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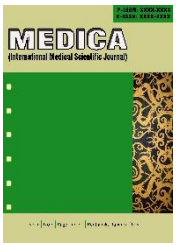

Lifestyle Related Chronic Kidney Disease Among Young Adults of Productive Age In Indonesia: Analysis of The 2023 Indonesian Health Survey

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Abstract

Chronic Kidney Disease (CKD) has traditionally been associated with older adults; however, its prevalence among adolescents and young adults has increased in recent years, largely due to changing lifestyle patterns. This trend threatens the productivity of the younger generation and may increase the burden on Indonesia's healthcare system. This study aimed to analyze lifestyle-related factors associated with CKD among Indonesian young adult males aged 15–24 years. A quantitative cross-sectional study was conducted using secondary data from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI). Total sampling was applied to eligible respondents, resulting in 46,510 male participants after excluding female respondents to minimize sex-related confounding. Data were analyzed using Chi-square tests and multivariable logistic regression. The results showed that the consumption of sugar-sweetened beverages ($p < 0.001$) and hypertension status ($p = 0.001$) were significantly associated with CKD. Multivariable analysis revealed that hypertension was the strongest factor associated with CKD among young adults, while the consumption of sugar-sweetened beverages also remained significantly associated with the condition. These findings highlight the importance of early prevention strategies focusing on blood pressure control and healthier dietary behaviors to reduce the risk of CKD in young populations. However, because of the cross-sectional design, the study can only identify associations and cannot establish causal relationships between lifestyle factors and CKD.

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1. INTRODUCTION

Chronic Kidney Disease (CKD) is increasingly recognized as a significant health problem among adolescents and young adults, largely driven by modern lifestyle changes, including the frequent consumption of junk food and ultra-processed diets. CKD is a non-communicable disease characterized by persistent structural and functional abnormalities of the kidneys for more than three months (Vaidya & Aeddula, 2024). According to (Robinson et al., 2016), CKD is a progressive and irreversible condition in which kidney function gradually deteriorates, often requiring lifelong renal replacement therapies such as hemodialysis or kidney transplantation to sustain life. Among young adults, the development of CKD has become increasingly linked to modifiable behavioral factors associated with contemporary lifestyle patterns, making it an emerging public health concern in this age group (Kuma & Kato, 2022).

Although CKD has traditionally been regarded as a disease of older adults, recent global evidence suggests a notable epidemiological shift toward younger populations. Data from the Global Burden of Disease (GBD) 2021 study indicate a growing burden of CKD among adolescents and young adults worldwide (Ma et al., 2025). Furthermore, (Wang et al., 2025) reported that between 1990 and 2021, the burden of CKD among individuals aged 15–29 years increased substantially, with incidence rising by 30%, prevalence by 7%, and mortality by 6%. These findings demonstrate that CKD is no longer confined to older populations but has emerged as an important public health challenge among young people, potentially affecting their long-term health, productivity, and quality of life.

In Indonesia, CKD imposes a considerable burden on both the healthcare system and the national economy. Treatment of kidney disease, particularly hemodialysis, accounts for the second-highest expenditure in the national health insurance system (BPJS) (Sunariyanti et al., 2023). National claims for CKD treatment reached nearly IDR 3 trillion in 2015, while the estimated lifetime cost of hemodialysis therapy per patient is approximately IDR 1,368,447,750 (± USD 96,908) (Putri et al., 2022). As CKD requires long-term management, the increasing number of patients places substantial financial pressure on healthcare resources and highlights the need for effective preventive strategies (Kristina et al., 2021).

The Indonesian Health Survey (SKI) 2023 reported a CKD prevalence of 0.02% among individuals aged 15–24 years (Kementerian Kesehatan Republik Indonesia, 2023). Although the prevalence appears relatively low, the severity of the condition is reflected by the fact that 16.2% of affected individuals in this age group had already undergone hemodialysis. This finding is particularly concerning because adolescents and young adults represent a critical component of Indonesia’s productive population and are expected to contribute significantly to the country's demographic dividend (Maryam et al., 2025). Early-onset CKD may result in long-term dependence on renal replacement therapy, reduced life expectancy, diminished quality of life, and impaired productivity during the most economically active years of life (Al Salmi et al., 2021; Busink et al., 2023).

A growing body of evidence suggests that lifestyle-related factors play a crucial role in the development and progression of CKD among young adults. Behaviors such as smoking, excessive alcohol consumption, and high sodium intake from fast food have been associated with kidney dysfunction, accelerated renal damage, and the development of hypertension, a major risk factor for CKD (Molino et al., 2021; Sun et al., 2025; Al-Haifi et al., 2023). In addition, rapid urbanization and the modernization of food systems in Indonesia have contributed to a shift in dietary habits toward instant foods, ultra-processed products, and sugar-rich diets (Anyanwu et al., 2022). High sugar consumption,

particularly through sugar-sweetened beverages (SSBs), has been linked to fructose-induced metabolic disturbances that increase uric acid production and promote endothelial dysfunction, thereby contributing to kidney damage (Baharuddin, 2024). Moreover, the regular consumption of carbonated soft drinks and energy drinks may impose a significant chemical burden on the kidneys and increase the risk of acute kidney injury (AKI), which is recognized as an important precursor to CKD (Murt, 2025; Rahmadi et al., 2024).

Besides lifestyle factors, hereditary predisposition remains an important determinant of CKD risk. A family history of hypertension and type 1 diabetes mellitus has been associated with microvascular damage and increased susceptibility to kidney disease (Mallamaci & Tripepi, 2024; Pavkov et al., 2023; Zdravkova et al., 2025). The interaction between genetic susceptibility and unhealthy lifestyle behaviors may further accelerate kidney function decline, particularly among young individuals who are increasingly exposed to adverse environmental and behavioral risk factors.

Despite the growing burden of CKD among young adults, evidence regarding the influence of contemporary lifestyle transitions on kidney health in the Indonesian context remains limited. Previous studies have often focused on older populations, employed smaller samples, or inadequately controlled for sex-related confounding factors when examining CKD risk. Consequently, a comprehensive analysis using nationally representative data is needed to better understand the determinants of CKD among young Indonesians. Therefore, this study aimed to analyze the association between lifestyle-related and hereditary factors and the occurrence of chronic kidney disease among Indonesian male young adults aged 15–24 years using data from the 2023 Indonesian Health Survey (SKI).

2. METHOD

This study employed a quantitative cross-sectional design using secondary data from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI). The study population consisted of 96,564 individuals aged 15–24 years recorded in the SKI 2023 database. Participant selection was conducted using a total sampling technique. The sample included respondents who met specific inclusion and exclusion criteria. The exclusion criteria comprised respondents with incomplete data for the variables of interest and all female respondents. If a respondent does not have complete data, they will be excluded from the sample to be studied

The exclusion of female participants was undertaken to control for sex as a significant confounding variable. Sex is considered a biological confounder in CKD studies due to physiological differences in muscle mass, hormonal profiles, and variations in the prevalence of lifestyle-related risk factors between males and females. By applying restriction (excluding female respondents), this study minimized the confounding effect of sex, allowing for a more focused analysis of lifestyle and hereditary determinants within the male youth population. After applying these criteria, the final sample size for analysis was 46,511 respondents.

Data were originally collected in SKI 2023 using structured questionnaires. The dependent variable in this study was CKD status, categorized nominally as “Yes” or “No” based on self-reported medical diagnosis. The independent variables analyzed included smoking habits, passive smoking exposure, alcohol consumption, excessive salt intake, high-sugar food consumption, sugar-sweetened beverage (SSB) consumption, soda consumption, energy drink consumption, physical activity, type 1 diabetes mellitus, and hypertension.

These variables were measured and categorized according to the operational definitions established in the SKI 2023 instrument. Smoking habits, passive smoking exposure, excessive salt intake, high-sugar food consumption, SSB consumption, soda intake, and energy drink consumption were categorized on an ordinal scale as “Frequent” (e.g., daily or ≥1 time per day), “rarely” (e.g., not daily, 2–6 times per week, or <3 times per month), and “never.” Meanwhile, alcohol consumption, physical activity, type 1 diabetes mellitus, and hypertension were categorized nominally as “Yes” or “No.”

Data analysis was performed using SPSS for Windows in three stages. First, univariate analysis was conducted to describe the distribution and frequency of each variable. Second, bivariate analysis was performed using the Chi-square test (with a 95% confidence level) to assess the association between each independent categorical variable and CKD incidence. Fisher’s exact test was used as an alternative when Chi-square assumptions were not met. Finally, variables with a p-value < 0.25 in the bivariate analysis were included in a multivariate analysis using logistic regression. This stage identified the independent variables with the strongest association with CKD, as indicated by the highest Exp(B) value. This research has been approved by the Semarang State University Research Ethics Committee with number 402/KEPK/FK/KLE/2026.

3. RESULTS AND DISCUSSION

Table 1. Variable Distribution

Variable	Frequency (N)	Percentage (%)
Smoking habit		
Frequent (everyday)	13.753	29.6%
Rarely (not everyday)	4.746	10.2%
Never	28.011	60.2%
Passive smoking exposure		
Frequent (everyday)	15.731	33.8%
Rarely (not everyday)	21.455	46.1%
Never	9.324	20.0%
Alcohol consumption		
Yes	2.602	5.6%
No	43.908	94.4%
Excessive salt intake		
Frequent (≥1 per day)	12.063	25.9%
Rarely (2-6 per week) or (<3 per month)	31.294	67.3%
Never	3.153	6.8%
High sugar food consumption		
Frequent (≥1 per day)	15.955	34.5%
Rarely (2-6 per week) or (<3 per month)	29.938	64.4%
Never	617	1.3%
Sugar-Sweetened Beverages		
Frequent (≥1 per day)	21.883	47.1%
Rarely (2-6 per week) or (<3 per month)	24.061	51.7%
Never	566	1.2%
Soda drink consumption		
Frequent (≥1 per day)	5.499	11.8%
Rarely (2-6 per week) or (<3 per month)	21.401	46.0%
Never	19.610	42.2%

Energy drink consumption		
Frequent (≥1 per day)	1.411	3.0%
Rarely (2-6 per week) or (<3 per month)	17.230	37.0%
Never	27.869	59.9%
Physical activity		
Yes	16.571	35.6%
No	29.939	64.4%
Diabetes mellitus		
Yes	14	0.03%
No	46.496	99.96%
Hypertension		
Yes	96	0.2%
No	46.414	99.8%
Chronic kidney disease status		
Yes	22	0.04%
No	46.488	99.96%

Based on the univariate analysis presented in Table 1, the prevalence of CKD among 46,511 young adults was 0.04% (n = 22), while the majority of respondents (n = 46,488; 99.96%) were not diagnosed with CKD. Previous research by Ma et al. (2025) indicates a significant increase in CKD cases among individuals aged 15–29 years between 1990 and 2021. This upward trend confirms that CKD is increasingly emerging as a critical public health issue among young adults (Wang et al., 2025), reflecting a shift in disease burden toward younger populations.

Clinically, the prevalence of comorbidities among young adults remained relatively high, with hypertension reported at 0.2% (96 cases) and diabetes mellitus at 0.03% (22 cases). However, in the case of hypertension, there is a possibility of true false bias, as the study relied on secondary data without further clinical examination by the researchers to confirm the hypertension status of the participants. Despite this limitation, lifestyle-related risk factors were highly prevalent. A substantial proportion of respondents frequently consumed sugar-sweetened beverages (47.1%) and high-sugar foods (34.5%), while 25.9% reported excessive daily salt intake. In addition, 29.6% of respondents were daily smokers, and 33.8% were exposed to secondhand smoke. Notably, 64.4% of respondents were categorized as having insufficient physical activity. The most prominent lifestyle risk factors identified were inadequate physical activity and frequent consumption of sugar-sweetened beverages.

Table 2. Determinant Factor of Chronic Kidney Disease.

Variable	**Chronic Kidney Disease Status**					
	Yes		**No**		**OR (95% CI)**	**p-Value**
	N	**%**	**N**	**%**		
Smoking habit						
Frequent (everyday)	3	13.6%	13.750	29.6%	2.292	
Rarely (not everyday)	5	22.7%	4.741	10.2%	0.474	0.070
Never	14	63.3%	27.994	60.2%	1.0 Reference	
Passive smoking exposure						
Frequent (everyday)	5	22.7%	15.726	33.8%	1.688	

Rarely (not everyday)	12	54.5%	21.443	46.1%	0.959	0.544
Never	5	22.7%	9.319	20.0%	1.0 Reference	
Alcohol consumption						
Yes	1	4.5%	2.602	5.6%	0.803	1.00
No	22	95.5%	43.908	94.4%		
Excessive salt intake						
Frequent (≥1 per day)	6	27.3%	12.057	25.9%	2.553	
Rarely (2-6 per week) or (<3 per month)	12	54.5%	31.282	67.3%	3.311	0.092
Never	4	18.2%	3.149	6.8%	1.0 Reference	
High sugar food consumption						
Frequent (≥1 per day)	11	50.05	15.944	34.3%	2.353	
Rarely (2-6 per week) or (<3 per month)	10	45.5%	29.928	64.4%	4.858	0.104
Never	1	4.5%	616	1.3%	1.0 Reference	
Sugar-Sweetened Beverages						
Frequent (≥1 per day)	12	54.5%	21.871	47.0%	9.712	
Rarely (2-6 per week) or (<3 per month)	7	31.8%	24.054	51.7%	18.311	<0.001*
Never	3	13.6%	563	1.2%	1.0 Reference	
Soda drink consumption						
Frequent (≥1 per day)	4	18.2%	5.495	11.8%	0.701	
Rarely (2-6 per week) or (<3 per month)	8	36.4%	21.393	46.0%	1.364	0.534
Never	10	45.5%	19.600	42.1%	1.0 Reference	
Energy drink consumption						
Frequent (≥1 per day)	1	4.5%	1,410	3.0%	0.658	
Rarely (2-6 per week) or (<3 per month)	8	36.4%	17.222	37.0%	1.005	0.918
Never	13	59.1%	46.488	59.9%	1.0 Reference	
Physical activity						
No	5	22.7%	16,566	35.6%	0.531	0.206
Yes	17	77.3%	29.922	64.4%		
Diabetes mellitus						
Yes	0	0%	14	0.03%	1.000	1.000
No	22	100%	46.496	99.96%		
Hypertension						
Yes	2	9.1%	94	0.2%	49.355	0.001*
No	20	90.9%	46.394	99.8%		

** = p-value <0.05*

Bivariate analysis using the Chi-square test (or Fisher's exact test as an alternative) was conducted to examine the association between variables. The results showed that two variables were significantly associated with CKD incidence: consumption of sugar-

sweetened beverages ($p < 0.001$; OR = 0.835) and a history of hypertension ($p = 0.001$; OR = 49.355; 95% CI: 11.376–214.136).

In contrast, other lifestyle variables were not statistically significant, including smoking habits ($p = 0.070$), passive smoking exposure ($p = 0.544$), alcohol consumption ($p = 1.000$), excessive salt intake ($p = 0.092$), high-sugar food consumption ($p = 0.104$), soda consumption ($p = 0.534$), energy drink consumption ($p = 0.918$), insufficient physical activity ($p = 0.206$), and a history of diabetes mellitus ($p = 1.000$). Detailed results are presented in Table 2.

Table 2 indicates that frequent consumption of sugar-sweetened beverages was associated with an odds ratio (OR) of 9.712, suggesting that young adults who frequently consume such beverages have a 9.71-fold higher risk of developing CKD compared to those who never consume them. Meanwhile, occasional consumption was associated with an OR of 18.311, indicating an even higher risk (18.31-fold) compared to non-consumers. These findings highlight that sugar-sweetened beverage consumption is a risk factor for CKD.

These results are consistent with evidence from a meta-analysis by Lo et al. (2021) and a longitudinal study by Yuzbashian et al. (2016), both of which demonstrate that sugar-sweetened beverage intake significantly increases CKD risk. The meta-analysis reported that individuals with the highest sugar intake had a relative risk (RR) of 1.30 (95% CI: 1.17–1.45; $p < 0.001$), with each additional daily serving increasing risk by 1.12 times (RR = 1.12; 95% CI: 1.06–1.18; $p < 0.001$). Furthermore, cohort studies indicate that high consumption of sweetened beverages increases the risk of newly onset kidney disorders by up to 2.25 times (OR = 2.25; 95% CI: 1.22–4.15; p-trend = 0.006), with carbonated drinks contributing significantly (OR = 2.14; 95% CI: 1.18–3.88; p-trend = 0.002).

The consumption of sugary beverages, particularly those high in fructose, induces hyperuricemia (elevated uric acid levels), which contributes to inflammation and oxidative stress in renal tubular cells. Additionally, many carbonated beverages contain phosphoric acid, which is associated with alterations in urine composition, kidney stone formation, and impaired renal filtration function. Indirectly, sugary beverages also exacerbate major CKD risk factors such as obesity, hypertension, and type 2 diabetes mellitus through disruptions in glucose metabolism and increased central adiposity. Meta-analytic evidence further demonstrates a significant dose–response relationship, where consumption exceeding four to seven servings per week markedly increases the likelihood of CKD compared to low consumption (<0.5 servings per week).

The variable of hypertension history showed an OR of 49.355, indicating that young adults with a history of hypertension have a 49-fold higher risk of developing CKD compared to those without hypertension. Previous studies have established that prolonged hypertension leads to progressive damage to renal blood vessels and glomeruli. Although excessive salt intake was not directly associated with CKD in this study, existing literature suggests that high sodium intake forces the kidneys to work harder, thereby accelerating structural damage (Borrelli et al., 2020; Gupta et al., 2018). High salt consumption also promotes fluid retention, as sodium attracts water, increasing blood volume and ultimately leading to elevated blood pressure (hypertension).

Table 3. Multivariate Analysis Result.

Variable	B	Wald	p-Value	Adj OR (95% CI)
Hypertension	3.487	19.562	<0.001	32.683 (6.970-153.243)
Sugar-Sweetened Beverages (Frequent)	-1.996	8.713	0.003	0.136 (0.036-0.511)
Sugar-Sweetened Beverages (rarely)	-2.628	13.350	<0.001	0.072 (0.018-0.296)
Constant	-5.571	79.290	<0.001	0.004

In the multivariate analysis using logistic regression, variables with a p-value < 0.25 in the bivariate stage were included in the model including smoking habit,excessive salt intake, high sugar food consumption, the consumption of sugar-sweetened beverages,physical activity, and hypertension. Table 3 shows that in the final multivariate model, the consumption of sugar-sweetened beverages demonstrated a reversal of effect direction, yielding an AOR of 0.136 (p = 0.003) for the "Frequent" category and 0.072 (p < 0.001) for the "Rarely" category. Statistically, an AOR below 1.00 indicates a protective association within this specific model. This drastic change from the initial (bivariate) analysis to the advanced (multivariate) analysis is actually a statistical anomaly, so it should not be interpreted as meaning that ssb somehow protect the kidneys from damage. This seemingly "protective" figure appears purely due to data limitations. This happens because the number of people who actually tested positive for chronic kidney disease in this study is very small only 22 people while the total sample analyzed is massive, reaching 46,511 people.Futhermore Table 3 shows that, after adjusting for other compounding variables, a history of hypertension remained the strongest potential predictor of CKD among individuals aged 15–24 years, yielding an Adjusted OR (AOR) of 32.683.

This finding aligns with a national cohort study by (Bae et al., 2021) involving 3,030,884 young adult participants (20–39 years), which indicated that individuals with stage 1 hypertension (systolic 130–139 mmHg or diastolic 80–89 mmHg) faced a significantly higher risk compared to the normotensive group. Specifically, the stage 1 isolated diastolic hypertension (IDH) group had a hazard ratio (HR 1.32; 95% CI 1.22–1.42), while the stage 1 isolated systolic hypertension (ISH) group had an HR of 1.21 (95% CI 1.06–1.38), with risks increasing sharply in stage 2 hypertension (≥140/90 mmHg) to an HR of 2.36 (95% CI 2.13–2.61).

Adolescents are often highly attracted to foods high in salt and sugar-sweetened beverages due to their palatable and addictive taste. These foods stimulate dopamine release in the brain, creating a sense of pleasure that reinforces repeated consumption (Atar, 2026; Greenberg & St. Peter, 2021). Such unhealthy lifestyle patterns negatively affect individual productivity and increase the burden on national healthcare expenditure. Therefore, lifestyle modification is essential to prevent CKD among young adults, ensuring improved quality of life, sustained productivity, and the successful realization of a high-quality demographic dividend.

4. CONCLUSION

Based on the findings of this study, it can be concluded that the hypertension status and the consumptions of sugar sweetened beverage are the primary determinants of Chronic Kidney Disease (CKD) among young adults aged 15-24 in Indonesia. Although the multivariate model reflects statistical limitations regarding the sweetened beverages variable due to low disease prevalence, both factors remain epidemiologically crucial in driving renal function decline among the productive-age population.As a preventive

measure, the government, particularly the Ministry of Health, should develop targeted policies and health campaigns to reduce the consumption of sugar-sweetened beverage and high-sodium processed foods among adolescents. Educational institutions and families must also play a proactive role in fostering healthier dietary environments. Lastly, since this study relied on secondary data which may introduce information bias, future research should employ longitudinal designs with direct clinical blood pressure measurements to obtain more precise risk estimates.

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