figure 3 shows the percentages of those with hyperuricemia by body type in each age group. More than 30% of men of both age groups with A&P types had hyperuricemia. Over 40% of men \geq 40 years old with A type had hyperuricemia. Binary logistic regression analysis showed an odds ratio of 0.626 (p< 0.01) for body type.

IV. Discussion

Concentrations of UA were higher in men than in women (Table 1). According to the 2010 National Health and Nutrition Examination Survey (NHNES), 21.5% (51/237) of men aged 20-39 years and 27.2% (162/896) of men aged 40-69 years had UA concentrations \geq 7.0 mg/dL. In contrast, 0.7% (3/426) of women aged 20-39 years and 0.14% (18/1264) of women aged 40-69 years had UA concentrations \geq 7.0 mg/dL (Ministry of Health, Labour and Welfare, 2010). Concentrations of UA in men \geq 40 years old tended not to be always higher than those of men <40 years old, both in this study and nationally. Concentrations of UA generally vary in conjunction with genetic components such as estrogen predominantly released in females, but also increase with aging (Yamamoto, 2003). However, our results were difficult to compare with national data, due to the lack of information pertaining to medications for hypertension, hyperlipidemia, and diabetes mellitus. Health screenings conducted in 2003 at the Itabashi Chuo Medical Examination (Tokyo, Japan) reported that, of the 9,166 men with UA levels \geq 7.0 mg/dL, 18.8%, 19.8%, and 21.8% had no hypercholesterolemia, hypertension, or abnormal glucose tolerance, respectively (Fujimori et al., 2006). These reports reveal that, in recent years, hyperuricemia is becoming more prominent even among young Japanese men, suggesting that this is no longer a post-

middle age trend. According to NHNES in 2014, 25% (500/2034) of men between the ages of 20-39 and 32% (1477/4619) of men between the ages of 40-69 had a BMI ≥25 (Ministry of Health, Labour and Welfare, 2014). Being overweight/obese is positively associated with elevated UA or hyperuricemia (Mangge et al., 2013), and UA concentrations often increase more readily with the presence of certain lifestyle habits such as overeating and drinking alcohol, compared to aging alone (Yamamoto, 2003). Therefore, hyperuricemia can apparently occur in obese men, nearly regardless of age (Figure 1). According to the 2014 NHNES, 33% (152/457) of men aged 20-39 and 56% (789/1399) of men aged 40-69 years had a WC \geq 85 cm (Ministry of Health, Labour and Welfare, 2014). However, hyperuricemia seems to occur quite readily in abdominally obese men of nearly any age group (Figure 2), because visceral fat area strongly contributes to elevation in UA (Takahashi et al., 1997, Yamada et al., 2016). According to the 2014 NHNES, 63.0% (293/465), 2.2% (10/465), 10.1% (47/465), and 24.7% (115/465) of men aged 20-39 years were of the NO, A type, P type, and A&P type, respectively. Meanwhile, 41.8% (575/1386), 1.6% (23/1386), 25.9% (361/1386), and 30.7% (427/1386) of men aged 40-69 years were of the NO, A type, P type, and A&P type, respectively (Ministry of Health, Labour and Welfare, 2014). The percentage of men \geq 40 years with a P type was more than double the percentage of those under 40 years old. Collectively, the national trend and our results suggest that excess visceral fat accumulates with age, because those of a P type or A&P type are assumed to have increased amounts of visceral fat. Excess visceral fat accumulation would be one major factor contributing to hyperuricemia, as visceral fat obesity is linked more closely to the overproduction of UA (Matsuura et al., 1998). Over 30% of men of both age groups had a A&P type and hyperuricemia (Figure 3). The highest frequency of



S≤7 mg/dL
S mg/dL, left side: <40 years old, right: ≥40 years old</p>

Figure 1 Percentage of hyperuricemic male participants by body mass index (BMI) and age group. N.S. difference between age groups, and significant difference (**p<0.01) between BMI definitions according to Pearson's chi-squared test.





Figure 2 Percentage of hyperuricemic male participants according to waist circumference (WC) cutoff and age group. N.S. difference between age groups and significant differences (**p<0.01 and *p<0.05) between WC divisions according to Pearson's chi-squared test.





Figure 3 Percentage of hyperuricemic male participants according to body type and age group. N.S. difference between age groups and significant differences (**p<0.01) between body types <40 and ≥40 year old divisions according to Pearson's chi-squared test.

hyperuricemia was observed in men ≥ 40 years old with A type (Figure 3). Being middle aged would increase the likelihood of having hyperuricemia as a complication, due to visceral fat accumulation with age. Obese men with hyperuricemia were highly likely to become MetS (Han et al., 2014), because UA is an independent predictor of MetS (Oda, 2014, Yu et al., 2016). In the present study, binary logistic regression analysis revealed that UA may be a predictor for body type. Furthermore, 1t was also suggested that intervention strategies directed towards reduction of visceral fat could result in reduction of the total number of metabolic risk factors, including hyperuricemia (Tamba et al., 2008). Then hyperucicemia could be improved by getting rid of excess fat, especially visceral fat through healthy diet and exercise.

Limitations

Due to the voluntary nature of the survey, some selection bias may exist in that most participants of the present study did not consider the health checkups as a mere obligation, and displayed initiative to use the results to improve their lifestyles. Nationwide generalizations may be difficult to make from the present study results, as the study population comprised those who conduct primarily sedentary activities. Finally, BMI and WC are useful methods for measurement, but are limited in its ability to measure visceral fat as compared to MRI or CT.

V. Conclusions

Hyperuricemia developed more readily in obese men—especially in the abdominally obese —compared to those who were middle aged. Hyperuricemia developed commonly in adult men (in particular, abdominally obese men).

Conflicts of Interest

The authors declare no conflicts of interest.

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