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Original article

Body composition and metabolic syndrome in patients with primary gout in Vietnam

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Abstract

Objective. To characterize the body composition, to determine the prevalence of metabolic syndrome (MetS), and to examine the association between body composition and the components of MetS in Vietnamese patients with primary gout.

Methods. A total of 107 males with gout and 107 age-matched healthy males underwent physical examination, body composition assessment by dual-energy X-ray absorptiometry and blood tests. Both the original and revised National Cholesterol Education Program Adult Treatment Panel (NCEP/ATP) III criteria were used to define MetS.

Results. Means of total body and trunk fat mass in patients with gout were higher ($P < 0.001$) than those in controls: 20.9 *vs* 13.3 kg and 11.4 *vs* 6.1 kg, respectively. The prevalence of MetS according to the original and revised NCEP/ATP III criteria in patients with gout was also higher ($P < 0.001$) than in controls (33.6 *vs* 15.9% and 56.1 *vs* 23.4%), respectively. In patients with gout, total fat mass was strongly correlated with BMI ($r = 0.86$, $P < 0.001$), while trunk fat mass was strongly correlated with waist circumference ($r = 0.91$, $P < 0.001$). Total fat mass, trunk fat mass and trunk fat mass/legs fat mass ratio were positively correlated ($P < 0.05$) with glycaemia, triglyceridaemia, blood pressure and negatively correlated ($P < 0.05$) with high-density liproprotein cholesterol levels.

Conclusion. Patients with gout had significantly higher fat mass, especially in the trunk region, and higher prevalence of MetS than healthy controls. Therefore, management of weight and MetS should be emphasized in patients with gout to reduce their risk of cardiovascular diseases.

Key words: Gout, Body composition, Dual-energy X-ray absorptiometry, Metabolic syndrome, Vietnam, Obesity, Hypertension, Dyslipidaemia, Insulin resistance, Diabetes.

CLINICAL SCIENCE

Introduction

Gout, the most common inflammatory arthritis in men, is a metabolic disease characterized by hyperuricaemia, recurrent attacks of acute arthritis, deposits of monosodium urate monohydrate microcrystals in and around the joints and uric acid nephrolithiasis [1]. Gout results from the interaction of genetic, constitutional and environmental risk factors like high protein (red meat and seafood) and alcohol (mainly beer and spirits) and fructose-rich sodas and juices intake [2, 3], and its prevalence has recently increased considerably [1]. Gout is often associated with obesity, dyslipidaemia, hypertension and hyperglycaemia [4–6]. These abnormalities are a clustered syndrome termed metabolic syndrome (MetS) [7]. MetS increases the risk of atherosclerotic cardiovascular diseases (CVDs) and type 2 diabetes mellitus (DM2) [8], and also mortality from CVD and all-causes [9]. Prevalence of MetS was remarkably high among patients with gout ranging from 30.1 to 82% [10–16]. Moreover, gout is also associated with all-causes and CVD mortality, independent of MetS [16–19]. Therefore, the EULAR and the British Society for Rheumatology (BSR) guidelines recommend screening and treating comorbid CVD risk factors in patients with gout [20–21]. However, the screening of comorbidities and management of gout is still suboptimal [22, 23]. Obesity, particularly abdominal obesity,

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increases the risk of CVD and DM2 [24]. Although anthropometric measurements, such as BMI, waist circumference (WC) are widely used as indices of obesity, the appropriateness of their use as proxies of obesity, defined as a state of excess body fat accumulation, has been questioned [25]. The amount of body fat, which depends on sex, age and race, can be different at the same level of BMI or WC [24, 25]. BMI can misclassify certain individuals such as those with increased muscle mass or the elderly who tend to lose muscle mass [24]; the variations in WC measurements of inter- and intra-investigators are large [26]. Therefore, accurate determination of body composition (BC) is needed [27]. Bio-electrical impedance analysis (BIA) is based on a two-compartment model, widely used because of its simple, inexpensive and non-invasive method. However, BIA tends to overestimate the percentage of body fat (%BF) in lean subjects and underestimate %BF in obese subjects [27]. Dual-energy X-ray absorptiometry (DXA) is based on a three-compartment model, can measure the amount of total and regional body fat mass (FM), lean mass (LM) and BMC [28]. DXA-measured abdominal fat was highly correlated with intra-abdominal fat (IAF) obtained by CT [29] or MRI [30], and cardiovascular risk factors in normal weight [31, 32] and obese subjects [33]. However, the study of BC assessed by BIA or DXA method and its relationship with metabolic risk factors in patients with gout, to our knowledge, has not yet been reported.

During the last two decades, socio-economic conditions and lifestyle have profoundly changed in Vietnam; and these changes had strong effects on disease patterns in the population [34, 35]. The prevalence of nutrition-related chronic diseases was rapidly increasing; and the relationship between urbanization, sedentary lifestyle and these diseases was also demonstrated [34–37]. The mean BMI of the Vietnamese increased from 19 to 23 kg/m^2, and the prevalence of MetS reached 12% in the general population by 2005 [35, 37]. However, the MetS has not yet been studied among patients with gout in Vietnam. Therefore, the aims of this study were to characterize BC assessed by the DXA method, to determine the prevalence of MetS and to examine the association between BC and the components of MetS in Vietnamese patients with primary gout.

Materials and methods

Study design and subjects

The study was designed as a cross-sectional investigation with two comparison groups. The first comprised 107 Vietnamese males with primary gout aged from 22 to 77 years who visited our Outpatient Department from March 2008 to July 2009; the second was 107 age-matched (±2 years) healthy males who were selected randomly from applicants for annual health check. They were judged normal on physical examination. All patients fulfilled the ACR criteria for the diagnosis of primary gout [38]. Patients with secondary gout (e.g. drug induced or due to renal failure) were excluded. Written informed consent according to the Helsinki Declaration was obtained from each subject. The study was approved by the Research and Ethical Review Board of the Bach Mai University Hospital, Hanoi, Vietnam.

Data collection

Interviews were performed with the standard questionnaire to obtain information on age, disease duration, smoking and alcohol-drinking habit. Subjects were weighed to ~0.1 kg. Height was measured to ~0.5 cm. BMI was calculated as body weight divided by square of height (kg/m^2). WC was measured with an inelastic plastic tape, placed directly on the skin, perpendicularly to the long axis of the body, while the subject stood balanced on both feet and both arms hanging freely. The measurement was taken at the end of expiration, at midway between the costal arch and the iliac crest to ~0.1 cm [26]. Blood pressure (BP) was measured by a mercury sphygmomanometer in the sitting position after 5 min of rest.

Body composition was assessed by DXA Hologic Explorer (Hologic Inc., Waltham, MA, USA). FM, LM and BMC of the whole body and specific anatomical regions (arms, trunk and legs) were obtained. The ratio of the trunk FM to leg FM (RTL) as an index of fat distribution was also obtained. Daily quality control of spine phantom test was performed according to the manufacturer's direction [39]. The coefficient of variation in our laboratory was 0.42%. The results of FM and LM only are reported in this article.

Biological tests were performed on venous blood samples after an overnight fast. Plasma fasting glucose (FG) was measured by using the glucose oxidase method. High-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were measured using a corresponding non-precipitating method. Serum uric acid (SUA), creatinine, triglycerides (TG) and total cholesterol (TC) were measured using an auto-analyser (Olympus AU 400, Olympus, Tokyo, Japan). Creatinine clearance (CrCl) was calculated using modification of diet in renal disease (MDRD) formula [40].

MetS was assessed by using the original National Cholesterol Education Program Adult Treatment Panel (NCEP/ATP) III criteria [41]. Participants with three or more of the following criteria were defined as having MetS: abdominal obesity (WC $\geqslant$102 cm for men, $\geqslant$88 cm for women), high TG [$\geqslant$150 mg/dl (1.69 mmol/l)], low HDL-C [$<$40 mg/dl (1.04 mmol/l) for men and $<$50 mg/dl (1.29 mmol/l) for women], high BP ($\geqslant$130/85 mmHg) and high FG [110 mg/dl (6.1 mmol/l)]. Participants currently taking anti-hypertensive or hypoglycaemic drugs met the criteria for high BP or high FG. Because the original NCEP/ATP III criteria have been recently revised [8] to require a lower FG level [$\geqslant$100 mg/dl (5.6 mmol/l)] in accordance with the revised definition of impaired FG of the American Diabetes Association and a lower WC ($\geqslant$90 cm for men, $\geqslant$80 cm for women for Asian populations) [the same cut-off points as the World Health Organization (WHO) Asia Pacific Criteria APC] [24], and the International Diabetes Federation (IDF) criteria,

since the available data show that the risk of DM2 is apparent at much lower levels of adiposity in Asian than in European populations [42], we reported results obtained using both the original and revised criteria.

Statistical analyses

Data were presented as mean and 95% CI for normally distributed continuous variables, as well as median and inter-quartile range for skewed continuous variables. Frequency and percentage were used for categorical variables. The values of TG were $\log_{10}$ transformed before statistical analyses because of skewed distribution. Comparisons of the values between patients with gout and controls were performed by using paired *t*-test for continuous variables and chi-squared test for categorical variables. Bivariate correlations were done to examine the relationships between BC and the components of MetS. All statistical analyses were done using SPSS version 17.0 for Windows (SPSS, Chicago, IL, USA). Statistical significance was defined as two-tailed $P < 0.05$.

Results

Anthropometric characteristics

Mean (S.D.) duration of disease was 3.3 (1.7) years. Anthropometry and BC characteristics are shown in Table 1. Weight, BMI, WC and BP in patients with gout were higher ($P < 0.001$) than those in controls.

Body composition

Both total FM and LM in patients with gout were significantly higher than those in controls, but the magnitude of difference was much higher for FM (20.9 *vs* 13.3 kg) than LM [(48.8 *vs* 46.8 kg), $P < 0.001$]. Both trunk FM and leg FM in patients with gout were also significantly higher than those in controls but the magnitude of difference was much higher for trunk FM, almost doubled (11.4 *vs* 6.1 kg) than leg FM (5.7 *vs* 4.3 kg) ($P < 0.001$). RTL in patients with gout was also significantly higher than that in controls.

Biological variables

Results of biological variables are presented in Table 2. SUA, creatinine, glucose, TC, LDL-C and TG levels were higher ($P < 0.001$), whereas HDL-C and CrCl levels in patients with gout were lower ($P < 0.001$) than those in controls.

Prevalence of MetS

Using the original criteria, the crude prevalence of MetS in patients with gout was higher ($P < 0.001$) than that in controls: 34.6 *vs* 16.8%; and after age standardization, it was 33.6 *vs* 15.9%. Using the revised criteria, the crude prevalence was much higher: 57.9 *vs* 24.3%; and after age standardization, it was 56.1 *vs* 23.4%, in patients with gout and in controls, respectively. The difference between patients with gout and controls using the new criteria was double the difference between groups in terms of prevalence: delta 17.7% *vs* delta revised 32.7%. Results of prevalence of MetS are presented in

Table 1 Anthropometric and body composition data of patients with gout and controls

Variables	Gout ($n = 107$)	Control ($n = 107$)	*P*-value
Age, mean (S.D.), years	48.2 (14.2)	47.1 (13.4)	0.34
Smoker, *n* (%)	75 (70.1)	41 (38.3)	0.001
Alcohol drinker, *n* (%)	69 (64.5)	17 (15.9)	0.001
Body weight, kg	72.7 (71.5, 73.9)	62.4 (61.6, 63.2)	0.001
Height, cm	165.9 (165.2, 166.6)	165.1 (164.6, 165.6)	0.42
BMI, kg/m^2	26.4 (25.9, 26.8)	22.7 (22.3, 23.1)	0.001
BMI $\geqslant$23, *n* (%)	106 (99.1)	49 (45.8)	0.001
BMI $\geqslant$25, *n* (%)	72 (67.3)	14 (13.1)	0.001
BMI $\geqslant$30, *n* (%)	8 (7.5)	1 (0.9)	0.001
WC, cm	93.1 (92.0, 94.2)	85.4 (84.4, 86.4)	0.001
WC $\geqslant$102, *n* (%)	19 (17.8)	3 (2.8)	0.001
WC $\geqslant$90, *n* (%)	66 (61.7)	26 (24.3)	0.001
Per cent fat (%)	28.5 (27.3, 29.7)	21.2 (20.6, 21.9)	0.001
Per cent fat $\geqslant$25, *n* (%)	73 (68.2)	13 (12.1)	0.001
Fat mass, kg	20.9 (19.7, 22.1)	13.3 (12.8, 13.8)	0.001
Lean mass, kg	48.8 (47.9, 49.6)	46.8 (46.2, 47.4)	0.001
Trunk fat mass, kg	11.4 (10.8, 12.0)	6.1 (5.8, 6.4)	0.001
Legs fat mass, kg	5.7 (5.4, 6.0)	4.3 (4.1, 4.5)	0.001
Trunk fat mass/leg fat mass	2.0 (1.9, 2.1)	1.4 (1.2, 1.6)	0.001
Systolic blood pressure, mmHg	124.4 (121.3, 127.5)	119.0 (117.3, 120.7)	0.001
Diastolic blood pressure, mmHg	78.2 (77.3, 79.1)	74.9 (73.8, 75.9)	0.001
Blood pressure $\geqslant$130/85 mmHg, *n* (%)	44 (41.1)	26 (24.3)	0.001

Values are given as mean (95% CI), if not specified.

TABLE 2 Biological data of patients with gout and controls

Variables	Gout ($n = 107$)	Control ($n = 107$)	P-value
Serum uric acid, μmol/l	463.3 (449.4, 477.3)	355.3 (343.3, 367.4)	0.001
Serum uric acid ⩾420, *n* (%)	90 (84.1)	15 (14.0)	0.001
Creatinine, μmol/l	75.9 (73.9, 77.9)	71.8 (70.0, 73.6)	0.001
Creatinine clearance, ml/min	105.2 (100.1, 109.9)	111.8 (105.5, 116.2)	0.001
Glucose, mmol/l	5.8 (5.7, 5.9)	5.0 (4.9, 5.1)	0.001
Glucose ⩾6.1, *n* (%)	48 (44.9)	11 (10.3)	0.001
Glucose ⩾5.6, *n* (%)	78 (72.9)	21 (19.6)	0.001
Total cholesterol, mmol/l	5.9 (5.7, 6.1)	5.1 (4.9, 5.3)	0.001
Total cholesterol ⩾5.2, *n* (%)	66 (61.7)	42 (39.3)	0.001
HDL-C, mmol/l	1.31 (1.25, 1.37)	1.72 (1.64, 1.80)	0.001
HDL-C <1.04, *n* (%)	38 (35.5)	20 (18.7)	0.001
LDL-C, mmol/l	3.8 (3.6, 4.0)	3.0 (2.8, 3.2)	0.001
LDL-C ⩾2.6, *n* (%)	93 (86.9)	64 (59.8)	0.001
Triglycerides, mmol/l[a]	3.64 (2.31–4.96)	2.13 (1.24–3.17)	0.001
Triglycerides ⩾1.69, *n* (%)	74 (69.2)	39 (36.2)	0.001

Values are given as mean (95% CI), if not specified. [a]Non-normal distribution, expressed as median (inter-quartile range), statistical analyses were performed on $\log_{10}$-transformed variables.

Fig. 1. Using the revised criteria, the prevalence was doubled compared with the original criteria in the young group (48.6 *vs* 24.3%). The prevalence increased with age ($P < 0.001$) in both the groups.

All prevalence rates of individual metabolic components in patients with gout were higher ($P < 0.001$) than those in controls, and among them, the most prevalent were hyperglycaemia, hypertriglyceridaemia and abdominal obesity in patients with gout; and hypertriglyceridaemia, abdominal obesity and hypertension in controls (Tables 1 and 2). Subjects with MetS (revised criteria) had higher SUA levels ($P < 0.001$) than those without MetS: 490.1 (49.9) *vs* 429.1 (84.5) μmol/l [mean (S.D)] and 392.5 (49.4) *vs* 343.9 (63.4) μmol/l in patients with gout and in controls, respectively. CrCl levels were lower ($P < 0.001$) in subjects with MetS than those without MetS: 96.8 (18.8) *vs* 115.8 (17.4) ml/min and 104.1 (22.3) *vs* 114.1 (19.4) ml/min in patients with gout and in controls, respectively. Similar results were observed by using the original criteria (data not shown).

Correlations between body composition and the components of MetS in patients with gout

BMI, WC, %BF, total FM, trunk FM and RTL were positively correlated ($P < 0.05$) with SUA, glucose, TC, TG, BP and negatively correlated with HDL-C levels (Table 3). BMI and WC were highly correlated ($P < 0.001$) with DXA variables: total FM ($r = 0.86$; 0.77), %BF ($r = 0.82$; 0.71), trunk FM ($r = 0.76$; 0.91) and RTL ($r = 0.72$; 0.85). CrCl was negatively correlated ($P < 0.001$) with SUA ($r = -0.67$) and BMI ($r = -0.53$).

Discussion

This study was carried out in Vietnamese patients with primary gout and revealed three major findings: (i) patients with gout had unfavourable characteristics of BC with higher FM, especially in the trunk region, than controls. (ii) The prevalence of MetS in patients with gout was more than two times higher than controls. (iii) In patients with gout, total FM, trunk FM and RTL were positively correlated with glycaemia, triglyceridaemia, BP and negatively correlated with HDL-C levels. To our knowledge, ours is apparently the first investigation to characterize BC in patients with gout using the DXA method. This technique is quick, accurate and exposes the subject to minimal radiation; however, it is relatively expensive, and it has been validated as an efficient tool to assess total and regional BC [28] for studying the relationship between obesity and CVD risk factors [31–33]. We found that patients with gout had higher FM and LM compared with controls but the magnitude of difference was greater for FM, especially in the trunk region, as it was almost doubled. Recently, Takahashi *et al*. [43] used the CT method and found that patients with gout had higher IAF/surface body area than controls. According to WHO/APC, obesity is defined as %BF >25% in males and >35% in females, corresponding to a BMI of 30 kg/m^2 in Caucasians and 25 kg/m^2 in Asians [24]. We applied this criteria and found that the prevalence of subjects having %BF >25% was similar to those having BMI ⩾25 kg/m^2. This finding reinforces the use of ethnic-specific cut-off points for BMI to define obesity [24]. Trunk FM and RTL were significantly correlated with the components of MetS. Similar findings were also reported in healthy people [31, 32]. WC was strongly correlated with DXA variables, especially for trunk FM; and the correlations between WC and other components of MetS were similar to those of trunk FM. These findings are consistent with the results in normal weight [30, 31] and obese subjects [33]. Lee *et al*. [33] reported that no single abdominal adiposity measurement such as WC, DXA-measured abdominal fat or CT-assessed IAF, was a stronger predictor of metabolic risk factors than the other in obese women.

FIG. 1 Prevalence of metabolic syndrome according to the original (**A**) and the revised (**B**) NCEP/ATP III criteria in male Vietnamese patients with primary gout and healthy controls.

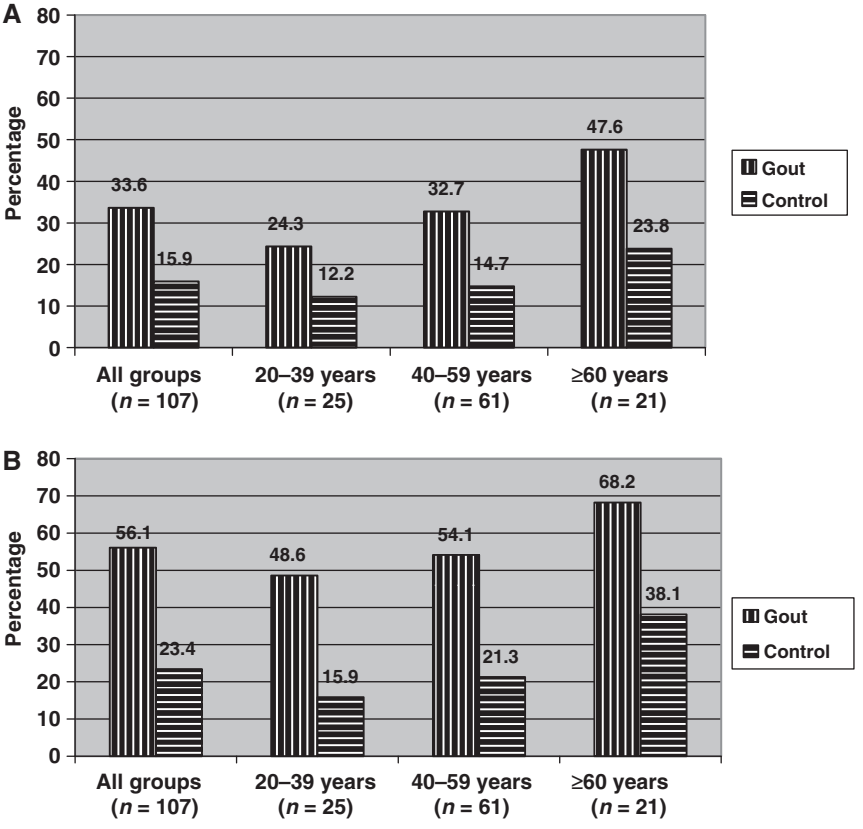

TABLE 3 Bivariate correlations between anthropometric, body composition and metabolic risk factors in patients with gout[a]

Variables	Uric acid	Glucose	Cholesterol	HDL-C	TG	Systolic BP	Diastolic BP
BMI	0.31*	0.44*	0.68**	−0.28*	0.41*	0.39*	0.32*
WC	0.39*	0.45*	0.74**	−0.35*	0.42*	0.41*	0.39*
Per cent BF	0.41*	0.46*	0.65**	−0.29*	0.42*	0.34*	0.33*
Total FM	0.40*	0.48*	0.68**	−0.29*	0.42*	0.31*	0.30*
Trunk FM	0.44*	0.56**	0.76**	−0.36*	0.45*	0.48*	0.37*
RTL	0.45*	0.51**	0.69**	−0.34*	0.43*	0.45*	0.37*

[a]Spearman's correlation coefficient (r). *$P < 0.05$; **$P < 0.01$.

Kamel *et al*. [30] found that in non-obese men, DXA and WC can predict IAF equally, while in non-obese women, DXA is superior to WC [30].

Overall, our results support the use of WC as a routine tool in clinical and research settings, and DXA as a tool in research settings for studying the relationship between BC, obesity and cardiovascular risk factors in patients with gout.

Although most experts recognize that obesity-related insulin resistance may be the fundamental cause of MetS, each society has its emphasis in defining the syndrome. The WHO diabetes criteria centres on diabetes and insulin resistance [44], whereas the IDF focuses on central obesity as the essential condition [42], while the NCEP/ATP III guideline gives equal weight to each component of MetS [8, 41]. We used NCEP/ATP III criteria because it is widely used in all previous studies in patients with gout [10–16] and in the Vietnamese population [34, 37] enabling us to compare our results with those of previous studies. We found that the prevalence of MetS in patients with gout was more than two times greater than controls. These findings are in agreement with the results of earlier studies [10–16]. Prevalence of MetS in patients with gout varied considerably, ranging from 30.1–57.2% in Korean [10, 12], 36.8% in Taiwanese [16], 48.6% in Japanese [15] to 62.8% in American [14], and 82% in

Mexican men [11]. This phenomenon is likely due to the difference of lifestyle and genetic predisposition [2]. Using the revised criteria, the prevalence of MetS increased considerably compared with the original criteria, especially in the young group where it doubled, suggesting the potential underestimation of the original criteria in defining MetS. This discrepancy is mainly explained by using the lower cut-off points for WC for Asians in the revised criteria [8]. Our results support the use of different cut-off points for WC for different population groups as in the revised NCEP/ATP III [8] and IDF criteria [42]. The link between gout and MetS has been supported by the close association between hyperuricaemia and insulin resistance [2, 5, 45, 46]. Insulin resistance is known as a common cause of various components of MetS including hyperlipidaemia and hypertension, which contributes to the hyperuricaemia by inhibiting the renal clearance of uric acid [46] and increasing the production of uric acid [10]. Consequently, an increased SUA level has been recognized as a common feature in patients with MetS [5, 46]. The higher SUA levels and lower CrCl levels in individuals with MetS compared with those without MetS in this study were also previously reported [47]. Furthermore, the prevalence of MetS increased with increasing SUA levels [48], and patients with gout had higher insulin resistance than controls [10]. We found that in patients with gout, the correlations between BMI and the components of MetS were similar to those of WC, suggesting the importance of using both BMI and WC since they independently contribute to the prediction of non-abdominal, abdominal subcutaneous and IAF and CVD risk factors [24, 44, 49].

Prevalence of MetS in healthy controls was higher than that in an earlier study in Vietnam [37], and lower than that in the USA [50]. BMI in both groups was much higher than average BMI of Vietnamese in the last two decades [35]; 67.3% of patients with gout and 13.1% of controls had BMI $\geqslant 25\,kg/m^2$, a cut-off point for obesity definition according to WHO/APC [24]. During the previous decades, the Vietnamese had spent a long time with insufficient food, so BMI was constant from 1985 to 1994 [35]. With socio-economic development and urbanization, a shift in traditional lifestyle with high levels of occupational and leisure time, lower fat meals to a more Westernized one is taking place, and the disease patterns have also profoundly changed [34–37]. Our results confirm that obesity has increased in Vietnam, as shown in previous population-based studies [34, 37]. Moreover, we also found that the prevalence of MetS increased with age in both the groups. Similar findings were also observed in the earlier reports [13, 14]. With the nation's increase in life expectancy, there will be a significant future increase in the prevalence of MetS. Therefore, weight control by association of dietary and physical activity enhancement should be emphasized for the prevention of obesity as well as obesity-related CVD.

Strengths and limitations of this study deserve comment. This is the first study, to our knowledge, to characterize BC by using the DXA method and to examine the relationship between BC variables and components of MetS in patients with gout. DXA has been validated to assess total and regional BC; however, it cannot discriminate between different fat deposits: subcutaneous and visceral fat [27], Furthermore, DXA is a relatively expensive technique and time consuming compared with other methods such as anthropometric measurements and BIA; therefore, it cannot be routinely used in clinical practice [27]. Further studies using other methods such as BIA (simple, inexpensive and non-invasive) with a larger scale of patients should be useful. The study design was cross-sectional, so it was unable to make any cause–effect inference on the relationship between MetS and gout. Prospective studies should be valuable to determine the causal relationship between these diseases.

In summary, this study demonstrated that patients with gout had significantly higher FM, especially in the trunk region, and higher prevalence of MetS than controls. These findings suggest that clinicians should screen for MetS in patients with gout to control its components and therefore reduce their risk of cardiovascular diseases.

Rheumatology key messages

- Vietnamese gouty patients had significantly higher fat mass, and prevalence of metabolic syndrome than controls.
- Increased prevalence of metabolic syndrome in Vietnam was related to the Westernized diet, sedentary lifestyle.
- Management of weight and metabolic syndrome should be emphasized in patients with gout.

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