

Correlation Between High Serum Uric Acid Levels with Occurrence of Diabetic Peripheral Neuropathy in Patients with Type 2 Diabetes Mellitus in Soetomo General Hospital

by Deasy Putri Sukarno

Submission date: 18-Aug-2020 04:22PM (UTC+0800)

Submission ID: 1370939052

File name: Correlation_Between_High_Serum_Uric_Acid.pdf (134.72K)

Word count: 5132

Character count: 27096

1 ИЗУЧЕНИЕ ВЛИЯНИЯ ПОВЫШЕННОГО СОДЕРЖАНИЯ МОЧЕВОЙ КИСЛОТЫ В СЫВОРОТКЕ КРОВИ НА ВЕРОЯТНОСТЬ ВОЗНИКНОВЕНИЯ ДИАБЕТИЧЕСКОЙ ПЕРИФЕРИЧЕСКОЙ НЕЙРОПАТИИ У ПАЦИЕНТОВ С САХАРНЫМ ДИАБЕТОМ 2 ТИПА В ГОСПИТАЛЕ СОЕТОМО



© Deasy Putri Sukarno^{1,2}, Muhammad Hamdan^{1,2}, Fidiana^{1,2}, Fadil^{1,2}, Mudjiani Basuki^{1,2}

¹Soetomo General Hospital, Сурабая, Индонезия

²Universitas Airlangga, Сурабая, Индонезия

АКТУАЛЬНОСТЬ. Повышенное содержание мочевой кислоты (МК) в сыворотке крови при сахарном диабете 2 типа ассоциировано с высокой вероятностью макрососудистых осложнений. Однако зависимость между уровнем МК в сыворотке и риском развития диабетической периферической нейропатии до сих пор полностью не изучена.

ЦЕЛЬ. Целью данного исследования было изучение корреляции между повышенной концентрацией МК в сыворотке и диабетической периферической нейропатией.

МЕТОДЫ. В данное исследование, спланированное по типу «случай-контроль», включались последовательные пациенты в соответствии с принятыми критериями включения/исключения. Диагностику диабетической периферической нейропатии проводили с помощью электронейромиографии (ЭНМГ). Также выполняли определение уровня МК в сыворотке крови. Для оценки корреляции использовали критерий χ^2 Пирсона.

РЕЗУЛЬТАТЫ. В исследование были включены 30 пациентов, 15 из которых вошли в экспериментальную группу, а остальные 15 составили контрольную группу. Достоверной зависимости между повышенной концентрацией МК в сыворотке и диабетической периферической нейропатией выявлено не было (отношение шансов (ОШ) = 3,143; 95% доверительный интервал (ДИ) 0,681–14,503; $p=0,136$).

ЗАКЛЮЧЕНИЕ. Нами не было установлено корреляции между высоким уровнем МК в сыворотке и диабетической периферической нейропатией.

КЛЮЧЕВЫЕ СЛОВА: мочевая кислота; диабетическая периферическая нейропатия; сахарный диабет 2 типа

6 CORRELATION BETWEEN HIGH SERUM URIC ACID LEVELS WITH OCCURRENCE OF DIABETIC PERIPHERAL NEUROPATHY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS IN SOETOMO GENERAL HOSPITAL

© Deasy Putri Sukarno^{1,2}, Muhammad Hamdan^{1,2}, Fidiana^{1,2}, Fadil^{1,2}, Mudjiani Basuki^{1,2}

¹Soetomo General Hospital, Surabaya, Indonesia

²Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

BACKGROUND: The increased serum uric acid (SUA) levels have been linked to macro vascular disease in Type 2 Diabetes Mellitus. The correlation between serum uric acid levels and diabetic peripheral neuropathy has not been addressed properly.

OBJECTIVE: The aim of this study was to determine the correlation between high serum uric acid levels and diabetic peripheral neuropathy.

METHODS: This was a case-control design study and the sampling was done consecutively by following the inclusion and the exclusion criteria. The diabetic peripheral neuropathy was evaluated using Electroneuromyography (EMNG) and the serum were taken for uric acid level examination. Chi square test was used for the correlation analysis.

RESULT: Thirty subjects were enrolled and divided into an experimental group of 15 subjects and a control group of 15 subjects as well. We found that the diabetic peripheral neuropathy did not show a significant correlation with high serum uric acid levels, $p=0,136$ and OR 3,143 (CI 95% 0,681-14,503).

CONCLUSIONS: There was no correlation between high serum uric acid levels with diabetic peripheral neuropathy.

KEYWORDS: uric acid; diabetic peripheral neuropathy; diabetes mellitus type 2



52
Diabetes mellitus (DM) is a clinical syndrome characterized by hyperglycemia that occurs due to insulin secretion abnormalities, insulin performance, or both.[1, 2] Type 2 Diabetes Mellitus (T2DM) is an increasing health problem of incidence and prevalence so it becomes a worldwide concern.[1-4] Diabetic Peripheral Neuropathy (DPN) is one of the most frequent chronic microvascular complications in T2DM.[3-5] Finger or foot infections and amputations are common risks faced by DPN. This causes an increase in morbidity and mortality resulting in increased medical costs of patients with DPN.[4-6] Prevalence of neuropathy in DM patients over 50% for 25 years.[7] The overall prevalence of neuropathy was estimated at 30%.[4, 8, 9] In the EURODIAB IDDM Complication Study, DPN is associated with blood glucose control and DM duration. Microvascular complications still occur, despite controlling of blood glucose levels was performed well (HbA_{1c} 5.4% to 7%), so it is suspected other factors involved besides blood glucose control and duration of DM [10].

High serum uric acid (SUA) levels were associated with the incidence of macrovascular and microvascular complications in patients with DM.[11] Increased levels of SUA have been associated with endothelial dysfunction, ischemic heart disease, stroke, peripheral artery disease and death from cardiovascular disease.[3, 12, 13] In T2DM, the increasing levels of SUA were associated with metabolic syndrome and insulin resistance. The association of high SUA levels with DM was reported in several studies.[13-17] The association of hyperuricemia with DPN is still controversial. The study by Ito et al (2011) showed a significant difference between the proportion of DPN in hyperuricemia and normosemia ($p=0.19$).[11] But another study showed that DPN had a moderate significance ($p < 0.001$) with a positive correlation ($r=0.509$) towards high SUA levels.[18]

Therefore, the purpose of this study was to determine the correlation between high serum uric acid levels and diabetic peripheral neuropathy.

METHODS

Research design

This study used a case control design with the population of all T2DM patients who visited to the endocrinology outpatient unit of Soetomo General Hospital and fulfilled the inclusion and the exclusion criteria during the period of August to December 2016.

Conformity criteria

The inclusion criteria were 40-60 years old, EMNG results supported the DPN and agreed to join the research.

While the exclusion criteria were chronic renal impairment, chronic liver disorder, history of malignancy, history of drug use and radiotherapy, history of alcohol consumption.

Group analysis

We used consecutive sampling as the sampling technique because it was the best non-probability sampling and easy to do. The sample size was determined using the formula of unpaired categorical analytic research. The value of the effect proportion on the control (P_2) was determined based on the preliminary study and the calculation of the required minimum sample size was 15 people in each group.

The samples were divided into two groups; 15 subjects with EMNG results that did not support the diabetic neu-

ropathy referred to as a control group and 15 subjects with EMNG results that supported the diabetic neuropathy, hereinafter referred to as case/experimental group. The sampling conducted for 5 (five) months.

Additionally, the T2DM patients who fulfilled the inclusion and the exclusion criteria will be performed anamnesis, physical examination and then performed the blood tests for serum uric acid levels and other confounding factors.

Ethical review

This study has been approved by the ethical committee of Soetomo General Hospital with ID 658/Panke.KKE/XI/2016 on 17 November 2015.

12

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, N.Y., USA). Collected categorical data (hypertension, dyslipidemia, disease duration, DPN) were analyzed using Chi-Square test while numerical data were analyzed by T-test. Because from the analysis of normality was normal ($p=0,20$). We used P value level $< 0,05$ as statistically significant.

RESULTS

Research sample (participants/respondents)

The total subjects were 30 patients consisting of 15 subjects with EMNG results that did not support the DPN that referred to as a control group and 15 subjects with EMNG results that supported the DPN, referred to as case/experimental group. The basic characteristics of research subjects consisting of demographic and clinical data were showed in table 1.

Primary findings

While the correlation between high serum uric acid levels and the incidence of diabetic peripheral neuropathy was shown in table 2. Subjects in case group who had high serum uric acid levels as many as 8 people (53.3%) more than subjects in the control group with high serum uric acid level of 4 people (26.7%). However, there was no statistically significant difference ($P = 0.136$).

In this study, the glycemic control and disease duration analyzed as cofounding factors. There was no significant difference in glycemic control (HbA_{1c}) between two groups with $P = 0,682$, while the duration of disease was significant with $P < 0,001$.

DISCUSSIONS

This was an observational analytic study to determine the correlation between high serum uric acid levels and the incidence of diabetic peripheral neuropathy in patients with T2DM.

Case control was used in this study. This design was chosen because it was considered in accordance with the purpose of the research to assess the role of risk factors for high serum uric acid levels in the occurrence of diabetic peripheral neuropathy (cause-effect relationship).[19, 20]

In this study, there were no significant differences in basic variables consisting of demographic data. In addition, we obtained that there were no significant differences in clini-

Table 1. The Basic Characteristics of Subjects

Characteristics	DPN Incidence			p	OR (CI 95%)
	Experimental	Control	Total		
Sex					
-	Male	5 (33.3 %)	5 (33.3 %)	10 (33.3 %)	1,000
-	Female	10 (66.7 %)	10 (66.7 %)	20 (66.7 %)	(0.219-4.564)
Age					
-		51.60±6.52	53.53±4.72		0.25
Body Mass Index (BMI)					
-	Normal	9 (60.0 %)	9 (60.0 %)	18 (60.0 %)	1,000
-	Obesity	6 (40.0 %)	6 (40.0 %)	12 (40.0%)	(0.232-4.310)
Dyslipidemia					
-	Dyslipidemia	10 (66.7 %)	13 (86.7 %)	23 (76.7 %)	0.270
-	Normal	5 (33.3 %)	2 (13.3 %)	7 (23.3 %)	(0.049-1.928)
Hypertension					
-	Hypertension	4 (26.7 %)	6 (40.0 %)	10 (33.3 %)	0.305
-	Normal	11 (73.3 %)	9 (60.0 %)	20 (66.7 %)	(0.117-2.549)
Smoking					
-	Yes	1 (6.7 %)	1 (6.7 %)	2 (6.7 %)	1,000
-	No	14 (93.3 %)	14 (93.3 %)	28 (93.3 %)	(0.057-17.621)
Duration of Disease					
Type 2 Diabetes Mellitus					
-	≥ 5 years	12 (80.0 %)	2 (1.3 %)	14 (46.7 %)	0.001
-	< 5 years	3 (20.0 %)	13 (86.7%)	16 (53.3 %)	(0.005-0.271)
Serum HbA_{1c} Levels					
-	High	12 (80.0 %)	10 (66.7 %)	22 (73.3 %)	0.473
-	Normal	3 (20.0 %)	5 (33.3 %)	8 (26.7 %)	(0.117-2.549)

Table 2. The Correlation between High Serum Uric Acid Levels and the Incidence of Diabetic Peripheral Neuropathy

Serum Uric Acid Levels	DPN Cases			p*)	OR (CI 95%)
	Experimental	Control	Total		
-	High	8 (53.3%)	4 (26.7%)	12 (40 %)	0.094
-	Normal	7 (46.7%)	11 (73.3 %)	18 (60 %)	(0.681-14.503)
Total					
		15 (100%)	15 (100%)	30 (100%)	

cal data except the T2DM duration ($P < 0,001$). Demographic data included age and sex while clinical data included BMI, dyslipidemia, hypertension, smoking, serum HbA_{1c} levels and T2DM duration.

In this study, among the total 30 subjects, there were 10 (33,3%) male and 20 (66,7%) women. This was consistent with T2DM epidemiologic data suggesting that women were more likely to have diabetes mellitus than men. Women were at higher risk for T2DM because women have a greater chance of increasing body mass index than men.[21] The prevalence of DPN by sex was in accordance with the other developing countries such as Sri Lanka, India, North Africa, and Iran.[22] Some studies also suggested that men were fewer than women.[22-24] Bansal et al reported that women had a DPN risk of three times higher than men (OR 3.15, 95% CI 1.57-6.31, $p < 0.001$).[24] However, this study found

that there were no statistically significant difference in sex proportion between the experimental and control groups.

The mean age of the experimental group (51.60±6.52 years) was slightly younger than the control group (53.53±4.72 years), but this difference was not statistically significant with $p=0.360$. This result was in accordance with a study by Guirero et al that the mean age of samples that has suffering from DPN was 56.9±9.6 years.[25] But the mean age in this study was relatively young compared to the research that conducted by Lu et al that the mean age of samples suffering DPN was 68.27±10.66 and the mean age that did not suffer DPN was 62.26±10.05.[26] Multicenter studies conducted in the United Kingdom reported that the prevalence of diabetic peripheral neuropathy increases with age, from 5% (3.1-6.9%) in the 20-29 years age group to 44.2% (41.1-47.3%) in the 70-79 years age group.[27] However, the

samples over the age of 60 were not included in this study, because the age affects other types of neuropathy such as neuropathy due to vitamin deficiency, malnutrition, and others.

Characteristics of the subjects based on body mass index (BMI) in the experimental group were the subjects with normal BMI that was 9 patients (60.0%) meanwhile the subject of obesity in 6 patients (40.0%). However, this difference was not statistically significant with $p=1,000$. This was in accordance with a study that conducted by Kiani et al., reported that there was also no significant difference between BMI and diabetic neuropathy ($p=0.056$) in 84 subjects[22]. Obesity or combination with metabolic syndrome was a risk factor for neuropathy complications. Obesity and triglycerides were associated with the loss of small axon nerves that were unveiled myelin. Obesity was associated with edema that precedes the occurrence of clamp phenomena that disrupt the barrier so that nutritional deficiencies in susceptible nerve tissue. Obesity along with other metabolic syndromes leads to an increase in insulin resistance.[28, 29] T2DM and obesity have a complex relationship. Obesity was a precursor of T2DM via insulin resistance mechanism.[30, 31]

Characteristics of the subjects based on the risk factor of dyslipidemia in the experimental group were found in 10 patients (66.7%) that less than the control group as many as 13 patients (86.7%). However, this difference was not statistically significant with $p = 0.390$. This was consistent with a study conducted by Basal et al who found that dyslipidemia in the diabetic neuropathy group was 8% while in the diabetic neuropathy group was 44% with $p=0.075$ ($p < 0.001$).[24] The study of dyslipidemia as a risk factor for neuropathy was still controversial. There was no significant difference between total cholesterol, HDL, LDL and triglyceride levels in people with type 2 DM who had somatic neuropathy with or without neuropathy.[32] Patients with type 2 DM who were treated intensively with statins reduce the risk of autonomic neuropathy, but not DPN.[33] The different studies found that dyslipidemia was an independent risk factor for macro vascular disease in type 2 diabetes mellitus patients. In the preliminary study, decreased lipid levels with both fibrates and statins within 5 years prevented the incidence of new sensory neuropathy. The decrease in lipid levels was performed using fibrate therapy (HR= 0.52; 95% CI 0.27-0.98) and the use of statins therapy (HR = 0.65; 95% CI 0.46-0.93; $p < 0.042$).[32] The results was consistent with the in vitro studies and animal studies that showed the levels of lipid-lowering therapy had the neuroprotective effects by improving the Schwann cells, polyol pathway, and the repair of nerve blood flow.[33]

The characteristics of subjects based on hypertension in the experimental group found 4 patients (26.7%) with hypertension, then fewer than the control group that was 10 patients (40.0%). But in this study there was no statistically significant difference between the experimental and control group ($p=0.439$). This was consistent with a study that conducted by Papanas et al., stated that there was also no statistically significant difference between the case and the control group in 130 subjects ($p=0.999$).[3] Kiani et al's study also found that there was no significant difference between the history of hypertension ($p=0.124$), systolic blood pressure ($p=0.373$), and diastolic blood pressure ($p=0.640$) with diabetic neuropathy.[22] Hypertension was an inde-

pendent factor in macro vascular disease, retinopathy, and nephropathy. Hypertension was a complication of blood vessels due to hyperinsulinemia. Insulin resistance increases sodium reabsorption in the proximal tubules of the kidney.[28]

The characteristics of subjects based on smoking were 1 person (6.7%) who smoked in the experiment group while in the control group there were 14 people who did not (93.3%). But in this study there was no statistically significant difference between the experiment and control group ($p=1.000$). This was according to the research conducted by Kiani et al., who found that there was no significant difference between smoking and diabetic neuropathy in 84 subjects.[22] The study by Mitchel et al examined the association between smoking and diabetic neuropathy that resulted in a strong relationship between the number of cigarettes smoked during their lifetime and the presence of neuropathy. Patients who smoked >30 pack/year had a 3.32 times increased risk of neuropathy compared with those who smoked <30 pack/year.[34] In recent years, there was a potential role of vascular factors in the pathogenesis of diabetic neuropathy. It was speculated that smoking could lead to tissue hypoxia which might further injure the microvascular.[34]

Additionally, the characteristics of subjects based on long-term T2DM ≥ 5 years in the case group were 12 people (80.0%) it was more than the control group that only 2 people (13.3%). While the subjects who suffer from DM <5 years in the case group was 5 people (20.0%), less than the control group that was 13 people (86.7%). The correlation test results showed that there was a correlation between the duration of DMT2 and the incidence of diabetic peripheral neuropathy ($P < 0,001$; odds ratio 0.038; 95% CI 0.005-0.271). This was consistent with some studies obtained a correlation between the duration of DM and diabetic neuropathy.[24, 35] Research conducted by Fatkhur et al stated that the longer the patient suffering from DM, the risk of diabetic neuropathy was 16.7787 times greater in DM ≥ 5 years ($P < 0,001$).[35] In addition to hyperglycemia, the duration of DM was a risk factor for DPN in Diabetes Control and Complications Trial. [10] DPN was a microangiopathic complication in patients with type 2 DM which increases its prevalence in accordance with the duration of DM.[24] DPN complications could occur in patients with DM through various mechanisms. Hyperglycemia that has a long period, genetic and other mechanisms such as immune will increase oxidative stress and stimulate other pathways that caused damage of nerve, vascular endothelial, glomerular, mesangial, and retinal cells.[36] Examination using electrophysiology can detect subclinical DPN as indicated by the decrease in both sensory and motor neuronal conductivity in patients with DM after 5-10 years.[37]

Moreover, characteristics of the subjects by high serum levels of HbA_{1c} as many as 12 people in the experimental group (80.0%) was more than the control group as many as 10 people (66.7%). However, this difference was not statistically significant with $p=0.682$. This was consistent with research conducted by Kiani et al. who stated that there was no significant correlation between serum HbA_{1c} levels and the incidence of diabetic neuropathy.[22] Research by Kamran et al showed HbA_{1c} levels associated with neuropathy in patients with DM. HbA_{1c} levels greater than 10 mg/dL were associated with neuropathy.[38] HbA_{1c} levels were associated with micro vascular complications.[38, 39]

32

Based on the risk factor of serum uric acid level in the group of the incidence of peripheral diabetic neuropathy was obtained 8 people (53.3%) with high serum uric acid level, it was more than in the group without peripheral paralytic neuropathy that found 4 people with high serum uric acid level (26.7%). However, there was no statistically significant difference with $p=0.136$ and odds ratio by 3.143 (95% CI 0.681-14.503) in this study. The result of odds ratio (OR) was more than 1, so then it was concluded that high serum uric acid levels had no correlation with the incidence of diabetic peripheral neuropathy in type 2 diabetes mellitus. It was not in accordance with this research that conducted by Rafie et al against 132 patients with T2DM aged 45-80 years who suggested there was a correlation between high serum uric acid and diabetic peripheral neuropathy in DM patients ($p < 0.0001$) [40].

Next, the difference could be caused by the age of research. The subjects in this study was 40-60 years while the subjects by Rafie et al up to 80 years. In general, the older age also affects the incidence of peripheral diabetic neuropathy. The multicenter study conducted in the UK, the prevalence of diabetic peripheral neuropathy increased with age, from 5% (3.1- 6.9%) in the 20-29 year age group to 44.2% (41.1-47.3%) in the 70-79 age group [27].

Lastly, in this study, the risk factor that affected the DPN was the duration of T2DM. In the experimental group with T2DM duration ≥ 5 years more than the control group and statistically significant with $P < 0,001$

7. In addition, the previous studies suggested that there was an inadequate correlation between high serum uric acid levels and diabetic peripheral neuropathy with $r=0.509$. [18] This research strength was 30% statistically, in other word, there was a 70% chance to not find a significant correlation between high serum uric acid levels with the incidence of DPN.

CONCLUSIONS

There was no correlation between the high serum uric acid levels and the incidence of diabetic peripheral neuropathy in patients with T2DM.

ADDITIONAL INFORMATION

Conflict of interests. Authors declare no explicit and potential conflicts of interests associated with the publication of this article.

Authors involvement. DPS initiated, drafted the manuscript, and analyzed the data; MB designed and revised the manuscript; MH, Fi and Fa contributed to interpretation of data.

СПИСОК ЛИТЕРАТУРЫ | REFERENCES

- PERKENI. *Konsensus Pengelolaan dan Pencegahan Diabetes Mellitus Tipe 2 di Indonesia*. Jakarta: Toko Teknologi; 2015.
- PERKENI. *Konsensus Pengelolaan dan Pencegahan Diabetes Mellitus Tipe 2 di Indonesia 2006*. 2nd ed. Jakarta: Aksara Buana; 2007. Jakarta.
- Papanas N, Katsiki N, Papatheodorou K, et al. Peripheral neuropathy is associated with increased serum levels of uric acid in type 2 diabetes mellitus. *Angiology*. 2011;62(4):291-295. doi: 10.1177/0003319710394164
- Mehravaran H, Makvandi M, Samarbaaf Zade A, et al. Association of Human Cytomegalovirus with Hodgkin's Disease and Non-Hodgkin's lymphomas. *Asian Pac J Cancer Prev*. 2017;18(3):593-597. doi: 10.22034/APJCP.2017.18.3.593
- Veves A, Caselli A. *Micro- and Macrovascular Disease in Diabetic Neuropathy*. In: Veves A, Malik RA, editors. *Diabetic Neuropathy: Clinical Management*. Totowa: Humana Press; 2007. p. 259-274.
- Tesfaye S, Selvarajah D. Advances in the epidemiology, pathogenesis and management of diabetic peripheral neuropathy. *Diabetes Metab Res Rev*. 2012;28 Suppl 1:8-14. doi: 10.1002/dmrr.2239
- Feldman EL, Stevens MJ, Thomas PK, et al. A Practical Two-Step Quantitative Clinical and Electrophysiological Assessment for the Diagnosis and Staging of Diabetic Neuropathy. *Diabetes Care*. 1994;17(11):1281-1289. doi: 10.2337/diacare.17.11.1281
- Callaghan BC, Cheng HT, Stables CL, et al. Diabetic neuropathy: clinical manifestations and current treatments. *Lancet Neurol*. 2012;11(6):521-534. doi: 10.1016/s1474-4422(12)70065-0
- Kazamel M, Dyck PJ. Sensory manifestations of diabetic neuropathies: anatomical and clinical correlations. *Prosthet Orthot Int*. 2015;39(1):7-16. doi: 10.1177/0309364614536764
- Tesfaye S. Epidemiology and etiology of diabetic peripheral neuropathies. *Adv Stud Med*. 2004;4(10G):S1014-1021.
- Ito H, Abe M, Mifune M, et al. Hyperuricemia is independently associated with coronary heart disease and renal dysfunction in patients with type 2 diabetes mellitus. *PLoS One*. 2011;6(11):e27817. doi: 10.1371/journal.pone.0027817
- Yu S, Chen Y, Hou X, et al. Serum Uric Acid Levels and Diabetic Peripheral Neuropathy in Type 2 Diabetes: a Systematic Review and Meta-analysis. *Mol Neurobiol*. 2016;53(2):1045-1051. doi: 10.1007/s12035-014-9075-0
- Chien KL, Chen MF, Hsu HC, et al. Plasma uric acid and the risk of type 2 diabetes in a Chinese community. *Clin Chem*. 2008;54(2):310-316. doi: 10.1373/clinchem.2007.095190
- Yoo TW, Sung KC, Shin HS, et al. Relationship Between Serum Uric Acid Concentration and Insulin Resistance and Metabolic Syndrome. *Circulation Journal*. 2005;69(8):928-933. doi: 10.1253/circj.69.928
- Kramer CK, von Muhlen D, Jassal SK, Barrett-Connor E. Serum uric acid levels improve prediction of incident type 2 diabetes in individuals with impaired fasting glucose: the Rancho Bernardo Study. *Diabetes Care*. 2009;32(7):1272-1273. doi: 10.2337/dc09-0275
- Nakanishi N, Okamoto M, Yoshida H, et al. Serum uric acid and risk for development of hypertension and impaired fasting glucose or Type II diabetes in Japanese male office workers. *Eur J Epidemiol*. 2002;18(6):523-530. doi: 10.1023/a:1024600905574
- Kodama S, Saito K, Yachi Y, et al. Association between serum uric acid and development of type 2 diabetes. *Diabetes Care*. 2009;32(9):1737-1742. doi: 10.2337/dc09-0288
- Darsana IN. *Korelasi Positif Kadar Asam Urat Serum Tinggi Dengan Neuropati Diabetik Perifer Penderita DM Tipe 2 di Rumah Sakit Umum Pusat Sanglah Denpasar*. Denpasar: Udayana University; 2014.
- Sastroasmoro S, Ismael S. *Dasar-dasar Metodologi Penelitian Klinis*. 5 ed. Jakarta: Sagung Seto; 2014.
- Sastroasmoro S, Ismael S. *Dasar-Dasar Metodologi Penelitian Klinis*. 2 ed. Jakarta: Sagung Seto; 2002.
- Fatimah RN. *Diabetes Mellitus Tipe 2*. *J Majority* 2015;4(5):93-101.
- Kiani J, Habibi Z, Tajziehchi A, et al. Association between serum uric acid level and diabetic peripheral neuropathy (A case control study). *Caspian J Intern Med*. 2014;5(1):17-21.
- Katulanda P, Ranasinghe P, Jayawardena R, et al. The prevalence, patterns and predictors of diabetic peripheral neuropathy in a developing country. *Diabetol Metab Syndr*. 2012;4(1):21. doi: 10.1186/1758-5996-4-21
- Bansal D, Gudala K, Muthyala H, et al. Prevalence and risk factors of development of peripheral diabetic neuropathy in type 2 diabetes mellitus in a tertiary care setting. *J Diabetes Invest*. 2014;5(6):714-721. doi: 10.1111/jdi.12223
- Millan-Guerrero R, Trujillo-Hernandez B, Isais-Millan S, et al. H-reflex and clinical examination in the diagnosis of diabetic polyneuropathy. *J Int Med Res*. 2012;40(2):694-700. doi: 10.1177/147323001204000233
- Lu B, Yang Z, Wang M, et al. High prevalence of diabetic neuropathy in population-based patients diagnosed with type 2 diabetes in the Shanghai downtown. *Diabetes Res Clin Pract*. 2010;88(3):289-294. doi: 10.1016/j.diabres.2010.02.002

27. Fedele D, Comi G, Coscelli C, et al. A Multicenter Study on the Prevalence of Diabetic Neuropathy in Italy. *Diabetes Care*. 1997;20(5):836-843. doi: 10.2337/diacare.20.5.836
28. Yagihashi S, Mizukami H, Sugimoto K. Mechanism of diabetic neuropathy: Where are we now and where to go? *J Diabetes Investig*. 2011;2(1):18-32. doi: 10.1111/j.2040-1124.2010.00070.x
29. Li C, Hsieh MC, Chang SJ. Metabolic syndrome, diabetes, and hyperuricemia. *Curr Opin Rheumatol*. 2013;25(2):210-216. doi: 10.1097/BOR.0b013e32835d951e
30. Hussain A, Hydrie MZ, Claussen B, Asghar S. Type 2 Diabetes and obesity: A review. *Journal of Diabetology* 2010;2(1):1-7-4.
31. Yaturu S. Obesity and type 2 diabetes. *J Diabetes Mellitus*. 2011;1(4):79-95. doi: 10.4236/jdm.2011.1.4012
32. Subbalakshmi N, Rao S, Adhikari P, Sheila RP. Influence of dyslipidemia on somatic neuropathy in type 2 diabetes mellitus. *Nitte University Journal of Health Science* 2013;3(3):25-30.
33. Davis TM, Yeap BB, Davis WA, Bruce DG. Lipid-lowering therapy and peripheral sensory neuropathy in type 2 diabetes: the Fremantle Diabetes Study. *Diabetologia*. 2008;51(4):562-566. doi: 10.1007/s00125-007-0919-2
34. Mitchell BD, Hawthorne VM, Vinik AI. Cigarette Smoking and Neuropathy in Diabetic Patients. *Diabetes Care*. 1990;13(4):434-437. doi: 10.2337/diacare.13.4.434
35. Fatkhur N. *Hubungan Antara Hiperqlikemia, Usia Dan Lama Menderita Pasien Diabetes Dengan Angka Kejadian Neuropati Diabetika*. Yogyakarta: University of Muhammadiyah; 2012.
36. Vincent AM, Russell JW, Low P, Feldman EL. Oxidative Stress in the Pathogenesis of Diabetic Neuropathy. *Endocrine Reviews*. 2004;25(4):612-628. doi: 10.1210/er.2003-0019
37. Nathan DM. Long-term complications of diabetes mellitus. *N Engl J Med*. 1993;328(23):1676-1685. doi: 10.1056/NEJM199306103282306
38. Aziz KMA. Association between high risk foot, retinopathy and HbA1c in Saudi Diabetic population. *Pak J Physiol* 2010;6(2):21-28.
39. Sabanayagam C, Liew G, Tai ES, et al. Relationship between glycosylated haemoglobin and microvascular complications: is there a natural cut-off point for the diagnosis of diabetes? *Diabetologia*. 2009;52(7):1279-1289. doi: 10.1007/s00125-009-1360-5
40. Rafie S, Moqaddam MM, Tarahomi S, et al. The Comparison of Serum Uric Acid Level in Patients with Diabetic Neuropathy with Diabetics without Neuropathy. *Persian Journal of Medical Sciences*. 2016;3(1):109-113.

ИНФОРМАЦИЯ ОБ АВТОРАХ [AUTHORS INFO]

***Mudjiani Basuki**, MD, Neurologist, Staff of Department of Neurology; address: Mayjend Prof. Dr. Moestopo 6-8, Airlangga, Gubeng, Surabaya, 60285 Indonesia; e-mail: mudjianibasuki038@outlook.com

Deasy Putri Sukarno, MD, Resident in Department of Neurology; e-mail: dputrisukarno@gmail.com

Muhammad Hamdan, MD, Neurologist; Staff of Department of Neurology; e-mail: luki.hamdan@gmail.com

Fidiana, MD., Neurologist, Staff of Department of Neurology, Universitas Airlangga; e-mail: fidiana99@yahoo.fr

Fadil, MD., Neurologist, Staff of Department of Neurology; e-mail: fadil.neuro@gmail.com

ЦИТИРОВАТЬ:

Sukarno DP, Hamdan M, Fidiana, Fadil, Basuki M. Изучение влияния повышенного содержания мочевой кислоты в сыворотке крови на вероятность возникновения диабетической периферической нейропатии у пациентов с сахарным диабетом 2 типа в госпитале Soetomo // *Сахарный диабет*. — 2018. — Т. 21. — №4. — С. 277-282. doi: 10.14341/DM9590

TO CITE THIS ARTICLE:

Sukarno DP, Hamdan M, Fidiana, Fadil, Basuki M. Correlation between High Serum Uric Acid Levels with Occurrence of Diabetic Peripheral Neuropathy in Patients with Type 2 Diabetes Mellitus in Soetomo General Hospital. *Diabetes Mellitus*. 2018;21(4):277-282. doi: 10.14341/DM9590

Correlation Between High Serum Uric Acid Levels with Occurrence of Diabetic Peripheral Neuropathy in Patients with Type 2 Diabetes Mellitus in Soetomo General Hospital

ORIGINALITY REPORT

23%

SIMILARITY INDEX

17%

INTERNET SOURCES

18%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

1

elib.pstu.ru

Internet Source

3%

2

link.springer.com

Internet Source

2%

3

worldwidescience.org

Internet Source

1%

4

www.ijss-sn.com

Internet Source

1%

5

Ming Jiang, Lirong Yan, Xin Yan, Weiwei Wang, Hongtao Hu. "The value of serum uric acid levels to differentiate causes of transient loss of consciousness", *Epilepsy & Behavior*, 2019

Publication

1%

6

libmast.utm.my

Internet Source

1%

7

osteo-endojournals.ru

Internet Source

1%

8	www.soc-bdr.org Internet Source	1%
9	"Abstracts of the EASD, Stockholm 2010", Diabetologia, 2010 Publication	1%
10	"Diabetes and Aging-related Complications", Springer Science and Business Media LLC, 2018 Publication	1%
11	www.tandfonline.com Internet Source	<1%
12	ir.ymlib.yonsei.ac.kr Internet Source	<1%
13	pt.scribd.com Internet Source	<1%
14	Zhaohong Kong, Jian Jiang, Ming Deng, Zhaohui Zhang, Gaohua Wang. "Edaravone reduces depression severity in patients with symptomatic intracranial stenosis and is associated with the serum expression of sex hormones", Medicine, 2020 Publication	<1%
15	Syaiful A. Hadi, Dody P. Masri. "Palmaris longus absence in six largest Indonesian ethnicities and its relationship with gender, ethnicity, and hand dominance", Medical Journal of Indonesia, 2015	<1%

16

"14th Annual Meeting of The Korean Society of Nephrology", *Kidney International*, 01/1995

Publication

<1%

17

issuu.com

Internet Source

<1%

18

Nagahama, Kazufumi, Taku Inoue, Kentaro Kohagura, Kozen Kinjo, and Yusuke Ohya. "Associations between serum uric acid levels and the incidence of hypertension and metabolic syndrome: a 4-year follow-up study of a large screened cohort in Okinawa, Japan", *Hypertension Research*, 2014.

Publication

<1%

19

Papanas, N., N. Katsiki, K. Papatheodorou, M. Demetriou, D. Papazoglou, T. Gioka, and E. Maltezos. "Peripheral Neuropathy is Associated With Increased Serum Levels of Uric Acid in Type 2 Diabetes Mellitus", *Angiology*, 2011.

Publication

<1%

20

repository.unair.ac.id

Internet Source

<1%

21

Theosobia Grace Orno, Mansyur Arif, Irfan Idris. "Correlation Between Onset of Diabetes Mellitus and Nitric Oxide Levels in Patient with Type 2 Diabetes Mellitus", *Medical Laboratory*

<1%

-
- 22** Galvani Volta Simanjuntak, Marthalena Simamora. "Lama menderita diabetes mellitus tipe 2 sebagai faktor risiko neuropati perifer diabetik", *Holistik Jurnal Kesehatan*, 2020
Publication <1%
-
- 23** Liu, Peng, Yingying Chen, Bin Wang, Fengmei Zhang, Debao Wang, and Yangang Wang. "Allopurinol treatment improves renal function in patients with type 2 diabetes and asymptomatic hyperuricemia: a three years of randomized parallel-controlled study", *Clinical Endocrinology*, 2014.
Publication <1%
-
- 24** www.dovepress.com
Internet Source <1%
-
- 25** jebmh.com
Internet Source <1%
-
- 26** www.researchsquare.com
Internet Source <1%
-
- 27** www.surgeongeneral.gov
Internet Source <1%
-
- 28** Amarasekara, Amarasekara Appuhamillage Thamara D, Warunee Fongkaew, Savithri Wasundara Wimalasekera, Sue Turale, and <1%

Chawapornpan Chanprasit. "Cross-sectional study of glycemic control among adults with type 2 diabetes : Glycemic control in type 2 diabetes", Nursing and Health Sciences, 2015.

Publication

29

thieme-connect.com

Internet Source

<1%

30

Andyanita Hanif Hermawati, Eka Puspitasari, Cholila Lailatul Nurmala. "Low density lipoprotein (LDL) in type 2 diabetes mellitus", Medical Laboratory Analysis and Sciences Journal, 2019

Publication

<1%

31

etheses.whiterose.ac.uk

Internet Source

<1%

32

Qin Lv, Xian-Fang Meng, Fang-Fang He, Shan Chen et al. "High Serum Uric Acid and Increased Risk of Type 2 Diabetes: A Systemic Review and Meta-Analysis of Prospective Cohort Studies", PLoS ONE, 2013

Publication

<1%

33

Nutrition and Oral Medicine, 2014.

Publication

<1%

34

R Amelia, A S Wahyuni, R A Ariga Felicia, Preveena. "Relationship between family support with quality of life among type 2 diabetes

<1%

mellitus patients at Amplas primary health care in Medan, Indonesia", Journal of Physics: Conference Series, 2018

Publication

35

pesquisa.bvsalud.org

Internet Source

<1%

36

www.conferenciasindromemetabolico.org

Internet Source

<1%

37

Nagahama, Kazufumi, Taku Inoue, Kentaro Kohagura, Ayano Ishihara, Kozen Kinjo, and Yusuke Ohya. "Hyperuricemia predicts future metabolic syndrome: a 4-year follow-up study of a large screened cohort in Okinawa, Japan", Hypertension Research, 2013.

Publication

<1%

38

archive.org

Internet Source

<1%

39

ir.imvaccine.com

Internet Source

<1%

40

"Metabolic Influences on Risk for Tendon Disorders", Springer Science and Business Media LLC, 2016

Publication

<1%

41

Xu, Yili, Jiayu Zhu, Li Gao, Yun Liu, Jie Shen, Chong Shen, Glenn Matfin, and Xiaohong Wu. "Hyperuricemia as an Independent Predictor of

<1%

Vascular Complications and Mortality in Type 2 Diabetes Patients: A Meta-Analysis", PLoS ONE, 2013.

Publication

42

Mohamed Fouad, Hoda Fathy, Amal Zidan.
"Serum uric acid and its association with hypertension, early nephropathy and chronic kidney disease in type 2 diabetic patients",
Jornal Brasileiro de Nefrologia, 2016

Publication

<1%

43

F J Nieto. "The association between serum uric acid level and long-term incidence of hypertension: population-based cohort study",
Journal of Human Hypertension, 12/2006

Publication

<1%

44

www.ukessays.com

Internet Source

<1%

45

followscience.com

Internet Source

<1%

46

apps.who.int

Internet Source

<1%

47

cvd-ia.uii.ac.id

Internet Source

<1%

48

core.ac.uk

Internet Source

<1%

49

cris.maastrichtuniversity.nl

Internet Source

<1%

50

Oentarini Tjandra, Linda J Wijayadi, Marcella E Rumawas. "Green tea moisturizer improves skin hydration in elderly", *Universa Medicina*, 2018

Publication

<1%

51

persianjms.com

Internet Source

<1%

52

Asri Hendrawati, Syaefudin Ali Akhmad, AH Sadewa, - Tasmini. "The Effect of Combination of Quercetin And Glibenclamide on Myocardial Nuclear Factor Erythroid 2-Related Factor 2 (Nrf2) Expression In Type 2 Diabetic Rat", *Bangladesh Journal of Medical Science*, 2017

Publication

<1%

53

africanjournalofdiabetesmedicine.com

Internet Source

<1%

54

www.usrp.ru

Internet Source

<1%

55

X.-P. Liao, H.-W. Zhu, F. Zeng, Z.-H. Tang. "The association and interaction analysis of hypertension and uric acid on cardiovascular autonomic neuropathy", *Journal of Endocrinological Investigation*, 2015

Publication

<1%

56

"The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus", New England Journal of Medicine, 09/30/1993

Publication

<1%

57

Dandan Yan, Yinfang Tu, Feng Jiang, Jie Wang, Rong Zhang, Xue Sun, Tao Wang, Shiyun Wang, Yuqian Bao, Cheng Hu, Weiping Jia. "Uric Acid Is Independently Associated with Diabetic Kidney Disease: A Cross-Sectional Study in a Chinese Population", PLOS ONE, 2015

Publication

<1%

Exclude quotes On

Exclude matches Off

Exclude bibliography On

Correlation Between High Serum Uric Acid Levels with Occurrence of Diabetic Peripheral Neuropathy in Patients with Type 2 Diabetes Mellitus in Soetomo General Hospital

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

/100

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6
