THE SYNERGISTIC EFFECT OF HIGH BMI AND LOW PHYSICAL ACTIVITY ON GOUT ARTHRITIS RISK: A CASE -CONTROL STUDY IN WEST SUMATERA, INDONESIA

Erma Widhiastuti[1], Mega Hasanul Huda[2*], Herry Susanto[3], Maria Dyah Kurniasari[4], Hasriza Eka Putra[5]

[1]Postgraduate student, Faculty of Nursing, University of Indonesia, Depok, Indonesia.
[2]Faculty of Nursing, University of Indonesia, Depok, West Java, Indonesia.
[3]Faculty of Nursing, Universitas Islam Sultan Agung, Semarang, Indonesia.
[4]Faculty of Health Science. Kristen Setya Wacana University, Kartini Street, Salatiga, West Java, Indonesia
[5]Tengku Rafi'an Regional Public Hospital, Siak, Riau, Indonesia.

e-mail : megahasanulhuda@gmail.com/mega.hasanul13@ui.ac.id*, ermawidhia123@gmail.com, herry_susanto@unissula.ac.id, maria.kurniasari@uksw.edu, hasrizaekaputra@gmail.com

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ABSTRAK

Pendahuluan: Indeks massa tubuh (IMT) >24,9 kg/m² merupakan faktor risiko yang sudah mapan untuk artritis gout. Namun, efek gabungan antara obesitas dan penurunan aktivitas fisik terhadap prevalensi artritis gout di Sumatera Barat, Indonesia, masih perlu diteliti lebih lanjut. Penelitian ini bertujuan untuk menyelidiki hubungan antara obesitas dan efek sinergisnya dengan penurunan aktivitas fisik dalam meningkatkan risiko artritis gout. **Metode:** Studi kasus-kontrol dilakukan dengan 105 partisipan yang direkrut dari sebuah pusat Kesehatan di Sumatera Barat, Indonesia. Partisipan dibagi menjadi dua kelompok: control sehat (n=57) dan pasien artritis gout (n=48). Tingkat aktivitas fisik dinilai dengan menggunakan Pedoman Aktifitas Fisik yang dimodifikasi dari Advisory Committee for Americans dan diukur sebagai metabolis equivalent of task (MET)-jam per minggu selama periode 12 bulan. IMT diukur dengan berat badan dalam kilogram dibagi dengan kuadrat tinggi badan dalam meter. Analisis regresi logistic digunakan untuk menentukan asosiasi. **Hasil:** Partisipan dengan IMT ≥ 24,9 kg/m² memiliki kemungkinan 4,78 kali lebih besar untuk mengembangkan artritis gout dibandingkan dengan mereka yang memiliki IMT < 24,9 kg/m² (Adjusted Odds Ratio [AOR] = 4,78; 95% Confidence Interval [CI] = 1,73–13,23; p < 0,01). Selain itu, mereka yang melakukan aktivitas fisik rendah (< 7,5 MET-jam/minggu) memiliki kemungkinan 3,35 kali lebih besar untuk mengembangkan artritis gout dibandingkan dengan mereka yang memiliki tingkat aktivitas lebih tinggi (AOR = 3,35; 95% CI = 1,06–10,53; p < 0,05). **Diskusi:** Di Sumatera Barat, Indonesia, obesitas (IMT >24,9 kg/m²) dan interaksi sinergisnya dengan penurunan aktivitas fisik secara signifikan berkontribusi terhadap peningkatan risiko artritis gout. Intervensi kesehatan masyarakat yang menangani baik manajemen berat badan maupun promosi aktivitas fisik sangat penting untuk mengurangi beban penyakit.

Kata Kunci: artritis gout, imt, aktivitas fisik, efek sinergis, sumatera barat

ABSTRACT

Background: A body mass index (BMI) of >24.9 kg/m² is a well-established risk factor for gout arthritis. However, the combined effect of obesity and decreased physical activity on the prevalence of gout arthritis in West Sumatra, Indonesia, remains unclear. This study aimed to investigate the relationship between obesity and its synergistic effect with decreased physical activity in increasing the risk of gout arthritis. **Methods:** A case-control study was conducted with 105 participants recruited from a health center in West Sumatra, Indonesia. Participants were divided into two groups: healthy controls (n=57) and gout arthritis patients (n=48). Physical activity levels were assessed using the modified Physical Activity Guidelines from the Advisory Committee for Americans and quantified as metabolic equivalent of task (MET)-hours per week over a 12-month period. BMI was measured by weight in kilograms divided by the square of their height in meters. Logistic regression analysis was used to determine the associations. **Results:** Participants with a BMI ≥ 24.9 kg/m² were 4.78 times more likely to develop gout arthritis compared to those with a BMI < 24.9 kg/m² (Adjusted Odds Ratio [AOR] = 4.78; 95% Confidence Interval [CI] = 1.73–13.23; $p < 0.01$). Additionally, those engaging in lower physical activity (< 7.5 MET-hr/week) were 3.35 times more likely to develop gout arthritis compared to those with higher levels (AOR = 3.35; 95% CI = 1.06–10.53; $p < 0.05$). **Conclusions:** In West Sumatra, Indonesia, obesity (BMI >24.9 kg/m²) and its synergistic interaction with decreased physical activity significantly contribute to the increased risk of gout arthritis. Public health interventions addressing both weight management and promotion of physical activity are essential for reducing the disease burden.

Keywords: gout arthritis, bmi, physical activity, synergistic effect, west sumatera

INTRODUCTION

Gout arthritis is an auto-inflammatory disease that affects populations worldwide (Rock 2013). The disease has a significant potential to cause disability globally (Xia 2020 & Yu 2018), and its prevalence has increased over the past five decades (Kuo 2015 & Singh 2019). Previous studies have reported a rising trend in gout arthritis cases in several countries, including the United States (Singh 2019 & Terkeltaub 2011), South Korea, Australia, New Zealand, and Taiwan (Singh 2020). In developing countries, such as Indonesia, the prevalence of gout arthritis is also notable, affecting approximately 1.7% of adults (Kuo 2015). In West Sumatra, the prevalence is even higher, affecting about 21.8% of the population, suggesting that gout arthritis is a significant public health issue in this region (Indonesian Ministry of Health 2018). These empirical findings highlight that gout arthritis is a growing health concern in Indonesia, particularly in West Sumatra. The high prevalence of gout in West Sumatra can be attributed to several interrelated factors, including socio-economic conditions, dietary patterns rich in purines, cultural habits, and environmental factors that contribute to obesity and metabolic disorders. Additionally, the region’s limited access to healthcare and education regarding disease management plays a critical role in the increasing rates of gout arthritis, further emphasizing the need for localized public health interventions.

The focus on West Sumatra for this study is justified by the region's high prevalence of gout arthritis, significant obesity rates, the impact of COVID-19 restrictions on physical activity, and the need for localized research to inform public health strategies.

Obesity often leads to insulin resistance, which can impair the kidneys' ability to excrete uric acid. Elevated insulin levels can increase uric acid reabsorption in the renal proximal tubules, further contributing to hyperuricemia. Physical activity can improve metabolic health by reducing body weight and improving insulin sensitivity, which in turn can help lower uric acid levels. Conversely, a lack of exercise can exacerbate metabolic syndrome, which is closely linked to hyperuricemia and gout. Previous research in China found that 53% of 43 patients diagnosed with gout were aged between 30 and 49 years, suggesting that hyperuricemia may develop at a young age (Zhang 2020). Elevated serum urate levels are a key factor associated with several comorbidities, including chronic kidney disease (Sing 2020). According to the American College of Rheumatology and the European League Against Rheumatism, urate-lowering therapies (ULTs) are the primary treatment options for gout arthritis (Khanna 2012). However, in Indonesia, adherence to these therapies remains a challenge. A previous study found that up to 61% of gout patients in Indonesia failed to adhere to ULTs (Setyawan 2022), which may explain the persistent health issues, including pain, experienced by patients (Ten Klooster 2022). This highlights the need for alternative or complementary prevention strategies, such as identifying modifiable risk factors, to improve disease management and reduce the disease burden.

One such modifiable risk factor is body mass index (BMI). A high BMI is known to increase the risk of gout arthritis (Aune 2016), as adipose tissue (BMI > 24.9 kg/m²) has been associated with increased serum uric acid levels (Kurniasari 2021). Previous research on this association in Indonesia has been limited to Sulawesi. However, West Sumatra is one of the three major provinces in Indonesia with a high prevalence of obesity (23%) among individuals aged 29 to 59 years (Ayuningtyas 2022). Obesity is characterized by an excessive accumulation of body fat, which alters uric acid production due to insulin resistance, disrupting uric acid metabolism. High uric acid levels, in turn, exacerbate the risk of obesity by accelerating fat accumulation in the liver and peripheral tissues (Li 2021). Evidence from studies conducted in Bangladesh and China supports the coexistence of glycolipid and uric acid metabolism disorders, which may contribute to the observed link between obesity and gout arthritis (Ali 2018 & Lee 2020). Given the role of BMI as a risk factor for gout arthritis, it is essential to investigate the extent to which a BMI > 24.9 kg/m² increases the risk of gout arthritis in the context of West Sumatra, Indonesia.

The COVID-19 pandemic further complicated the situation. During the pandemic, Indonesia implemented strict restrictions on outdoor activities (Indonesian Ministry of Health 2023), with most work, school, and meetings shifting to online platforms. Studies reported that a significant proportion (27.8%) of Indonesians sat for 4 to 6 hours per day (Bachtiar 2020), leading to increased sedentary behavior. This shift in lifestyle resulted in weight gain and an increase in the prevalence of overweight and obesity (Gutiererez 2021). Another study found that the restrictions on outdoor activities during the pandemic reduced the physical activity levels of young adults in Indonesia (Arovah 2022). Given the potential for reduced physical activity to further elevate the risk of gout arthritis, understanding its interactive or synergistic role alongside BMI is crucial.

While previous studies have explored the association between BMI and gout arthritis, few have examined the combined, or "synergistic," effect of BMI and physical activity on the risk of gout arthritis. Most prior studies have been conducted outside Indonesia, with limited regional data available for West Sumatra. This study seeks to address this gap by investigating the relationship between BMI (> 24.9 kg/m²) and gout arthritis in West Sumatra. Furthermore, it examines the interactive (synergistic) effect of BMI and physical activity, which has not been previously explored in this region. The findings of this study aim to provide evidence for targeted public health interventions that promote physical activity and weight management as essential strategies for preventing gout arthritis in West Sumatra and other regions of Indonesia.

RESEARCH METHODS

Study Design, Setting, and Participants

A case-control study was conducted from July to August 2022 in the West Sumatra Province, Indonesia. The study location was selected due to the high prevalence of obesity reported in the most recent Basic Health Research Report (2018), which indicated a prevalence rate of 23% in West Sumatra (Indonesian Ministry of Health 2018). To minimize selection bias in our case-control study on gout arthritis in West Sumatra, we implemented a systematic randomization process. Initially, the West Sumatra Province was divided into 19 districts. From this list, one district was randomly selected using a random number generator, ensuring equal representation across the region. Three public health centers (Puskesmas) within the selected district were then invited to participate. While Area A and Area C declined to join, we proceeded to recruit participants from Area B, the only center that agreed to participate. This approach reduced the risk of bias, as it allowed for a fair selection process while still reflecting the broader population characteristics. Despite being limited to a single recruiting site, this method helped ensure that the findings of our study are more likely attributable to the examined associations rather than biased participant selection. The recruitment process was described in the following diagram (Figure 1):

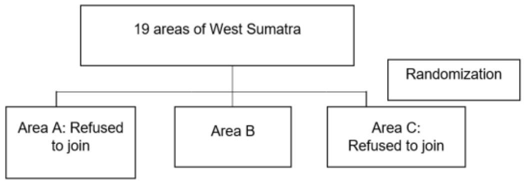

Figure 1. Recruitment process

The eligibility criteria for participants in the control group were as follows: (a) residents of the Puskesmas Kumpulan district; (b) no history of gout arthritis or chronic disease; (c) aged 18 to 60 years; and (d) provided informed consent to participate. Participants in the case group met the following criteria: (a) residents of the Puskesmas Kumpulan district; (b) aged 18 to 60 years; (c) provided informed consent to participate; (d) had a confirmed diagnosis of gout arthritis based on the criteria of the Indonesian Rheumatologist Association; and (e) attended the outpatient clinic at Puskesmas Kumpulan. Exclusion criteria for both groups included participants with chronic diseases or a history of inflammatory diseases, such as rheumatoid arthritis or spondyloarthritis.

Sample Size Calculation

The sample size was calculated using G*Power version 3.1 software, with an effect size of 1.2 (Kuo 2016), a significance level (α) of 0.05, and a power of 0.90. The study accounted for a 20% dropout rate and a total of 15 predictors, resulting in a final sample size of 105 participants. This approach ensured sufficient statistical power for the analysis.

Data Collection

Physical assessments and blood analyses were conducted by general practitioners and nurses at Puskesmas Kumpulan. Each participant underwent a 10-minute health check, which included weight and height measurements for BMI calculation. BMI was calculated as weight (kg) divided by height squared (m^2) (Weir

2019). Based on BMI, participants were categorized as having a BMI of <24.9 kg/m² or ≥ 24.9 kg/m². Nurses also measured blood pressure and conducted a standardized medical assessment. Capillary blood samples were collected via fingertip puncture by trained nurses to measure urea levels (Fabre 2018).

Demographic and Health-related Data Measurements

Demographic and health-related data were collected using a structured questionnaire designed by the research team based on previous studies (Kurniasari 2021). The demographic data included age, gender, marital status, educational level, wealth index, and job status. Health-related variables, such as genetics, physical activity, smoking status, and alcohol consumption, were also recorded.

Level of Knowledge

A structured questionnaire, adapted from Zhang et al. (2011), was used to measure participants' knowledge of gout arthritis. The questionnaire consisted of 10 items with 4 multiple-choice options for each item, covering topics on pathogenesis, treatment during acute conditions, and chronic gout management (Zhang 2011). The adaptation process followed standard procedures, including content validation (Sousa 2011). The content validity index (CVI) of the adapted questionnaire was 0.90, with a Cronbach's alpha of 0.88, indicating high validity and reliability.

Physical Activity

Physical activity was assessed using a modified Physical Activity Guidelines for Americans (Shiroma 2014) and the Godin Leisure-Time Exercise Questionnaire (GLTEQ) (Goding 1997), as adapted from previous research (Rias 2020). The physical activity measurement tools used in this study, including the modified Physical Activity Guidelines for Americans and the Godin Leisure-Time Exercise Questionnaire (GLTEQ), are known for their validity and reliability internationally. However, there is limited information on their specific validation within the Indonesian population. While the GLTEQ has been effective in various settings, it may require adaptation to ensure cultural relevance for Indonesian participants. Conducting localized pilot testing would help confirm that the questionnaire accurately captures physical activity patterns in this context. Overall, while the tools meet international standards, further validation in Indonesia would enhance their effectiveness and reliability.

The physical activity assessment captured data on the type, duration (in minutes), and intensity of physical activity performed during a typical week. Physical activity was categorized as (1) Light activity (e.g., yoga, floor sweeping); (2) Moderate activity (e.g., gym, badminton); Vigorous activity (e.g., running). The total weekly metabolic equivalent of task (MET)-hours was calculated for each participant. Light, moderate, and vigorous activities were weighted as 3, 5, and 9 METs, respectively. Participants were classified into five categories based on total MET-hr/week: Very high (≥ 25.50 MET-hr/week); High (16.50–25.49 MET-hr/week); Moderate (7.50–16.49 MET-hr/week); Low (3.75–7.49 MET-hr/week); Inactive (< 3.75 MET-hr/week) (Godin & Shephard 1997, Shiroma et al. 2014). All data on physical activity were collected by trained research assistants.

Body Mass Index (BMI)

BMI was calculated to assess body weight relative to height using the formula: weight in kilograms divided by the square of height in meters. BMI values were categorized into two groups: high BMI, defined as greater than 24.9 kg/m², indicating overweight or obesity; and low BMI, defined as less than or equal to 24.9 kg/m², indicating normal or underweight status. This method of computation and categorization follows the guidelines established by the World Health Organization (WHO 2000).

The decision to use a BMI cutoff of ≥24.9 kg/m² instead of the standard WHO threshold of ≥25 kg/m² is based on several factors. Research shows that health risks, such as heart disease and diabetes, can increase even at lower BMI levels, especially in certain populations. This adjusted cutoff allows for earlier identification and management of individuals at risk, which can support more effective public health initiatives. Additionally, it aligns with findings from other organizations that recognize the need for a more tailored approach to different demographics, ensuring that preventive measures are directed toward those who may be vulnerable at lower BMI thresholds.

Data analysis

Data completeness was checked before analysis. Statistical analysis was conducted using SPSS version 25.0 (Chicago, IL, USA). The data included numerical variables (e.g., age, diastolic and systolic blood pressure, BMI) and categorical variables (e.g., education level, smoking status, and genetics). Continuous variables were classified based on a previous study (Kurniasari 2021) Chi-square (X^2) tests were used to assess differences in participant characteristics between the case and control groups.

Univariate analysis was performed to identify significant covariates, including educational level, genetics, systolic blood pressure, smoking status, BMI, and physical activity. Logistic regression analysis was conducted to calculate unadjusted odds ratios (ORs) and adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The multivariate logistic regression model controlled for confounding factors, such as educational level, family history, diastolic blood pressure, and smoking status.

To examine the synergistic effect of BMI (≥ 24.9 kg/m²) and physical activity (> 7.5 MET-hr/week), four dummy variables were created to represent the following conditions: (1) Reference group: BMI of 24.9 kg/m² and physical activity of 7.5 MET-hr/week (00); (2) BMI of 24.9 kg/m² and physical activity > 7.5 MET-hr/week (10); BMI ≥ 24.9 kg/m² and physical activity of 7.5 MET-hr/week (10) (4) Synergistic group: BMI ≥ 24.9 kg/m² and physical activity of > 7.5 MET-hr/week. The additive interaction (synergistic effect) was categorized as: (1) No interaction: ($\beta 11 = \beta 01 + \beta 10$); (2) Positive interaction: ($\beta 11 > \beta 01 + \beta 10$) - indicates synergy; Negative interaction: ($\beta 11 < \beta 01 + \beta 10$) - indicates antagonism. Statistical significance was set at $p < 0.05$.

RESULTS

Participant Characteristics

Significant differences were observed between the gout arthritis group and the control group with respect to educational level, family history, diastolic blood pressure, and smoking status. However, there were no significant differences in gender, marital status, employment, income, alcohol consumption, hypertension comorbidity, systolic blood pressure, level of knowledge, or age between the two groups (Table 1). These findings suggest that certain sociodemographic and health-related factors may contribute to the risk of gout arthritis.

Table 1. Distribution of demographic characteristics of participants (n = 105)

Characteristic	Control Group (n = 57)		Gout Group (n = 48)		*p*
	n/M	%/SD)	n/M	% (SD)	
Gender					
Female	37	64.90	30	63.80	0.84 [a]
Male	20	35.10	18	37.50	
Marital status					
Not married	2	3.50	4	8.30	0.40 [a]
Married	55	95.50	44	91.70	
Education level					
High	2	3.50	8	16.70	0.04[a]
Low	55	96.50	40	83.30	
Income					
High	8	14	7	14.60	0.56 [a]
Low	49	86	41	85.40	
Occupation					
Yes	33	57.90	29	60.40	0.84 [a]
No	24	44.10	19	39.60	
Genetic					
No	25	43.90	11	22.90	0.02 [a]
Yes	32	56.10	37	77.10	
Alcohol consumption					
Non-drinker	38	66.70	25	52.10	0.09 [a]
Drinker	19	33.30	23	47.90	
Comorbidity: Hypertension					
No	41	71.90	26	54.20	0.06 [a]
Yes	16	28.10	22	45.80	
Systolic pressure					
< 131mmHg	20	35.10	11	22.90	0.20 [a]
≥ 131 mmHg	37	64.90	37	77.10	
Diastolic pressure					
< 80 mmHg	30	52.60	11	22.90	<0.01 [a]
≥ 80 mmHg	27	47.40	37	77.10	
Smoking status					
Non-smoker	15	26.30	6	12.50	
Passive smoker	20	35.10	28	58.30	0.04 [a]
Active smoker	22	38.60	14	29.20	
Level of Knowledge					
High	2	3.5	3	6.3	0.65 [a]
Low	55	96.5	45	93.6	
Age (years old) (Mean ± SD)	54.46	11.33	56	11.69	0.19 [b]

Note. [a] = X^2 test; [b] = t-test; BMI: bodymass index; n = total number of participants; % = percentage; SD = standard deviation.

Distribution of BMI and Physical Activity

Table 2 shows the distribution of potential risk factors for gout arthritis between the gout group and the control group. BMI was significantly associated with the risk of gout arthritis (p < 0.001), with a higher proportion of gout arthritis observed among participants with a BMI ≥ 24.9 kg/m² compared to those with a BMI < 24.9 kg/m². Similarly, physical activity was also significantly associated with the risk of gout arthritis (p = 0.04). Participants with lower physical activity levels (< 7.5 MET-hr/week) were more likely to have gout arthritis compared to those with higher physical activity levels (≥ 7.5 MET-hr/week).

Table 2. Distribution of potential risk factors between participants in the gout group and control group (n = 105)

Variable	Gout Group (n = 57)		Control Group (n = 48)		*p*
	n	%	n	%	
BMI					
≥ 24.9 kg/m²	44	77.20	16	33.30	< .001
< 24.9 kg/m²	13	22.80	32	66.70	
Physical activity					
≥ 7.5 MET-hr/week	12	37.50	13	17.80	.04
< 7.5 MET-hr/week	20	62.50	60	82.20	

Note. The X2 was used to compare between groups; BMI: body mass index.

BMI and Physical Activity as Risk Factors for Gout Arthritis

The results of the logistic regression analysis for BMI and physical activity as risk factors for gout arthritis. Participants with a BMI ≥ 24.9 kg/m² were 4.78 times more likely to develop gout arthritis than those with a BMI < 24.9 kg/m² (AOR = 4.78; 95% CI = 1.73–13.23; p < 0.01). The unadjusted odds ratio (OR) was also high (OR = 6.76), but after controlling for confounding factors, the adjusted odds ratio (AOR) revealed a more precise estimate of the association.

For physical activity, participants who engaged in less than 7.5 MET-hr/week of physical activity were 3.35 times more likely to develop gout arthritis compared to participants who engaged in 7.5 MET-hr/week or more of physical activity (AOR = 3.35; 95% CI = 1.06–10.53; p < 0.05). These findings suggest that both high BMI and low physical activity are significant and independent risk factors for gout arthritis.

Synergistic Effect of BMI and Physical Activity on Gout Arthritis Risk

The results illustrates that the synergistic effect of BMI and physical activity on the risk of gout arthritis. Participants with a BMI ≥ 24.9 kg/m² and physical activity < 7.5 MET-hr/week had a 6.7 times higher likelihood of developing gout arthritis compared to participants with a BMI ≤ 24.9 kg/m² and physical activity ≥ 7.5 MET-hr/week (AOR = 6.70; 95% CI = 1.49–29.95; p < 0.05).

The analysis controlled for confounding factors, including educational level, family history, comorbidity of hypertension, systolic blood pressure, and smoking status. The significant interaction effect suggests that the combination of high BMI and low physical activity produces a greater risk of gout arthritis than would be expected from the individual effects of these factors alone. This positive interaction reveals a synergistic relationship between BMI and physical activity, which highlights the importance of addressing both factors simultaneously in public health interventions.

In addition, genetic predisposition showed a significant difference between the groups (p = 0.02), with a higher percentage of individuals in the gout group having a family history of gout (77.10% vs. 56.10% in the control group), an underlying biological mechanism linking genetic factors to gout arthritis. Genetic predisposition may affect uric acid metabolism and excretion, thereby increasing the risk of hyperuricemia and subsequent gout development. Furthermore, a significant difference in diastolic blood pressure ($p < 0.01$) indicated that individuals in the gout group had a higher prevalence of high diastolic pressure (77.10% vs. 47.40% in the control group). High diastolic blood pressure may indicate underlying cardiovascular problems or metabolic syndrome, which are often associated with gout. Understanding how these conditions interact with gout pathology may provide valuable insights into the etiology of the disease.

The underlying biological mechanism interaction between Body Mass Index (BMI) and physical activity in the context of gouty arthritis is that higher BMI is associated with increased adipose tissue, which secretes pro-inflammatory cytokines that can increase systemic inflammation. This inflammation can lead to increased uric acid production and decreased renal clearance, both of which are important factors in the development of gout. In addition, low levels of physical activity contribute to metabolic dysfunction and insulin resistance, which further exacerbate the risk of hyperuricemia. Together, high BMI and low physical activity create a synergistic effect that significantly increases the likelihood of developing gouty arthritis.

DISCUSSION

This study is the first case-control study to examine the relationship between the BMI and physical activity particularly in the western region of Indonesia. The results of this study highlight the complex interplay between sociodemographic factors, health-related factors and the complex interplay between the BMI of ≥ 24.9 kg/m2 and physical activity < 7.5 MET-hr/week in increasing the risk of gout arthritis.

The results reveal that sociodemographic factors such as educational level and family history, as well as health-related factors like diastolic blood pressure and smoking status, significantly contribute to the risk of gout arthritis. These findings align with previous studies, which indicate that lower educational attainment is often linked to poorer health outcomes, including obesity and chronic diseases that exacerbate gout risk. Moreover, the role of family history underscores a genetic predisposition to gout arthritis, which interacts with lifestyle factors to increase susceptibility (Kurniasari 2021 & Nguyen 2017).

The association between BMI and gout arthritis is particularly notable. Participants with a BMI greater than 24.9 kg/m² were 4.78 times more likely to develop gout arthritis, underscoring the role of obesity as a key risk factor. This finding corroborates earlier research that links high BMI to hyperuricemia, a precursor to gout attacks (Jin 2024 & Hu 2021). Obesity contributes to hyperuricemia by increasing serum uric acid levels, driven by hyperinsulinemia and reduced renal clearance. These mechanisms are consistent with the findings of Sheng (2020), who identified a strong inverse correlation between visceral fat and renal vein saturation (Sheng 2020). Public health strategies that target weight management, as recommended by the American College of Rheumatology, remain essential in mitigating the risk of gout (Yeo 2019 & Nielsen 2017).

Physical activity emerged as another significant factor, with participants engaging in less than 7.5 MET-hr/week of physical activity being 3.35 times more likely to develop gout arthritis. This aligns with prior studies highlighting the protective role of physical activity against chronic diseases, including gout (Guglielmo 2021 & Elmagboul 2020). Regular exercise lowers serum uric acid levels, reduces systemic inflammation, and improves metabolic health (Jablonski 2020). Moreover, studies by William et al. and Yokose et al. showed that individuals with higher daily running distances or faster walking speeds had a significantly lower risk of developing gout arthritis (Williams 2008 & Yokose 2021).

The synergistic effect of high BMI and low physical activity is particularly striking. Participants with both risk factors (BMI ≥ 24.9 kg/m² and physical activity < 7.5 MET-hr/week) were 6.7 times more likely to develop gout arthritis than those with neither risk factor. This finding aligns with previous research indicating that obesity and sedentary behavior amplify the risk of metabolic disorders, including gout (Yeo 2019 & Mao 2024). The interplay between obesity and physical inactivity can be understood through several physiological mechanisms, particularly those involving insulin resistance and the secretion of adipokines.

Insulin resistance, a common consequence of obesity, plays a significant role in the accumulation of uric acid. When the body becomes resistant to insulin, the kidneys may become less efficient at excreting uric acid, leading to hyperuricemia. Elevated levels of insulin can further stimulate the renal reabsorption of uric acid, compounding its accumulation in the bloodstream. This excess uric acid can crystallize in joints, triggering the inflammatory response characteristic of gout arthritis.

Additionally, adipose tissue is not merely a passive store of energy; it is an active endocrine organ that secretes various substances known as adipokines. In obesity, there is an alteration in the profile of these adipokines, which can exacerbate inflammation. For instance, increased levels of pro-inflammatory adipokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), can promote inflammatory pathways in the body. This heightened inflammatory state not only contributes to the pathogenesis of gout but also impairs the body's ability to process and clear uric acid effectively.

Considering that the physical activities were associated with an acute pro-inflammatory response (Brown 2018), they served as a physiologically responsible chronic daily inflammatory exposure and produced immune tolerance to MSU crystal induction in synovium. These findings suggest that exercises decreased the TLR2 expression and inflammasome priming, resulting in a tolerogenic effect and a reduction in the inflammatory response (Brown 2018).

Physical activity enhances insulin sensitivity and reduces circulating levels of inflammatory adipokines, which collectively may contribute to lower uric acid levels and reduced gout flares.

Interventions that address both weight reduction and increased physical activity simultaneously could have a compounded effect in reducing gout incidence.

Obesity-induced hyperuricemia contributes to gout through several mechanisms. Excess adipose tissue produces pro-inflammatory cytokines, increases reactive oxygen species (ROS) production, and reduces antioxidant levels, all of which impair renal excretion of uric acid (Sheng 2020). This imbalance in uric acid metabolism leads to its crystallization and deposition in joints, triggering inflammatory responses (Jia 2022). Additionally, physical activity mitigates these processes by reducing systemic inflammation and fostering immune tolerance to monosodium urate crystals (Jablonski 2020).

This study's retrospective case-control design limits the ability to establish causal relationships. Additionally, the reliance on self-reported physical activity data introduces potential recall bias. However, the inclusion of newly diagnosed gout arthritis cases based on validated criteria by the Indonesian Rheumatology Association strengthens the study's reliability (Indonesian Rheumatology Association 2018).

The findings emphasize the need for targeted public health interventions focusing on lifestyle modifications, including weight management and regular physical activity, to reduce the burden of gout arthritis. Health education campaigns should address the importance of maintaining an optimal BMI and engaging in physical activity as recommended by the Indonesian Rheumatology Association (3-5 times per week, 30-60 minutes per session). These measures could significantly reduce the risk of gout arthritis and its associated comorbidities in at-risk populations.

CONCLUSION AND SUGGESTIONS

Conclusion

The gout arthritis is associated with a BMI (≥ 24.9 kg/m2) and the lower physical activity. After controlling the covariates, both have a synergistic effect in increasing the risk of developing the gout arthritis.

Suggestion

As a result, it is suggested to implement targeted educational campaigns that raise awareness about the risks of high body mass index (BMI) and low physical activity in relation to gout arthritis. These campaigns should include regular BMI screenings to identify at-risk individuals and provide personalized interventions that promote healthier lifestyle choices. Additionally, creating community programs that enhance access to parks and recreational facilities can encourage more physical activity among residents. By adopting these strategies, public health policies can effectively reduce the incidence of gout arthritis and promote overall community health.

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