



The impact of vegan diet for 21 days on blood uric acid level in adults

Pengaruh diet vegan selama 21 hari terhadap kadar asam urat dalam darah pada dewasa

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Article History:

Received: November 13, 2024; Revised: November 30, 2024; Accepted: March 05, 2025; Published: June 12, 2025.

Publisher:



Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

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Abstract

One of the risk factors for hyperuricemia is consumption of purine-rich foods. Plant-based sources, such as nuts and legumes, have high amount of purine, in which it is commonly consumed by vegan's. The aim of this study is to examine the impact of vegan diet for 21 days on serum uric acid (UA) levels. This research used cross-sectional design. Data were collected from secondary data in Jingsi Books and Café, from October 2021 until January 2022. The population of the study is derived from 21 days vegan diet program by Tzu Chi Buddhist Association with total sample of 95 by using total sampling method. The data in this study is grouped according to age (<50 and ≥50 years old), gender, and both. The statistical test that is used is paired T-tests. The results showed that serum UA (mg/dl) increased in female (both age groups) and male <50 years old with increased mean 0,3, 0,2, and 0,4. For male aged ≥50 years old, there's reduction in serum UA with reduction mean 0,1. The result is clinically significant with p-value 0,001. In conclusion, 21-day vegan diet increases serum UA levels in all populations, except for male ≥50 years old.

Keywords: 21 day vegan diet, serum UA, female, male

Abstrak

Faktor risiko yang dapat mendasari terjadinya hiperurisemia adalah pengonsumsi makanan yang tinggi purin. Makanan yang tinggi akan purin dari nabati seperti kacang dan polong, umumnya dikonsumsi oleh populasi berdiet vegan. Tujuan penelitian ini adalah untuk mengkaji pengaruh diet vegan selama 21 hari terhadap kadar asam urat dalam darah. Desain penelitian ini adalah *cross sectional*. Data diperoleh dari data sekunder dari Jingsi *Books and Café*, dari Oktober 2021 sampai Januari 2022. Populasi studi diperoleh dari program diet vegan selama 21 hari yang diselenggarakan oleh Yayasan Buddha Tzu Chi dengan total sampel 95 dengan teknik pengambilan sampel yang digunakan ialah *total sampling*. Data dari penelitian ini dikelompokkan berdasarkan usia (<50 dan ≥50 tahun), jenis kelamin, dan keduanya. Jenis statistik yang digunakan pada studi ini ialah tes T berpasangan. Hasil menunjukkan bahwa kadar asam urat meningkat pada perempuan (pada kedua kelompok usia) dan pada pria <50 tahun, dengan peningkatan mean 0,269, 0,17, dan 0,37. Sedangkan pada pria ≥50 tahun, terjadi penurunan kadar asam urat dengan pengurangan mean 0,09. Hasil ini bermakna secara klinis karena nilai p sebesar 0,001. Kesimpulan: diet vegan selama 21 hari meningkatkan kadar asam urat dalam darah pada semua populasi, kecuali pada populasi pria ≥50 tahun.

Kata Kunci: diet vegan selama 21 hari, asam urat serum, pria, wanita

Introduction

The incidence of hyperuricemia has always been increasing every year, with the prevalence of

hyperuricemia in Indonesia is 1-4% (Yusuf Alkandahri & Sukandar, 2024). The risk factor for hyperuricemia is male, age >50 years, history of eating rich purine foods, and occupation

(Meiyetrian et al., 2018). In females, estrogen can increase UA clearance and reduce its reabsorption in the tubule. This is why male is more prone to hyperuricemia than female (Lin et al., 2019).

Uric acid (UA) causes many diseases such as arthritis and gout, and is thought to play a role in the progression of metabolic syndrome. However, UA is a potent antioxidant that is necessary for the activation of immune response type 2. UA is derived from endogenous and exogenous sources. Its endogenous origin is the liver, intestine, muscle, kidney, and endothelium. Meanwhile, the exogenous origin is rich purine foods (El Ridi & Tallima, 2017). Purine is a precursor of UA. Some types of animal and plant products are abundant in purines. Animal products tend to contain an abundant amount of purine, especially in the internal organs. The exception for this is dairy and egg products (Wu et al., 2019). Meanwhile, the plant product that is high in purine is spinach, broccoli, soy, and legumes (Jakše et al., 2019). In vegan diet, although there are no animal products consumption, this population consume enormous amount of soy and legumes (Radnitz et al., 2015).

In Indonesia, approximately 2 million people have adopted vegetarian (VEG) or vegan diets. While these data may be diminutive, compared to 260 million people in Indonesia, today veganism has grown in popularity. It can be seen from the shifting usage of animal-based product to plant-based product (Arwanto et al., 2022).

Vegan diet is associated with weight reduction, lower low-density lipoprotein (LDL) and risk of chronic diseases, such as hypertension, diabetes mellitus (DM), cardiovascular disease, and some type of cancer (Wang et al., 2023). Although the vegan diet has numerous benefits, it has some drawbacks. Based on the research by Selinger et al. (2023), vegan diet increased the risk of fracture. Furthermore, vegans have been found to have higher UA levels than those who adhere to VEG and omnivorous (OMN) diets. People who adopt vegan diet also have tendency to develop hyperuricemia compared to diet that still consume fish (Beydoun et al., 2018).

The comparison of UA level in individual with vegan diet vs VEG vs OMN is 5,71 : 5,09 : 5,29 mg/dL in male and 4,05 : 3,86 : 3,98 mg/dL in female (Jakše et al., 2019). Besides that, based on the research that is conducted by Jian et al.

(2015), UA level has been found to be the highest in non-VEG diet ($5,6 \pm 1,5$ mg/dL), followed by vegan ($5,5 \pm 1,5$ mg/dL), and lastly followed by lacto-ovo-vegetarian (LOV) diet ($5,3 \pm 1,5$ mg/dL). The higher UA level in vegan diet may result from the higher consumption of legume, grain, and mushroom that is high not only in protein but also in purine (Menzel et al., 2020).

While there is evidence that a vegan diet can increase the risk of hyperuricemia, there is also some evidence that a vegan diet can protect against hyperuricemia. In research conducted by Chiu et al. (2015), the study sample that adhere to LOV diet had the lowest UA concentration, followed by vegan and OMN. In male, the comparison between UA level is 6,05:6,19:6,32 mg/dL, and in female 4,92:4,96:5,11 mg/dL.

There are still contrasting results, and research that addresses this issue is minimal. Theoretically, researchers believe that a vegan diet for 21 days would increase UA levels. Therefore, the purpose of this study was to further explore the impact of 21 days vegan diet on blood UA levels.

Methods

The study used a cross-sectional design of a 21-day vegan diet program held by the Tzu Chi Buddhist Association at Jingsi Books & Café, Medan City, North Sumatra. The total population in this study consisted of three different batches of diets, namely, on October 2–22, 2021 (40 people), October 22–November 14, 2021 (15 people), and January 3–24, 2022 (40 people). A total of 95 people were selected from three different batches. Subjects who participated in this diet program are the general public who have an interest in vegan diets and want to be healthier.

The dependent variable in this study was UA level. The independent variable was a vegan diet for 21 days. In addition, there are intervening variables, such as age and sex. The study data were obtained via secondary data from Jati Junction Books and Café Medan, which are branches of the Tzu Chi Buddhist Association Medan center.

After collecting the data, there was an inclusion and exclusion criterion for the data, which may cause bias in this study. The inclusion criterion was a research subject that checked their UA level in the Bunda Thamrin Clinic

Laboratorium and subjects who finished the 21 day vegan diet without eating animal-based products. In the Bunda Thamrin Clinic Laboratories, the method used to measure UA in blood is an enzymatic colorimetric test using uricase. Before examination, calibration was performed to prevent examination errors. The participants were instructed to fast before examination. Meanwhile, the exclusion criteria in this research were subjects who did not test their UA levels on the same day as another research subject. A total of 21 people had missing data on both pre and post 21 days vegan diet, while the 8 others did not test their UA levels at the same time as the others. Hence, the total population of this study was 95.

Because there is a limitation of population data that followed this diet program, this study used the total sampling method. The data limitation in this study was caused by the enormous amount of money spent on this diet program. To participate in this program, an individual needs to pay 4.400.000 Rupiah for both food and laboratory packages.

This research also underwent ethical clearance from the Ethical Committee for Health Research at the University of North Sumatra and has an ethical number of 757/KEPK/USU/2023. In addition, the Tzu Chi Buddhist Association approved the 21 days diet vegan program data to be used in this study (No: 010/TCI/MDN/X/2023). Before we started this study, informed consent to the 21 days diet participant was also provided, in which the participant agreed to give their laboratory data without mentioning their name in the research. The secondary data that the author analyzed in the statistical software was initially used to prevent privacy violations of the study participants.

After sampling, the data were analyzed using univariate and bivariate analyses. Univariate analysis was performed to determine the frequencies of age and sex. In addition, bivariate analysis was used to determine the impact of the vegan diet for 21 days on the UA level with adjustment for age (<50 and ≥50 years), sex, and both. A bivariate analysis was performed using a paired T test. This was used to compare the means of the two paired samples. To use this analytical test, the normality test (Kolmogorov-Smirnov) and homogeneity test (Levenne Homogeneity test) were conducted. A p-value higher than 0,05 in both tests indicates that the data are normally distributed (normality test) and have homogen variation.

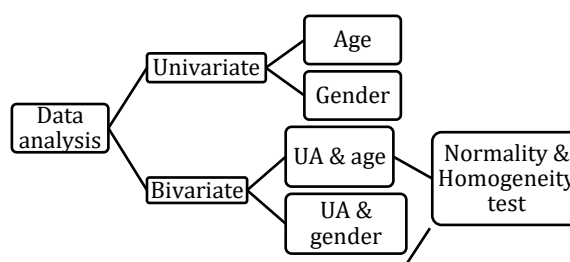


Figure 1. Research analysis

In this study, the Kolmogorov-Smirnov test had a p value of 0,2 for the UA level before the vegan diet in females and for the UA level after the vegan diet in both females and males. In addition, the p value for UA level before the vegan diet in male was 0,174. In conclusion, this study's data were normally distributed. The homogeneity test was used, and the p value in this study was 0,342 for the UA level before the vegan diet based on both mean and median. Meanwhile, the p-value for UA level after the vegan diet was 0,251 based on the mean and 0,269 based on the median. In conclusion, this study has a homogeneous variation, which means that this study has already fulfilled the requirement of using a paired T test for its analytical test. The paired T test with 95% CI was used in this study. After the analytical test, the conclusions of the data were obtained.

Table 1. Kolmogorov-Smirnov & Levenne test

Variable	Gender	df	p-value
UA level before	Female	71	0,200
	Male	24	0,174
	Based on Mean	0,913*	0,342
	Based on Median	0,910*	0,342
UA level after	Female	71	0,200
	Male	24	0,200
	Based on Mean	1,332*	0,251
	Based on Median	1,236*	0,269

*States Levenne statistics result

Result and Discussion

The average age that followed this diet program was 46,1 and the average age of both males and female was 44,9 and 46,5, respectively. Meanwhile, 71 participants were female and 24 were male.

Table 2. Research subject demographical characteristic

Variable	n	Mean Age	Std. Deviation (age)
Age (y.o)	95	46,1	12,27
Sex			
Female	71	46,5	12,40
Male	24	44,9	12,03
Age and gender adjustment			
Female and <50 years old	39	38,2	9,73
Female and ≥50 years old	32	56,6	6,36
Male and <50 years old	17	39,1	7,88
Male and ≥50 years old	7	59,0	7,96

There were significant differences between the male and female populations that participated in this study. Female have been found to be more likely to be vegan (2:1) than male (Modlinska et al., 2020). Females are associated with lower meat consumption and are more open to consuming plant-based diets. In contrast, males are associated with an increased amount of meat that is consumed and unwilling to eat plant-based diet food. The studies about reducing meat consumption that has been conducted, has also provided the data, shows that 37,1% study population markedly biased to female participant, while only 5,6%

markedly biased to male participant (Graça et al., 2019).

For variables such as sex and UA, it was found that both sexes had higher UA levels after a vegan diet for 21 days. In this study, there was an increase in UA levels in both female and male. The increase in UA levels is thought to be caused by the high amount of purine consumed by the population that adopts the vegan diet. The majority of food that is eaten by vegan diet population is fruit, vegetable, legumes, soya product, nuts, and seed (Bakaloudi et al., 2021).

Table 3. Impact of vegan diet for 21 days on UA level (mg/dl) with gender adjustment

Variable	Mean	Median	Std. Deviation
Female			
Before	4,9	4,9	0,14
After	5,1	5,0	0,26
Male			
Before	6,7	6,6	0,14
After	6,9	7,0	0,29

Based on the research by Hafez et al. (2017), the purine content (mg/100 gram) in dried Boletus mushroom 488 mg, dried white bean 128, dried lentils 127, soya 190, bean sprouts 80, and whole grain oat 94. While these data on UA content maybe lower than that of animal product (especially meat and animal internal organs), the average organ meat consumption is only 1,3 g/1,000 kcal (Zhang et al., 2022). Besides that, there's still many type of food that is lower in UA that OMN can consume, such as dairy and eggs that vegan diet population can't consume (Wu et al., 2019).

Table 4. Impact of vegan diet for 21 days on UA level with gender and age adjustment

Subject	UA (mg/dL)		Δ Mean $\pm$ SD	Lower – Upper 95% CI	p-value
	Mean	SD			
Female (Age <50 years old)					
Before	4,8	1,27	4,8 $\pm$ 1,27	4,389-5,210	0,001
After	5,1	1,23	5,1 $\pm$ 1,23	4,669-5,469	0,001
Female (Age ≥50 years old)					
Before	4,9	1,02	4,9 $\pm$ 1,02	4,597-5,334	0,001
After	5,1	1,05	5,1 $\pm$ 1,05	4,759-5,515	0,001
Male (Age <50 years old)					
Before vegan diet	5,8	1,25	5,8 $\pm$ 1,25	5,114-6,403	0,001
After vegan diet	6,1	1,39	6,1 $\pm$ 1,39	5,408-6,839	0,001
Male (Age ≥50 years old)					
Before vegan diet	5,5	1,42	5,5 $\pm$ 1,42	4,213-6,844	0,001
After vegan diet	5,4	1,41	5,4 $\pm$ 1,41	4,136-6,749	0,001

With the adjustment of age and sex (female), the vegan diet for 21 days increased UA levels in both age groups. Adjustment of sex (female) and age for the vegan diet for 21 days significantly changed the UA level ($p = 0,001$). For the male population, a vegan diet for 21 days has been found to increase UA levels in populations aged <50 years. In contrast, a vegan diet for 21 days has been found to positively impact UA levels in populations ≥ 50 years old. Adjustment of sex (male) and age for the vegan diet for 21 days significantly changed the UA level ($p = 0,001$).

While there's a linearly increasing incidence of hyperuricemia for age in man, in female, UA level has been founded to be relatively stable until 50 years old. After hitting the age of 50, the incidence of hyperuricemia in female will increase drastically and exceed the incidence of hyperuricemia in male in age higher than 65 (Zitt et al., 2020).

The higher level of UA in patients aged ≥ 50 years and in the female population is mostly caused by hormonal effects on metabolism. This event is mostly caused by menopause and usually occurs at 51 years of age. This result is in line with the research by Zahro & Rosidah (2021), in which, it is stated that menopausal female will be more likely to have high UA level, with the incidence as much as 50% of the research subject, as much as 45% have a normal UA level, and as much as 5% subject have low UA level. In menopause, there's a change in hormonal level, such as significantly decline in estrogen level (Ko & Kim, 2020). It's shown that estrogen level reduction start from 8 years before menopause, decreased significantly 2 years before menopause, and stable at lower level 2 years after menopause (Qiaoyun et al., 2024). Estrogen has been known for its function to increase metabolism rate (Trenti et al., 2018). Estrogen has also been shown to influence UA levels by modulating excretion via the kidneys. Estradiol, also known as E2, is also known to have drastically dropped when a female is in its perimenopausal period. It increase UA metabolism by its mechanism via increasing GLUT9 and URAT1, and increased UA excretion from kidney (Zahro & Rosidah, 2021).

In the renal proximal tubule, there is a transporter for UA reabsorption called URAT1 and GLUT 9. Xanthine, a UA precursor, is a substrate for both the URAT1 and GLUT9 transporters. While xanthine is a substrate, its derivative hypoxanthine is not a substrate for

either of these receptors. However, hypoxanthine can affect xanthine levels in the blood by converting it to xanthine via xanthine oxidase enzyme. URAT1 transports both xanthine and UA from the renal lumen to the cells. GLUT9 facilitates the transport of xanthine and UA to the blood. In conclusion, an increase in GLUT9 and URAT1 level in perimenopausal female will cause a condition that is favorable to hyperuricemia state (Arakawa et al., 2020; Chen et al., 2016).

This biomechanism of how E2 affects UA levels is in line with the results of the present study. It was shown that in female <50 years old had lower UA both before and after 21 days of a vegan diet (before: 4,8 mg/dl and: 5,1 mg/dl). On the other hand, female ≥ 50 years had higher UA (before: 4,9 mg/dl and: 5,1 mg/dl).

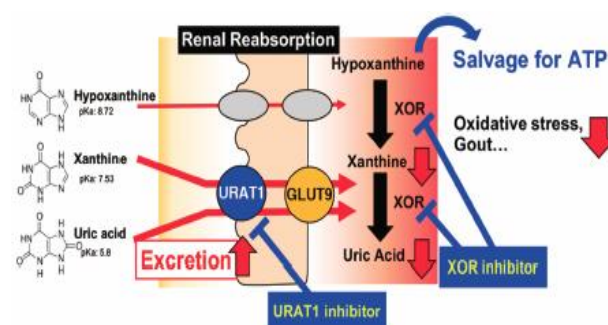


Figure 2. URAT1 and GLUT9 mechanism as UA transporter (Arakawa et al., 2020).

In this study, there was a higher level of UA in male <50 years than male ≥ 50 years old in this research. Based on the research by Tsai et al. (2022), increasing age is associated with lower testosterone level. Higher age has also been linked to increased UA levels, which is likely caused by lower testosterone levels in older age groups. A testosterone level < 400 ng/dL is associated with hyperuricemia (≥ 7 mg/dL, hazard ratio [HR]: 1,182 and ≥ 9 mg/dL, HR: 1,905]. This result was not in line with this study, the older population group have had lower UA level than younger population group (6,1:5,4 mg/dl after vegan diet for 21 days).

Testosterone has been hypothesized to play a role in insulin resistance, except in renal tissue. Systemic insulin resistance leads to pancreatic hypersecretions. This causes the insulin levels to increase in the blood. Insulin binds to its receptor in the kidney and enhances the reabsorption of urate. It inhibits UA secretion in renal tubules. Hence, it will lead to an increase of UA in serum (Bac et al., 2023).

Based on data from Kanabar et al. (2022), testosterone level was founded to be highest in 19-21 years old male population. This level slowly decreased until the population reached 30 years of age. After that, testosterone level will significantly drop until it increases significantly at the age of 40 years. The testosterone level slightly decreased at the age of 43-48 then will increase again until the male reached 54. Subsequently, testosterone levels tended to decrease slowly until the age of 69 years. There is an increase in testosterone level at 70-72 years old. Subsequently, it decreased slowly. This upward and downward trend in testosterone levels occurs throughout male life.

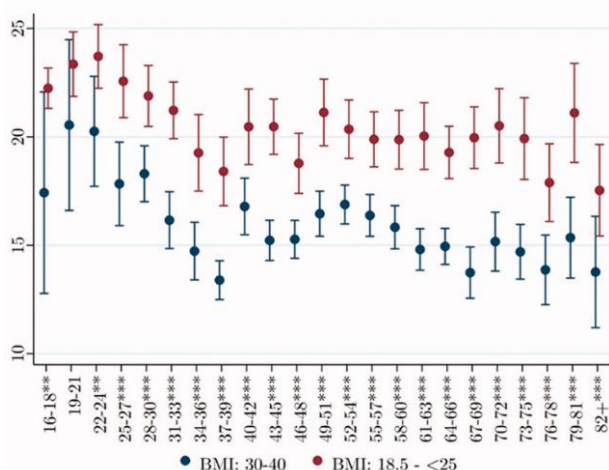


Figure 3. Testosterone level in different age groups (Kanabar et al., 2022)

In this study, the mean age of male <50 years was 39 years, and the mean age of male ≥50 years was 59. In this graph, we can see that the testosterone level in 39 years old age group (10-15 nmol/L) was significantly lower than that of 59 years old age group (15-20 nmol/L). This is why the population group that is male and aged ≥50 years has a lower UA level than male and those aged <50 years.

While the data have been proven to be clinically significant, limitations such as limited data on male ≥50 years old, the differences in participant physical activity, dietary pattern before the program, and hydration have not yet been noted in the diet program. Changes in UA levels over the long-term period are unknown because there was no follow-up research after the diet program ended.

Conclusion

In conclusion, a vegan diet for 21 days increased UA levels, with statistically significant results in both males and females. With the adjustment for age and sex, the vegan diet for 21 days also increased UA levels in both population groups, except for males, and the population aged ≥ 50 years had reduced UA levels. This result may be due to data limitations in the population of male aged ≥50 years. Further research is needed to prove that the vegan diet is indeed negatively correlated with UA levels.

Before the diet program is conducted, the subject's diet type, occupation, lifestyle, and habits should be documented. After 21 days of the vegan diet program, the types of physical activity and hydration should also be documented to prevent data bias in future studies. A larger sample size is also preferable to prove the credibility of the study.

Acknowledgements

We thank all the related parties who assisted in the process of this research. Special thanks to all lecturers, especially Dr. Fitriyani Nasution, Sp.GK, dr. Cut Adeya Adella, Sp.OG (K), and dr. Tetty Aman Nasution, M.Med.Sc that assisted and helped researcher to finish the process of this study. Special thanks to all the staff in Faculty Medicine, University of North Sumatra, Medan, for their efforts and assistance in gaining ethical clearance for this study. Finally, we thank the Tzu Chi Buddhist Association for providing the data used in this study and Mrs. Sylvia Chuwardi as the head of 21 days vegan diet challenge.

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