

ORIGINAL RESEARCH

What kind of lifestyle can trigger early kidney function damage in adolescents?

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Abstract

Kidney function damage in adolescents can be influenced by lifestyle behaviors and family risk factors. However, limited studies in Indonesia assessed the risk factor of kidney injury among adolescents. Therefore, this study aims to describe the lifestyles that potentially trigger early kidney function damage among junior high school students. The research employed a descriptive observational design with a quantitative approach. The sample consisted of 60 students selected using a purposive sampling technique. Data were collected via questionnaires covering eating and drinking patterns, physical activity, smoking habits, family medical history, and mild symptoms of kidney disorders, which were then analyzed using descriptive statistics. The results showed that while most respondents were in the "good" category overall, several risk factors were still identified. Specifically, 51.7% of respondents did not meet daily water intake requirements, and 56.7% frequently consumed salty foods. Physical activity was dominated by low to moderate categories, with 55.0% not exercising routinely and 71.7% failing to meet the minimum physical activity requirement of 150 minutes per week. The majority of respondents were non-smokers, though a small percentage engaged in light smoking. A family history of hypertension was found in 46.7% of respondents, and diabetes in 13.3%. Furthermore, some respondents reported mild symptoms such as changes in urination, itching, fatigue, and concentration difficulties. The study concludes that there is a combination of unhealthy lifestyle behaviors, family risk factors, and early symptoms that potentially trigger kidney function disorders in adolescents. Therefore, promotive and preventive efforts through health education and the cultivation of healthy living habits starting from school age are necessary to preserve kidney function in the future.

Keywords: Acute kidney injury, eating and drinking patterns, medical history, physical activity, smoking habits, symptoms of kidney failure

Introduction

The kidney is a vital organ serving in filtering fluids from the bloodstream to eliminate toxins, metabolic waste products, and excess ions (Bjornstad et al., 2025). Acute kidney injury (AKI) is characterized by a sudden loss of renal function, resulting from the kidneys' inability to maintain homeostatic balance (Almazmomi et al., 2023). In addition to the accumulation of nitrogenous waste products such as urea and creatinine, this decline in renal function precipitates fluid and electrolyte imbalances that would otherwise be excreted by healthy kidneys (Nagalingam et al., 2025). From 1990 to 2021, the number of newly diagnosed CKD cases worldwide rose from 7,758,599 to 19,950,853 (Shahbazi et al., 2025). In Indonesia, based on the history of impaired kidney function diagnosed by physician, the prevalence of CKD found in this study was 0.5% (2,085/389,093) (Hustrini et al., 2022). Dietary behaviors and poor nutritional patterns stand out as primary drivers of renal diseases (Lu et al., 2025). Adolescents are particularly prone to risky snacking habits, frequently consuming items high in sugar, salt, and fat (high-sodium, high-sugar, and high-fat foods) (Sun et al., 2024). The nutritional profile escalates the risk of non-communicable diseases, such as diabetes and hypertension, which serve as foundational risk factors for kidney disease. Beyond dietary lifestyle factors, smoking habits also exhibit a significant association with the incidence of kidney disease; both the quantity of cigarettes consumed and the duration of smoking directly amplify the risk of chronic renal failure (Fu et al., 2022). Furthermore, pediatric renal failure can be triggered by long-term insufficient fluid intake (Amaerjiang et al., 2022), underlying nephropathies such as acute nephritis or glomerulonephritis, and hereditary diseases passed down from biological parents, including congenital hypertension and diabetes.

Assessing the risk factors for kidney disease among adolescents is critically important because early-stage renal damage often develops insidiously and remains asymptomatic, delaying clinical detection until irreversible structural harm has occurred (Avila et al., 2023). Adolescence represents a pivotal developmental window marked by rapid physiological shifts and the establishment of lifelong behavioral habits, making it a prime opportunity for early identification and targeted intervention. Rising rates of pediatric obesity, poor dietary patterns, sedentary lifestyles, and secondary hypertension have significantly elevated the vulnerability of young populations to early-onset kidney disease (Jebeile et al., 2022; Avesani et al., 2024). With identifying modifiable risk factors during this formative stage, public health initiatives and clinical providers can implement secondary prevention strategies to halt disease progression, optimize renal outcomes, and ultimately reduce the severe clinical, economic, and psychosocial burdens associated with end-stage renal disease (ESRD) in young adulthood.

Based on a preliminary survey conducted by the researcher at the target junior high school, it was revealed that most students regularly consume sugar-sweetened beverages daily, rarely bring their own water to school, and predominantly engage in sedentary behaviors, such as playing on mobile devices during recess. Several students also reported complaints of easy fatigability and a lack of regular physical exercise. Additionally, a subset of students disclosed a family medical history of hypertension and diabetes mellitus. These baselines indicate the presence of critical risk factors that could potentially trigger early-stage renal impairment. Consequently, this study focuses on profiling the lifestyle characteristics that may induce early renal function decline among junior high school students, encompassing dietary and fluid intake patterns, physical activity, smoking habits, family medical history, and mild symptoms of renal insufficiency. Ultimately, the specific objective of this research is to identify the risk categories of students' lifestyles to provide an empirical framework for promotive and preventive interventions within both school and family environments.

Method

This study utilizes a descriptive observational method with a quantitative approach. Data collection was carried out using validated research instruments, and the data analysis is strictly quantitative. The descriptive design was employed to obtain an objective, real-world depiction of the specific clinical conditions surrounding early renal dysfunction. In this study, the researchers observed the health status of male and female students by tracking their lifestyle behaviors within the school environment. These observations were then evaluated to determine the prevalence of mild, subclinical signs pointing toward early kidney function impairment. This study was conducted in December 2025, having obtained formal permission and approval from the school principal. The study employed a non-probability purposive sampling technique, recruiting a total of 60 active male and female students aged 12–14 from Prapanca Junior High School in Temanggung, Central Java, Indonesia to act as primary information sources. Due to the small population size, all eligible subjects were included, with participant selection guided by specific inclusion and exclusion criteria related to active enrollment and voluntary participation. The study subjects comprised active male and female students at Prapanca Junior High School who served as primary information sources and were capable of providing data relevant to the research problem. Participant selection was guided by specific eligibility protocols. The inclusion criteria required subjects to be active male or female students currently enrolled in the learning process at Prapanca Junior High School, fall within the early adolescent age range of 12–14 years (corresponding to standard junior high school age brackets), and voluntarily consent to participate in all data collection stages and research procedures until completion. Conversely, the exclusion criteria ruled out any students who were unwilling or unable to undergo the full data collection process until its conclusion.

The research instruments were adapted from relevant articles focusing on adolescent lifestyles and renal health. To ensure conceptual alignment with the investigated variables, the consolidated questionnaire underwent an expert judgment process involving health and nursing specialists. The experts evaluated the instrument's content relevance, linguistic clarity, indicator alignment, and item representation. Based on their feedback, the questionnaire was deemed appropriate for data collection following minor editorial refinements to suit the junior high school target demographic. Consequently, the instrument demonstrated sufficient content validity without requiring further statistical pilot testing. The first section of the instrument, assessing lifestyle profiles, was adapted from Aminuddin et al. (2020), who utilized a validated lifestyle questionnaire. In their foundational study, instrument reliability was established using the Perceived Stress Scale (PSS-10), which demonstrated excellent internal consistency (Cronbach's $\alpha=0.96$). The second section evaluated early, non-laboratory clinical indicators of renal dysfunction. This component was adapted from Vassilikopoulos et al. (2021), specifically modifying items related to daily habits, including daily water intake and voiding frequency. Vassilikopoulos et al. established face and content validity to verify that fluid intake and urinary frequency correlate with renal health. Their instrument yielded a moderate internal consistency (Cronbach's $\alpha=0.496$), indicating that while the

items accurately captured routine daily behaviors, they did not exhibit high statistical reliability. The third section incorporated lifestyle domains from Nurmanita (2020), capturing dietary habits, physical activity, and smoking behaviors. Although statistical reliability (such as Cronbach's alpha) was not reported in the original study, procedural reliability was maintained by administering uniform questionnaires through identical interview and observation protocols for all respondents.

The final section addressed the signs and symptoms of renal strain and family medical histories, adapted from literature examining symptom burdens in patients with chronic kidney disease not requiring renal replacement therapy. This instrument achieved content validity through its basis in standard nephrology and nursing literature. Furthermore, measurement consistency was secured through procedural uniformity, utilizing a standardized response format across all participants to ensure high procedural reliability. During the adaptation process, two specific items underwent editorial modifications based on expert judgment to align with the characteristics of junior high school students and the research objectives, without altering the core constructs being measured: Physical Activity Item: Formulated as *"Do you engage in daily activities at school, such as walking or cycling when commuting to and from school?"* This adjustment aimed to capture light-to-moderate physical activities typical of a student's daily routine. Fluid Intake and Excretory Function Item: Formulated as *"Do you use the restroom more than 4 times a day with a total urine output of less than 500 cc per day?"* This item was designed to identify potential fluid intake deficiencies as a lifestyle factor influencing renal health. These editorial refinements enhanced respondent comprehension and questionnaire clarity while preserving instrument validity. The finalized instrument comprises four distinct sections: respondent characteristics, lifestyle profiles, and subclinical signs and symptoms of acute kidney injury (AKI). The adapted items correspond directly with the risk factors of renal damage.

Data collection was conducted using primary data sources, gathered directly from respondents through a structured, multi-step process from administrative permitting to questionnaire distribution. First, the researcher obtained a preliminary study permit from the university to submit to Prapanca Middle School Temanggung, alongside conducting initial interviews regarding the school's general context. Following a successful thesis proposal defense, the researcher secured an official data collection permit from the university and delivered it to the institution. Eligible students were then selected as respondents based on predetermined inclusion criteria. Prior to data collection, the researcher explained the study's purpose and procedures to the participants. The questionnaires were subsequently distributed, accompanied by clear instructions on how to complete the items. If respondents encountered difficulties during the process, the researcher provided guidance while ensuring the answers reflected the respondents' own choices.

The gathered questionnaire responses were tabulated and analyzed using SPSS software. This study utilized descriptive statistics, a statistical technique designed to summarize, organize, and present data in a meaningful manner. Descriptive statistics involve percentage, frequency distribution of the data. The processed data were subsequently presented using frequency distribution tables and categorical classifications aligned with the scoring system of the administered questionnaire. This study obtained ethical approval from the Ethics Committee of the Faculty of Health Sciences (Number:014/KEPK-FIKES/II.3.AU/F/2025), and the research team strictly adhered to ethical principles throughout the study.

Results

The majority of respondents in this study were 9th-grade students ($n=31$, 52.5%), most were 14 years old ($n=27$, 45.8%), and the majority were male ($n=35$, 59.3%) (**Table 1**). Meanwhile, the results of this study show that the majority of respondents had not yet engaged in optimal physical activity. Specifically, 55.0% did not exercise regularly, and 71.7% failed to meet the recommended minimum of 150 minutes of physical activity per week. Although 65.0% performed light activities such as walking or cycling to school, these actions remained daily routine habits rather than structured exercise, thereby limiting their potential health benefits. Regarding dietary and fluid intake habits, 51.7% of respondents fell short of the recommended daily water intake of at least 8 glasses per day. Furthermore, 56.7% frequently consumed salty foods, and 35.0% fairly often consumed caffeinated beverages. While a portion of respondents (42.4%) maintained a frequency of three meals per day, the overall dietary quality and fluid adequacy remained unbalanced, highlighting the need for dietary adjustments to support optimal renal health.

In terms of smoking behaviors, the majority of respondents were non-smokers (55.0%), with 91.7% not smoking 11–20 cigarettes daily and 98.3% not exceeding 20 cigarettes per day; nevertheless, the presence of a small subgroup exposed to smoking underscores the necessity of early preventive education. Assessment of family medical history revealed that 46.7% of respondents had a family history of hypertension and 13.3% reported a family history of diabetes mellitus, indicating inherited risk factors that could increase future vulnerability to renal impairment. Additionally, several

respondents reported early mild symptoms, including altered urination patterns (35.0%), skin pruritus (41.7%), decreased appetite (31.7%), fatigue (20.0%), bone and joint pain (25.0%), and impaired concentration while studying (60.0%). Although these clinical manifestations remain mild, they serve as crucial early signals warranting close monitoring. Overall, these findings highlight a cumulative combination of sub-optimal lifestyle behaviors, familial predisposition, and early warning symptoms that may increase the risk of early renal dysfunction among students, emphasizing the need for sustained school-based health promotion and preventive initiatives to foster regular physical activity, healthy dietary habits, and early risk avoidance. The researcher did not include tables to present these findings.

Table 1. Demographic characteristics.

Characteristics	<i>n</i>	Percentage (%)
Class		
7 th	8	13.6
8 th	20	33.9
9 th	31	52.5
Age (in years old)		
11	1	1.7
12	6	10.2
13	4	6.8
14	27	45.8
15	17	28.8
16	3	5.1
17	1	1.7
Sex		
Male	35	59.3
Female	24	40.7

Discussion

This study demonstrates a variability in adolescent lifestyle behaviors that precipitate early renal function decline, encompassing dietary and fluid intake patterns, physical activity, smoking habits, familial medical histories, and mild signs of renal insufficiency. The variations in central tendency and data dispersion across each indicator illustrate differing degrees of risk factor exposure among respondents. Regarding dietary and fluid intake, the findings reveal that the majority of respondents fail to meet recommended daily water consumption thresholds, which potentially accelerates renal function decline; adequate hydration is recognized as a protective mechanism capable of slowing eGFR reduction. Additionally, respondents' sodium intake remains structurally high, a habit significantly associated with an elevated risk of developing kidney disease. In contrast, caffeine consumption among respondents generally falls within the low-to-moderate range; while caffeine does not invariably induce direct renal damage, it nonetheless influences fluid balance and blood pressure dynamics, acting as an ancillary risk factor for renal failure (Patil & Salunke, 2020). These insights reinforce the premise that the primary nutritional challenge lies not only in the types of food consumed but heavily in daily fluid management. A subset of students presents with insufficient water intake paired with a preference for high-sodium foods.

The results indicate that the physical activity levels of the respondents are confined to the low-to-moderate categories, particularly regarding structured, planned exercise and the fulfillment of cumulative weekly physical activity durations. Physical activity plays an indispensable role in preventing non-communicable diseases as recommends a minimum of 150–300 minutes of moderate-intensity aerobic physical activity per week to secure optimal health benefits (Yang et al., 2019). In terms of daily exercise habits, a substantial portion of respondents do not engage in regular physical exercise, mirroring global reports indicating that vast populations fail to meet established physical activity guidelines. Moreover, the majority of respondents fell short of the 150-minute weekly threshold, despite robust evidence showing that increased physical activity mitigates kidney disease risks by modulating blood pressure and reducing obesity. While daily incidental movement yields baseline health benefits, optimal protective effects against chronic systemic pathologies are only realized through regular MVPA, which enhances long-term physical health, cognitive function, mental well-being, and chronic disease prevention. Therefore, the low prevalence of regular exercise in this cohort warrants targeted public health attention through school-based promotive and educational strategies.

Smoking represents an established lifestyle risk factor capable of damaging renal structures via exposure to toxic substances like nicotine, carbon monoxide, and free radicals, which collectively trigger vascular endothelial dysfunction and oxidative stress (Matsumoto et al., 2024). The findings show that while the vast majority of respondents are non-smokers or smoke very infrequently, a small subset engages in light-to-moderate smoking. Nonetheless, chronic light smoking retains the pathological potential to induce renal impairment over time by fostering systemic hypertension, endothelial damage, and sustained oxidative stress pathways. Epidemiological evidence confirms that active smokers face a significantly higher risk of kidney disease progression; nicotine exposure specifically accelerates glomerular injury and worsens proteinuria, with smoking remaining strongly correlated with renal tissue damage via inflammatory cascades, even when initiated at a young age. Consequently, despite the absence of heavy smoking patterns in this sample, early-stage smoking behaviors demand immediate preventive and educational interventions within the school environment. Family medical history stands as a critical, non-modifiable risk factor that increases an individual's susceptibility to early renal dysfunction. This study reveals that nearly half of the respondents possess a family history of hypertension, suggesting an interplay of genetic predispositions and shared familial environmental/dietary patterns that could elevate cardiovascular risks from an early age.

Hypertension drives structural alterations within the renal parenchyma which impairs the filtration barrier, causes a gradual decline in kidney function and progress to kidney disease (De Bhailis & Kalra, 2022). Furthermore, a portion of respondents reported a family history of diabetes mellitus, which, despite its lower prevalence in this sample, represents an equally vital risk vector. Diabetes mellitus is the primary driver of diabetic nephropathy, a microvascular complication characterized by damage to the renal capillaries that serves as a leading cause of renal disease across both type 1 and type 2 diabetes lineages. Collectively, the presence of familial hypertension and diabetes underscores that these adolescents carry an elevated baseline risk for renal pathology. This necessitates the early adoption of health-protective lifestyles, proactive risk factor mitigation, and early clinical screening to preempt future renal damage (Tomašev et al., 2019). The self-reported mild symptoms among respondent's hint at potential early-stage renal insufficiency, though these indicators remain clinically non-specific. Some respondents noted an increased frequency of urination accompanied by low urinary volume, a clinical presentation that can indicate an early compromise in the kidneys' concentrating and filtration capacities. This pattern suggests that the renal system may be experiencing early difficulties maintaining fluid balance, causing the body to compensate by executing frequent, low-volume voiding cycles. Complaints of pruritus (itching) reported by several respondents may be explained by the subclinical accumulation of metabolic waste products in the bloodstream due to suboptimal renal excretory function. Additionally, diminished appetite was reported, a symptom often tied to early uremic toxin accumulation and subsequent neuro-hormonal dysregulation affecting the gastrointestinal tract. These manifestations illustrate that early renal strain extends beyond the urinary tract to impact broader systemic metabolism.

Furthermore, a subset of respondents reported excessive fatigue, which may correlate with subclinical anemia or disrupted energy metabolism secondary to renal impairment. Bone and joint discomfort noticed by some students could stem from early mineral imbalances involving calcium and phosphate homeostatic pathways. Meanwhile, the relatively high incidence of concentration difficulties points to the potential neurocognitive influence of retained toxic metabolites and subtle electrolyte imbalances. Viewed holistically, the emergence of these mild, interconnected symptoms serves as an early warning signal of potential renal strain. Although these complaints do not yet signify severe clinical pathology, their presence should not be overlooked; they emphasize the need for early health screening and lifestyle modifications within schools to prevent progression toward irreversible renal injury. In synthesis, this investigation highlights that junior high school students exhibit a complex web of lifestyle behaviors capable of triggering early-stage renal function decline. A significant proportion of the cohort lacks adequate fluid intake and exhibits high-sodium dietary patterns, thereby placing a continuous metabolic load on the kidneys. Concurrently, physical activity is dominated by sedentary or light behaviors that fail to meet standard public health guidelines, leaving students without optimal metabolic and cardiovascular protection. While heavy smoking is rare, the presence of light smoking habits presents a persistent threat to vascular and endothelial health. Compounding these modifiable behavioral risks are the non-modifiable liabilities of familial hypertension and diabetes, which place these adolescents at a higher baseline vulnerability. Crucially, the presence of subtle symptoms—such as altered voiding frequencies, pruritus, chronic fatigue, and cognitive friction—further aligns with potential early-stage renal strain. These findings confirm that renal risk in adolescents is multifactorial, emerging from the convergence of daily behavioral habits and genetic predispositions. Consequently, there is an urgent need to deploy structured promotive and preventive health strategies, cultivate healthy eating and hydration habits, and establish early screening mechanisms within the school environment to safeguard the long-term renal health of the adolescent population.

Conclusion

This study shows that certain students practice lifestyle habits—such as insufficient exercise, poor diet, low water intake, and light smoking—that may trigger early kidney decline. These risks are compounded by hereditary factors like a family history of hypertension and diabetes, which significantly increase long-term vulnerability to renal disorders. Especially, some respondents reported mild, subclinical signs of renal strain, including altered urination patterns, itching, fatigue, and poor concentration. This concerning intersection of behavioral habits and genetic predisposition elevates the overall risk of adolescent kidney damage. To protect future kidney health, schools must urgently implement structured health education programs that promote early, preventive wellness habits.

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AI statements

The authors declare that no generative text artificial intelligence (AI) tools were utilized at any stage of this research process, including data analysis and figure generation. The use of AI-assisted technology was strictly limited to the Grammarly plugin within Microsoft Office solely for grammar correction, copyediting, and improving text readability.

Author declaration

All authors contributed significantly to the conceptualization and formulation of the research topic, reviewed and refined the methodology and data collection processes, and participated in preparing and finalizing the manuscript for journal publication.

Availability of data and materials

All data collected in this study are fully presented within this article. Anyone requiring further details about the research process may contact the corresponding author.

Competing interests

None.

Ethical clearance

This study received ethical approval from the Research Ethics Committee of the Faculty of Health Sciences at Universitas Muhammadiyah Magelang. The researchers adhered to all ethical regulations and guidelines throughout the data collection process.

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Publishers and journal's note

This study holds significant value as it provides empirical data for the host institution to implement preventative measures against kidney disease in adolescents. Furthermore, these findings offer an evidence-based foundation for designing school-specific nutritional policies and early screening programs to young populations.

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Authors' perspective

Innovation points

- Excess sodium raises blood pressure, while high sugar intake leads to obesity and insulin resistance, both of which accelerate early kidney damage through renal hyperfiltration.
- Neglecting plain water in favor of energy drinks or sodas deprives the kidneys of the fluid needed to properly flush out metabolic toxins, forcing the organs to work under extreme stress.
- Prolonged sitting, excessive screen time, and a failure to meet the minimum weekly requirement of 150 minutes of physical activity contribute heavily to metabolic syndrome.

Potential areas of interest

- What is the exact statistical correlation between these overlapping dietary habits and the presence of early microalbuminuria or altered glomerular filtration rates (eGFR) in the sample group?
- How do hereditary family risk factors interact with an adolescent's sedentary lifestyle to accelerate the onset of early kidney dysfunction?
- What specific biochemical screening tools (e.g., urine dipsticks or serum creatinine tests) are recommended to complement these self-reported questionnaires for a more definitive clinical diagnosis?

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