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THE RELATIONSHIP BETWEEN HDL AND URINE PH IN PATIENTS WITH URINARY TRACT STONES

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KEYWORDS

HDL, urine pH, urinary tract stones

ABSTRACT

Decreased HDL levels are one of diagnosis component of dyslipidemia which is part of the metabolic syndrome. when HDL levels decrease, its role as an anti-atherosclerotic can affect insulin resistance and it can eventually lower urine pH and potentially can cause urinary tract stones formation. The objective of this study is to determine the correlation between HDL Levels and Urine pH in Patients with Urinary Stones. A hospital based cross-sectional study included 52 patients with Urinary Stone who attended urology outpatient clinic in dr. M. Soewandhie General Hospital Surabaya during April-June 2022. HDL levels and Urine pH were recorded. The correlation between HDL levels and urine pH were tested using Spearman's test. Mean of HDL levels were 44,96±9,109 mg/dL, and urine pH was 5,7692±0,70336. HDL levels was positively correlated with urine pH (r=0,336, p=0,015). There is a significant correlation between HDL levels and urine pH in patients with urinary stones. This is line with the fact that if HDL levels decrease, the urine pH will also decrease due to the influence of insulin resistance on the metabolic syndrome in patients with urinary tract stones.

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INTRODUCTION

Urinary tract stones (UTS) or Urolithiasis is defined as stone formation in the urinary tract which includes kidney, ureter, buli, and urethra stones (Tanggo, 2021; Hamamoto et al., 2023). Stone formation can be classified based on etiology, namely infection, non-infection, genetic disorders, and drugs. The formation of urinary tract stones is thought to have a relationship with impaired urine flow, metabolic disorders, urinary tract infections, dehydration, and other circumstances that are still not revealed (idiopathic) (Dahl & Goldfarb, 2022). Epidemiologically, there are several factors that facilitate the occurrence of urinary tract stones in a person. These factors are intrinsic factors, namely conditions that come from a person's body and extrinsic factors, namely influences that come from the surrounding environment (IAUI, 2018).

Urinary stone disease has been known since Babylonian times and ancient Egyptian times. As one proof is the discovery of stones in the bladder of a mummy. In developing countries, stone disease is common while in developed countries, stone disease of the upper urinary tract is more common; this is due to the influence of nutritional status and daily activities of patients.

In Indonesia, the problem of urinary tract stones is still the most common case among all urology cases. There is no data on the national prevalence of urinary tract stones in Indonesia. In some countries in the world it ranges from 1-20%. Males are more common than females at 3:1 with the peak incidence occurring at the age of 40-50 years (IAUI, 2018).

The occurrence of urinary tract stone formation is related to the presence of previous recurrence events and is very important in the pharmacological management and medical treatment of patients with urinary tract stones. Approximately 50% of urinary tract stone formation can also be found to recur at

least once in a lifetime. Risk factors for stone formation include young age UTS, heredity, uric acid stones, stones due to infection, hyperparathyroidism, metabolic syndrome, and medications (IAUI, 2018).

Urinary tract stones are one of the most common urological diseases worldwide, with a prevalence of around 5%-10 %, and are reported more frequently in men than women (Rams et al., 2020). There are still many urinary tract stone (UTS) patients in Indonesia, but complete data regarding their profiles has not been widely reported. The 2013 Basic Health Research Results Report shows that the prevalence of the Indonesian population suffering from kidney stones is 0.6% or 6 per 1000 population (Ministry of Health of the Republic of Indonesia, 2013).

The formation of urinary tract stones is thought to be related to impaired urine flow, metabolic disorders, urinary tract infections, dehydration, and other conditions that have not yet been revealed (idiopathic) (Purnomo, 2011). In epidemiological studies, an increased prevalence of kidney stones is often associated with metabolic syndrome (Cho et al., 2013).

Metabolic syndrome is a clinical condition defined by a combination of central obesity, increased body mass index (BMI), high blood pressure, increased total cholesterol, increased low-density lipoprotein (LDL), increased triglycerides, decreased high-density lipoprotein (HDL) and increased fasting blood sugar. Metabolic syndrome is directly related to the formation of kidney stones in that it affects the acidity in the urine, which theoretically influences the formation of uric acid stones, calcium stones and oxalate stones (Jeong et al., 2011; Torricelli et al., 2014; Yoshimura et al., 2016; Aritonang & Ali, 2020).

Meta-analysis research conducted by Besiroglu and Ozbek (2019) showed that patients with higher Triglyceride values and lower HDL had an increased estimated risk of urolithiasis. Masterson et al. (2015) stated in their research that dyslipidemia increases the risk of nephrolithiasis, with HDL levels of less than 45 for men and less than 60 for women.

Toricelli et al., in their research stated that low HDL levels and high Triglycerides (TG) were associated with lower urine pH. In linear regression, nonHDL was significantly correlated with urinary sodium and uric acid while TG influenced uric acid and urinary pH. Uric acid stones occur more often in patients with increased total cholesterol (TC) and TG (Torricelli et al., 2014).

In research conducted by Maalouf et al. (2007) there was a significant correlation between HDL levels and 24-hour tamped urine pH as well as between insulin resistance and 24-hour tamped urine pH ($p < 0.0001$). In conclusion, it was stated that the more acidic the urine pH in someone with metabolic syndrome, the higher the tendency to form uric acid stones in the kidneys.

Dyslipidemia is a component of metabolic syndrome and has been known to be a contributing factor to the development of urinary tract stones. Dyslipidemia is a component of metabolic syndrome and has been known to be a contributing factor to the development of urinary tract stones. Dyslipidemia is defined as an abnormality of lipid metabolism characterized by increased or decreased levels of lipid fractions in plasma. The main lipid fraction abnormalities are an increase in total cholesterol (K-total), LDL cholesterol (K-LDL) and or triglycerides (TG), and a decrease in HDL cholesterol (K-HDL) (PERKENI, 2019).

Lipids are fatty substances, in order to dissolve in the blood, lipid molecules must be bound to protein molecules (known as apolipoproteins, which are often abbreviated as apo. Lipid compounds with apolipoproteins are known as lipoproteins. Depending on the lipid content and the type of apolipoprotein contained, five types of liporotein are known, namely chylomicrons, Very Low-Density Lipoprotein (VLDL), Intermediate Density Lipo Protein (IDL), Low-Density Lipoprotein (LDL), and High Density Lipoprotein (HDL) (PERKENI, 2019).

Of the total serum cholesterol, K-LDL contributes 60-70%, has an apolipoprotein called apo B-100 (apo B). LDL cholesterol is the main atherogenic lipoprotein, and is the main target for dyslipidemia management. HDL cholesterol contributes to 20-30% of total serum cholesterol, the main apolipoproteins are apo A-1 and apo A-II. Evidence suggests that K-HDL inhibits the process of atherosclerosis.

Decreased HDL levels are one of the diagnostic criteria for dyslipidemia. Dyslipidemia is a lipid metabolism disorder that is one of the predictors of metabolic syndrome. The fact that patients with metabolic syndrome tend to produce slightly acidic urine is also supported by elevated uric acid levels in the blood. Disturbances in the process of ammonia production in the proximal tubules have been identified as a major source of aciduria, as reinforced by research showing an association between obesity and urine pH (A. W. Partin et al., 2020).

HDL consists of various types of fats and proteins, one of which is Spingosine-1-phosphate which is believed to have anti-inflammatory and anti-atherosclerosis/atheroprotective effects. In metabolic syndrome, there is a decrease in HDL levels which is thought to be due to inflammatory cytokines caused by visceral obesity. This situation is one of the factors in the onset of atherosclerosis, especially in the state of insulin resistance (Hoofnagle et al., 2010).

The results of research conducted by Torricelli et al. (2014), decreased HDL levels and increased Triglyceride levels associated with decreased urine pH levels. In his discussion, it was mentioned that dyslipidemia, obesity and metabolic syndrome have a complex relationship with insulin resistance. The results of the study found a significant correlation between decreased HDL levels and decreased urine pH. In fact, there was a significant correlation between HDL levels and TG levels with a more acidic urine pH. These patients also had higher urinary sodium, oxalate, and uric acid production (Torricelli et al., 2014).

Garbachinsky et al. stated that metabolic syndrome tends to cause lipotoxicity, one of which is in the kidneys. This situation is defined as the occurrence of lipid accumulation (in this case TG steatosis) especially in the renal tubules which affects the activity of NHE 3 thus reducing the synthesis and excretion of ammonium and increasing acid extraction in the urine which further causes a decrease in urine pH and increases the possibility of urinary tract stone formation (Gorbachinsky et al., 2010).

Through their research, Masterson et al. (2015) showed two significant findings. First, a diagnosis of dyslipidemia appears to confer an increased risk of nephrolithiasis. Second, from the lipid profile (LDL, HDL and TG), only HDL was found to be associated with nephrolithiasis and could increase the risk of nephrolithiasis by 30%.

A study conducted by Torricelli et al. (2014) stated that through multivariate analysis, all components of the 24-hour urinalysis were significantly correlated with a decrease in HDL levels, including urine pH levels with a p-value <0.001. This study did not address physiological mechanisms to explain why lipid profile components may cause specific changes in urinary tract stone risk. There may be an interaction between insulin resistance, cholesterol, TG and lipoproteins. For example, LDL remodelling in the setting of insulin resistance can influence the content, laboratory detection and particle size of cholesterol. High HDL levels may have anti-inflammatory effects and act as a protective agent against insulin resistance.

Several other studies also mention a relationship between reduced HDL levels and urine pH which tends to be acidic. The occurrence of lipotoxicity in the kidneys and impaired synthesis and excretion of ammonia are said to be factors causing urine pH to become more acidic and are directly related to dyslipidemia and insulin resistance in patients with metabolic syndrome. According to several studies, a more acidic urine pH increases the risk of forming urinary tract stones, especially uric acid stones (Torricelli et al., 2014; Maalouf et al., 2007; Hara et al., 2012; Gorbachinsky et al., 2010).

Based on the data that has been obtained and the results of several related studies, researchers want to know the relationship between HDL levels and urine pH in patients with urinary tract stones.

METHOD

This research is an analytical observational study with a cross-sectional study design approach. The independent variable in this study is HDL, while the dependent variable is urine pH. This study took an estimated population of all patients diagnosed with urinary tract stones at dr. M. Soewandhie General Hospital Surabaya from April 2022 to June 2022. The samples used in this study were patients diagnosed with urinary tract stones who met the inclusion and exclusion criteria at dr. M. Soewandhie General Hospital Surabaya from April 2022 to June 2022. The sampling technique for case samples in this study used consecutive sampling.

RESULTS AND DISCUSSION

General Descriptive Subject

Table 1. General Descriptive Subjects

	N	%	Range	Mean (STD)
Gender				
- **Man**	28	53.8%		
- **Woman**	24	46.2%		
Body weight	52		39-100	66.46(±14.447)
Body height	52		140-170	160.63(±6.849)
BMI	52		16.23-39.26	25.6972(±5.08776)
- **Underweight**	2	3.8%		
- **Normal**	23	44.2%		
- **Overweight**	18	34.6%		
- **Obesity**	9	17.3%		
Age	52		21-83	55.00(±13,442)

Based on Table 1, the number of male samples was 28 (53.8%) people, and the female saple was 24 (46.2%) people. The average body weight of the sample was 66.46 ± 14.447 kg while the average body height was 160.63 ± 6.849 cm. Of the total 52 samples, 23 (44.2%) samples had a normal BMI or body mass index, while 18 (34.6%) samples were categorized as overweight. The age of the sample varied from 21 to 83 years with a mean of 55 ± 13 years.

Descriptive Physical & Laboratory Examination

Table 2. Descriptive of Physical & Laboratory Examination

	n	Range	Mean (STD)
Blood pressure			
- **Systole**	52	100-180	132.81(±16,953)
- **Diastole**	52	60-110	81.88(±9.536)
Abdominal Circumference	52	64-118	92.48(±13.255)
Total cholesterol	52	110-268	193.19(±39.251)
Triglycerides	52	46-420	145.19(±74,799)
LDL	52	38-195	119.23(±36.417)
Gout	52	3.30-11.90	6,2000(±1.91424)
Fasting Blood Sugar (FBS)	52	66-381	128.87(±59.386)

Systolic blood pressure has an average of 132.81 ± 16,953 mmHg, and diastolic blood pressure has an average of 81.88 ± 9,536 mmHg. Abdominal circumference varied from 64-118 cm with an average of 92.48 ± 13.255 cm. The highest total cholesterol value was 268 mg/dL with an average of 193.19±39.251 mg/dL. The highest triglyceride value was 420 mg/dl, with an average of 145.19±74.799 mg/dL. The highest LDL value was 195 mg/dL, with an average of 119.23 ± 36.417 mg/dL. The highest uric acid value was 11.90 mg/dL with an average of 6.2000±1.91424 mg/dL. The highest FBS value was 381 mg/dL with an average of 128.87±59.386 mg/dL.

Descriptive and HDL Normality Test

Table 3. Descriptive and HDL Normality Test

	n	Range	Mean (STD)	p-value
HDL	52	29-66	44.96(±9.109)	0.015

The lowest HDL value was 29 mg/dL, while the highest value was 66 mg/dL, with an average of 44.96±9.109 mg/dL. The data normality test was carried out using the Kolmogorov-Smirnov test with a p-value = 0.015 or smaller than 0.05, so the data distribution was declared abnormal.

Descriptive and Normality Test of Urine pH

Table 4. Descriptive and Normality Test of Urine pH

	n	Range	Mean (STD)	p-value
Urine pH	52	5.00-9.00	5.7692(±0.70336)	0,000

The lowest pH value is 5.00, while the highest value is 9.00, with an average of 5.7692 ± 0.70336. The data normality test was carried out using the Kolmogorov-Smirnov *test* with a p-value = 0.000 or smaller than 0.05, so the data distribution was declared abnormal.

Analysis of the Relationship between HDL Levels and Urinary pH in Patients with Urinary Tract Stones

In this study, researchers used Spearman's test to determine the relationship between HDL levels and urine pH in patients with urinary tract stones.

Based on the results of Spearman's test, it was found that the significance value of this research was p=0.015 or less than 0.05, which indicates There is a significant relationship between HDL levels and urine pH in patients with urinary tract stones with an R-value or strength of relationship of 0.336, which means the strength of the relationship is weak. A positive R-value indicates a positive relationship between HDL levels and urine pH, meaning that if HDL levels increase, then urine pH also increases and vice versa (Figure 1).

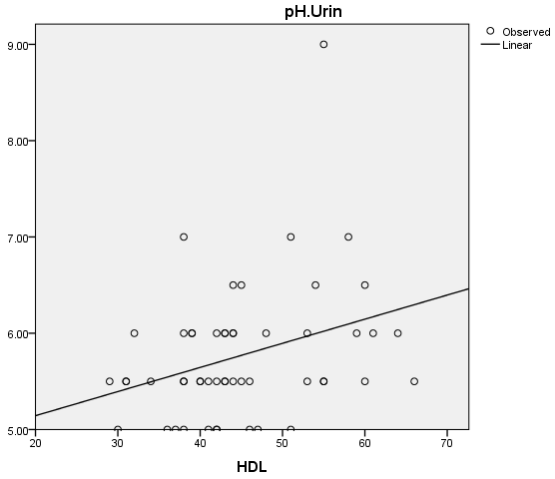

Figure 1. Curve Fit (Graph of the Relationship between HDL and Urine pH)

The results of the study showed that there was a relationship between HDL levels and urine pH in patients with urinary tract stones at dr. M. Soewandhie General Hospital Surabaya. In this study, it was found that the HDL levels and urine pH in patients with urinary tract stones were directly proportional. In patients with urinary tract stones with low HDL levels, urine pH levels are also low. In patients with urinary tract stones with high HDL levels, urine pH is also found to be high.

In this study, an association was found between HDL levels and urine pH in patients with urinary tract stones, in accordance with the initial hypothesis. These two research variables are included in the complex relationship between metabolic syndrome and urinary tract stones. Patients with metabolic syndrome tend to have decreased HDL levels followed by increased levels of triglycerides, LDL, random blood sugar (RBS), GDP, and uric acid. The role of HDL as anti-atherosclerosis cannot work well and worsens insulin resistance and lipotoxicity in metabolic syndrome patients. This situation affects the secretion and excretion of ammonium in the kidneys, thus affecting the level of urine acidity. The relationship between these two research variables is not directly related, but if you do not receive appropriate treatment and care, it can increase the risk of urinary tract stones, especially in patients with metabolic syndrome. (Torricelli et al., 2014; Maalouf et al., 2007; Gorbachinsky et al., 2010 Partin, 2021; Hoofnagle et al., 2010).

Several supporting research results, including those by Hara et al., stated that the sample group with high uric acid levels and low urine pH had a significant correlation with metabolic syndrome ($p < 0.001$) (Maalouf et al., 2007). Another study by Toricelli et al. stated that there was a significant correlation between low HDL levels and low urine pH ($p<0.001$) (Torricelli et al., 2014).

CONCLUSION

There is a relationship between HDL levels and urine pH in patients with urinary tract stones. Dissemination of information about urinary tract stones through counselling or other activities would be better if delivered through health workers with full support from community leaders and adjusted to the education level of the local population. The public is expected to increase their interest in maintaining their own health by checking themselves immediately if they experience symptoms of urinary tract stones, as an effort to prevent the worsening of the disease and maintain a healthier diet and lifestyle. It is hoped that the results of this research can be a source of information about research related to urinary tract stones using different methodologies and that further research can be carried out to examine other factors that can influence the occurrence of urinary tract stones.

REFERENCES

Aritonang, J., & Ali, Z. (2020). Metabolic syndrome traits in urolithiasis patients. Indonesian Journal of Urology, 27(2), 117–121.

Besiroglu, H., & Ozbek, E. (2019). Association between blood lipid profile and urolithiasis: A systematic review and meta-analysis of observational studies. International Journal of Urology, 26(1), 7–17. https://doi.org/10.1111/iju.13781

Cho, S. T., Jung, S. Il, Myung, S. C., & Kim, T. H. (2013). Correlation of metabolic syndrome with urinary stone composition. International Journal of Urology, 20(2), 208–213. https://doi.org/10.1111/j.1442-2042.2012.03131.x

Dahl, N. K., & Goldfarb, D. S. (2022). Nutritional prevention and treatment of urinary tract stones. In Nutritional Management of Renal Disease (pp. 685–697). Elsevier.

Gorbachinsky, I., Akpinar, H., & Assimos, D. G. (2010). Metabolic syndrome and urologic diseases. Reviews in Urology, 12(4), e157.

Hamamoto, S., Inoue, T., Okada, S., Taguchi, K., & Yasui, T. (2023). Application of ultrasound imaging in the treatment of urinary tract stones. Journal of Medical Ultrasonics, 1–14.

Hara, S., Tsuji, H., Ohmoto, Y., Amakawa, K., Hsieh, S. D., Arase, Y., & Nakajima, H. (2012). High serum uric acid level and low urine pH as predictors of metabolic syndrome: a retrospective cohort study in a Japanese urban population. Metabolism, 61(2), 281–288. https://doi.org/10.1016/j.metabol.2011.06.026

Hoofnagle, A. N., Vaisar, T., Mitra, P., & Chait, A. (2010). HDL lipids and insulin resistance. Current Diabetes Reports, 10, 78–86. https://doi.org/10.1007/s11892-009-0085-7

IAUI. (2018). Panduan Penatalaksanaan Klinis Batu Saluran Kemih. Edisi Pertama. Jakarta: Ikatan Ahli Urologi Indonesia.

Jeong, I. G., Kang, T., Bang, J. K., Park, J., Kim, W., Hwang, S. S., Kim, H. K., & Park, H. K. (2011). Association between metabolic syndrome and the presence of kidney stones in a screened population. American Journal of Kidney Diseases, 58(3), 383–388. https://doi.org/10.1053/j.ajkd.2011.03.021

Kemenkes RI. (2013). Riset kesehatan dasar; RISKESDAS. Jakarta: Balitbang Kemenkes RI, 2013, 110–119.

Maalouf, N. M., Cameron, M. A., Moe, O. W., Adams-Huet, B., & Sakhaee, K. (2007). Low urine pH: a novel feature of the metabolic syndrome. Clinical Journal of the American Society of Nephrology, 2(5), 883–888. https://doi.org/10.2215/CJN.00670207

Masterson, J. H., Woo, J. R., Chang, D. C., Chi, T., L'Esperance, J. O., Stoller, M. L., & Sur, R. L. (2015). Dyslipidemia is associated with an increased risk of nephrolithiasis. Urolithiasis, 43, 49–53. https://doi.org/10.1007/s00240-014-0719-3

Partin, A. (2021). Campbell-Walsh-Wein Urology, Twelfth Edition. Elsevier, 1420–1421.

Partin, A. W., Peters, C. A., Kavoussi, L. R., Dmochowski, R. R., & Wein, A. J. (2020). Campbell-Walsh-Wein Urology Twelfth Edition Review E-Book.

PERKENI. (2019). Pedoman pengelolaan dislipidemia di Indonesia. PB PERKENI.

Purnomo, B. B. (2011). Dasar-dasar urologi edisi ketiga. Jakarta: CV Sagung Seto.

Rams, K., Philipraj, S. J., Purwar, R., & Reddy, B. (2020). Correlation of metabolic syndrome and urolithiasis: A prospective cross-sectional study. Urology Annals, 12(2), 144. https://doi.org/10.4103%2FUA.UA_77_19

Tanggo, C. R. K. (2021). The incidence rate of urinary tract stones in inpatients at the UKI General Hospital in 2015–2016. International Journal of Medical and Health Research, 7(12), 13–17.

Torricelli, F. C. M., De, S. K., Gebreselassie, S., Li, I., Sarkissian, C., & Monga, M. (2014). Dyslipidemia and kidney stone risk. The Journal of Urology, 191(3), 667–672. https://doi.org/10.1016/j.juro.2013.09.022

Yoshimura, E., Sawada, S. S., Lee, I.-M., Gando, Y., Kamada, M., Matsushita, M., Kawakami, R., Ando, R., Okamoto, T., & Tsukamoto, K. (2016). Body mass index and kidney stones: a cohort study of Japanese men. Journal of Epidemiology, 26(3), 131–136. https://doi.org/10.2188/jea.JE20150049