

## RELATIONSHIP BETWEEN CONSUMPTION OF SIMPLE CARBOHYDRATES AND SERUM URIC ACID CONCENTRATION IN ADOLESCENTS

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### Abstract

Indonesia is one of the countries with high uric acid levels that generally occur in adolescents. This condition is influenced by a number of factors, one of which is the consumption of simple carbohydrates. The aim of this study was to determine the relationship between consumption of simple carbohydrates and serum uric acid in adolescents. This study used a cross-sectional design, with as respondents 76 adolescents in the Impact Community Indonesia church, North Jakarta. The consumption pattern of simple carbohydrates was measured by filling the semi-quantitative food frequency questionnaire (SQ-FFQ), whereas serum uric acid was measured with the Autocheck instrument. Data were analyzed using SPSS version 23.0 at significance level of  $p < 0.05$ . Mean consumption of simple carbohydrates in male adolescents was 1839 grams and in female adolescents 1592 grams per month, whereas mean concentration of serum uric acid in male adolescents was 6.6 mg/dL and in female adolescents 5.2 mg/dL. The results of the Chi-Square test found a significant relationship between consumption of simple carbohydrates and serum uric acid concentration ( $p = 0.000$ ). The conclusion of this study was that there was a significant relationship between consumption of simple carbohydrates and serum uric acid concentration in adolescents.

**Keywords:** Simple Carbohydrates, Serum Uric Acid, Adolescent, Sweet Snacks, Blood Test

### Introduction

Uric acids are weak organic acids that are the end products of purine metabolism. They are mainly produced in the liver and excreted through the kidneys.<sup>(1-3)</sup> Uric acids are the principal antioxidant molecules in plasma, such that their concentration need to be maintained in the normal range.<sup>(1)</sup> The majority of the purines that are to be metabolized into uric acids by the body, are produced naturally in the body and a small part comes from daily dietary intake.<sup>(4)</sup> If the serum uric acid concentration is above normal or there is hyperuricemia, monosodium urate crystals may accumulate and if left untreated may cause problems in the joints, soft tissues, and kidneys.<sup>(5,6)</sup> The World Health Organization (WHO) states that Indonesia occupies fourth rank with the highest number of uric acid patients.<sup>(7)</sup> It is estimated that patients with hyperuricemia in Indonesia are commonly found in the relatively younger age groups. A survey of the WHO states that the prevalence of hyperuricemia in Indonesia of 35% is found in the younger age groups of under 34 years. The 2018 Basic Health Research (Riskesdas 2018) states that the prevalence of uric acid in Indonesia steadily increases by 7.3% in the group of diseases associated with the joints. The prevalence of hyperuricemia in Indonesian adolescents is currently not known for certain.<sup>(8)</sup>

There are many factors that may cause hyperuricemia, including age, sex, ethnicity, obesity, hormones, excessive alcohol consumption, unhealthy life style, and changes in dietary pattern,

including consumption of high-purine foods, and foods and drinks that contain simple carbohydrates, such as glucose, fructose, and others.<sup>(9)</sup>

Simple carbohydrates are carbohydrates that possess 1 or 2 types of sugars with simple chemical structures.<sup>(10,11)</sup> Excessive consumption of simple carbohydrates, particularly fructose and sucrose, may cause hyperuricemia, because its metabolic processes may stimulate the production of uric acid in the body.<sup>(12)</sup> The National Center for Health Statistics states that 16% of total calories that are consumed by adolescents are from sweet snacks and sweetened drinks, 40% of which are simple carbohydrates. In Indonesia, the consumption of foods and drinks with added sugar amounts to 21-23% in adolescents.<sup>(12,13)</sup>

Studies on the relationship between consumption of simple carbohydrates and serum uric acid concentration have shown results that are still a matter of debate. The study by Hapsari et al<sup>(12)</sup> showed that consumption of simple carbohydrates is associated with serum uric acid concentration in adolescents aged 16-18 years ( $r = 0.291$ ,  $p = 0.024$ ). This may have occurred because consumption of simple carbohydrates may stimulate the formation of uric acid in the body. In contrast, from the study results of Angelopoulos et al.<sup>(14)</sup> it was concluded that consumption of one simple carbohydrate namely fructose was not associated with serum uric acid concentration at age 20-60 years ( $p > 0.05$ ). This explains the possibility that consumption of simple carbohydrates is not the main factor for the increased serum uric acid concentration. The results of previous studies that have been conducted still showed inconsistent results, such that the present investigators were attracted to conduct further studies in connection with the relationship between consumption of simple carbohydrates and serum uric acid concentration.

## Methods

This was an analytical-observational study of cross-sectional design, that was conducted on 76 adolescents in the Impact Community Indonesia church by consecutive random sampling, from September to December 2023. The inclusion criteria in this study were male and female adolescents aged 10-24 years, with body mass index (BMI) in the normal category of 18.5-24 kg/m<sup>2</sup>, waist circumference in the normal range ( $< 90$  cm in males and  $< 80$  cm in females), and agreeing to participate voluntarily in this study by signing informed consent. The exclusion criteria in this study were adolescents who consumed alcohol; had a family history of high uric acid concentration; insufficient physical activity; consumed uric acid-lowering medications such as allopurinol; had chronic medical conditions requiring medical care by a physician, such as stroke, kidney failure, hypertension, and diabetes mellitus; had congenital abnormalities with low intellect. The consumption pattern of simple carbohydrates was determined by the participants filling out the semi quantitative food frequency questionnaire (SQ-FFQ), whereas serum uric acid concentration was determined by means of the Autocheck instrument manufactured by General Life Biotechnology Co., Ltd. Taiwan that measures the random uric acid concentration (without fasting) using a biosensor, namely a strip electrode that binds uric acid and produces an electric charge. This change in electric potential is then changed into a number that is proportional to the uric acid concentration in the blood. The data were analyzed with SPSS version 23.0, using the Chi Square test at a significance level of  $p < 0.05$ . This study obtained ethical clearance from the Research Ethics Commission, Faculty of Medicine, Universitas Trisakti under No. 126//KER-FK/VII/2023 and obtained permission from the Impact Community Indonesia church.

## Results

**Table 1. Distribution of study subject characteristics**

Characteristic	n (%)
<b>Sex</b>	
Male	43 (56.6)
Female	33 (43.4)
<b>Consumption of simple carbohydrates</b>	
Normal	43 (56.6)
High	33 (43.4)
<b>Serum uric acid concentration</b>	
Normal	51 (67.1)
High	25 (32.9)

n = number of respondents; % = percentage

In Table 1 may be seen the distribution of study subject characteristics by sex, with a majority of male study subjects of 43 persons (56.6%). The distribution of study subject characteristics by the consumption pattern of simple carbohydrates showed that the majority of subjects who consumed simple carbohydrates in normal amounts were 43 in number (56.6%). The distribution of study subject characteristics by serum uric acid concentration also showed that there were more subjects with normal serum uric acid concentration, namely 51 persons (67.1%), than were those with high serum uric acid concentration.

**Table 2. Relationship of sex with consumption of simple carbohydrates and serum uric acid concentration**

Variable	Consumption of simple carbohydrates		P value	Serum uric acid concentration		P value
	Normal n (%)	High n (%)		Normal n (%)	High n (%)	
<b>Sex</b>						
Male	23 (53.5)	20 (46.5)	0.535*	27 (62.8)	16 (37.2)	0.361*
Female	20 (60.6)	13 (39.4)		24 (72.7)	9 (27.3)	

\*p < 0.05 significantly different; Chi-Square test; n = number of respondents; % = percentage

Table 2 shows that there was no significant relationship between sex and consumption pattern of simple carbohydrates, at p = 0.535 and that there was no significant relationship between sex and serum uric acid concentration, at p = 0.361.

**Table 3. Relationship between consumption of simple carbohydrates and serum uric acid concentration**

Variable	Serum uric acid concentration		P value
	Normal n (%)	High n (%)	
<b>Consumption of simple carbohydrates</b>			
Normal	37 (86)	6 (14)	0.000*
High	14 (42.4)	19 (57.6)	

\*p < 0.05 significantly different; Chi-Square test; n = number of respondents; % = percentage

Table 3 shows a significant relationship between consumption pattern of simple carbohydrates and serum uric acid concentration at  $p$  value = 0.000.

## Discussion

This study showed that there were more male than female subjects (56.6% vs 43.4%). The obtained results were similar to those of a study conducted by Thayibah et al., where the research subjects comprised more persons of male sex (63.6%) than those of female sex (36.4%).<sup>(15)</sup> This was influenced by the willingness of the study subjects to participate in this study and their meeting the inclusion and exclusion criteria.

The results of data analysis showed that 33 (43.4%) or almost half of the 76 subjects had a high consumption of simple carbohydrates. These results were supported by a statement in the study of Rachmah et al., where most of the Indonesian population, particularly adolescents, consume simple carbohydrates exceeding the recommended limits, namely > 5% of total energy.<sup>(16)</sup> At the present time, Indonesia occupies third rank among the countries with the highest consumption of simple carbohydrates. The global consumption of simple carbohydrates has constantly increased during the last 30 years.<sup>(17)</sup> This increase is supposed to occur because of the numerous trends in the consumption of sweet snacks and sweetened drinks, that are considered to be contemporary foods and the numerous cafés or coffee shops that serve various sweetened drinks and sweet snacks of attractive appearance and form. The consumption of simple carbohydrates has become the lifestyle of the global adolescent community, including Indonesia.<sup>(18)</sup> Another study also showed similar results that more than half of the adolescent respondents in that study consumed simple carbohydrates exceeding the recommended limits, namely 63%.<sup>(19)</sup>

Based on serum uric acid concentration data in adolescents, there were 25 persons (32.9%) with high serum uric acid concentrations. This proves that high uric acid is not only present in the elderly but also in younger persons. The increase in uric acid is influenced by various factors such as genetics, unhealthy dietary pattern, obesity, medical conditions (hypertension, diabetes, heart disease, kidney disease, and metabolic syndrome), consumption of medications, and inadequate physical activity.<sup>(20)</sup> The main factor that increases blood uric acid concentration is unhealthy dietary pattern, where at present many adolescents consume high-protein foods, such as animal protein of high purine content, sea food, alcohol, and sweet snacks and sweetened drinks containing simple carbohydrates.<sup>(21)</sup> The study conducted by Istianah et al. that supports our study results, found 34 persons (55.70%) with high uric acid concentration and 27 persons (44.30%) with normal uric acid concentration. This may have been caused by the dietary pattern of the many study subjects who consumed high-purine meat, tempeh, soybean curd (tofu), and green vegetables, all of which are high in purines.<sup>(22)</sup>

Based on the results of the statistical analysis, the sex of the respondents consuming simple carbohydrates, showed a  $p$  value of 0.535, such that the investigators could conclude that there was no significant relationship between the sex of the respondents and consumption of simple carbohydrates. Our study found that among the respondents with a high consumption of simple carbohydrates there were 20 males and 13 females. This is in contrast with the study results of Sari et al. who found that in adolescents there was a significant relationship between sex and consumption of simple carbohydrates, at  $p = 0.03$ . Additionally, the study found that among the 167 respondents participating in the study, there were more males than females who had a high consumption of simple carbohydrates.<sup>(23)</sup> These differences in study results may have been caused by the fact that in our study

the difference in the number of study subjects was smaller, such that this difference may not describe the whole population. In addition, the studies were also conducted in different locations, such that there is the possibility of obtaining different results. However, these study results were similar to those of the study by Anwar et al. who found no significant relationship between sex and consumption of simple carbohydrates, at  $p > 0.05$ .<sup>(24)</sup>

Our statistical tests showed that for the relationship between sex and serum uric acid concentration, the  $p$  value was 0.361, such that it may be concluded that there was no significant relationship between the two variables. In our study there were 16 males and 9 females who had a high concentration of serum uric acid. These results were supported by the study of Untari et al. that showed no significant relationship between sex and serum uric acid concentration, with  $p$  value = 0.569. This proves that sex is not the main factor in the increase in serum uric acid concentration.<sup>(25)</sup> Meanwhile, the results of the study conducted by Arlinda et al. showed a significant relationship between sex and serum uric acid concentration, at  $p < 0.05$ .<sup>(26)</sup> The differing results are thought to be caused by the fact the previous study had an age range that was too wide, whereas the age of the respondents in our study were in the adolescent range and was also influenced by the difference in availability of the respondents at the time when the study was conducted.

The results of the statistical analysis that was performed on the consumption of simple carbohydrates and the serum uric acid concentration, had a  $p$  value of 0.000, showing a significant relationship. The study results of Charette et al. showed similar results with a  $p$  value of 0.003, such that there was a significant relationship between the consumption of simple carbohydrates and the serum uric acid concentration. Excessive consumption of simple carbohydrates may have stimulated the formation of uric acid in the body, because the metabolic process requires a high amount of ATP, such that ATP is rapidly reduced and degraded to AMP, that subsequently accelerates the synthesis of purine *de novo*.<sup>(27)</sup> These study results are also supported by another study conducted by Zhou et al., in that consumption of simple carbohydrates is significantly associated with serum uric acid concentration, at  $p = 0.002$ .<sup>(28)</sup> Changes in adolescent life style that are influenced by the social environment, such as the many trends in sweet snacks and sweetened drinks and the increase in the number of cafés or coffee shops in Indonesia, cause the adolescents to experience an uncontrolled increase in access to sweet snacks and sweetened drinks.<sup>(29)</sup> If these are not immediately overcome, they may increase the risk of health problems, one of them being the increase in blood uric acid concentration. This is in contrast with the study of Koujan et al. who found a  $p$  value of 0.698 and concluded that consumption of simple carbohydrates had no significant relationship with serum uric acid concentration.<sup>(30)</sup> A limitation of the present study is that we did not collect data on other causes of the increased serum uric acid concentration apart from the consumption of simple carbohydrates, such as genetic and demographic factors, lack of physical activity, and the history of previous groups, such that further studies are needed that include more comprehensive conditions.

## Conclusion

The results of this study showed that there was a significant relationship between consumption of simple carbohydrates and serum uric acid concentration in adolescents.

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