

Association Between High-Sodium Food Consumption and Sleep Quality among Young Adults

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Abstract

Background: Excessive sodium intake is associated with various health issues, including hypertension and cardiovascular disorders, which may contribute to circadian rhythm disturbances and nocturnal urination that can impair sleep quality. This study aimed to explore the association between high-sodium food consumption and sleep quality among young adults.

Methods: A cross-sectional study was conducted among 107 preclinical medical students aged 18–22 years at Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia, from August to October 2024. Participants were selected using proportional-to-size sampling. Sodium intake was assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), and sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI). Data were analyzed using Fisher's exact test.

Results: Among the 107 participants, 36.4% consumed sodium above the recommended daily intake. Male participants had a higher mean sodium intake than female participants ($2,262 \pm \text{SD mg/day}$ vs. $1,897 \pm \text{SD mg/day}$), although the difference was not statistically significant ($p=0.260$). Most participants (77.6%) had good sleep quality based on PSQI scores. A significant association was observed between high-sodium food consumption and sleep quality ($p<0.001$).

Conclusion: High sodium dietary habits are associated with poor sleep quality among young adults. These findings highlight the importance of monitoring the daily sodium intake and reducing the consumption of sodium-rich foods to support better sleep quality and overall health.

Keywords: Dietary sodium, sleep quality, sodium intake

Althea Medical Journal.
2026;13(2):107-114

Received: December 30, 2024

Accepted: October 31, 2025

Published: May 31, 2026

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Introduction

Healthy eating habits during adolescence are crucial for supporting growth and establishing lifelong dietary patterns.¹ The most important factor affecting health is a lifestyle. The current upward trend in overweight and obesity among younger populations is a consequence of inadequate lifestyle habits. The study aimed to characterise youth nutrition behaviour and knowledge in the context of the risk of developing overweight or obesity. The study group consisted of 307 high school students, 59% females and 41% males, aged between

15 and 19. Nutrition behaviours were studied using the standardised Questionnaire of Eating Behaviour. Body weight and body height were measured with a body composition analyser and a body height meter, respectively. It was observed that the average body mass index was $21.7 \pm 3.4 \text{ kg/m}^2$ for the females and $22.3 \pm 3.1 \text{ kg/m}^2$ for the males ($p=0.036$). Adolescent dietary behaviour significantly impact both current and future health outcomes, including the health of future offspring.² However, modern urban adolescents increasingly consume high-sodium foods, which has become a growing public health concern

because of its association hypertension and other non-communicable diseases.³

A study conducted in Jakarta, Indonesia has reported that average sodium consumption among adolescents has reached 2,694 mg/day, exceeding the World Health Organization recommendation of less than 2,000 mg/day.⁴ Interestingly, a study from South Korea resulted that most adolescents who frequently consumed high-sodium instant foods tended to have poorer sleep quality.⁵ Salt may contribute to the current health issues among adolescents. Excessive sodium intake may affect sleep quality through several mechanisms, including fluid retention mediated by activation of the renin-angiotensin-aldosterone system, nocturnal urination, obstructive sleep apnea, and disruption of circadian rhythm regulation.⁶⁻⁸ Sleep quality is particularly critical during adolescence since it influences overall health and academic performance.⁹

Recently, the studies investigating sodium intake and sleep quality mainly focused on office workers or adult populations, which may not accurately represent adolescents dietary behaviours and lifestyle patterns. In addition, prior studies commonly used food lists derived from the Korea National Health and Nutrition Examination Survey, which differ substantially from Indonesian dietary patterns and food composition. These differences underscore the need for population-specific investigations. Therefore, this study aimed to explore the association between high sodium dietary habits and sleep quality among young adult in Jakarta, Indonesia.

Methods

This analytical observational study employed a cross-sectional design and was conducted among medical students at the Atma Jaya Catholic University of Indonesia, North Jakarta, Indonesia, between August and October 2024. Sodium intake and sleep quality data were collected using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) and the Pittsburgh Sleep Quality Index (PSQI).

Participants aged 18-22 years were selected using proportional-to-size random sampling to ensure representation from first- through fourth-year medical students. Randomization was applied to minimize potential bias in data collection. Exclusion criteria were students using medications or supplements that could affect sleep quality, such as opioids, benzodiazepines, tricyclic antidepressants, barbiturates, amphetamines, or multivitamin

supplements, students following a medically supervised low-sodium diet program, and students diagnosed with sleep disorders. Eligibility criteria were assessed through a preliminary screening questionnaire containing self-reported medical and dietary history. Written informed consent was obtained from all participants prior to data collection. Ethical approval was granted by the Research Ethics Committee of the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia (No. 02/07/KEP-FKIKUAI/2024)

The SQ-FFQ questionnaire consisted of 50 sodium-rich foods items adapted from the Indonesian Food Composition Table (*Tabel Komposisi Pangan Indonesia*, TKPI).¹⁰ The questionnaire assessed food consumption frequency using categories of "never," "1-3 times per month," "1-4 times per week," "5-6 times per week," to "daily," with an additional section for portion size per meal estimation. Frequency categories were converted into median consumption values, multiplied by portion size, and summed to estimate total sodium intake. The cumulative value was then divided by 30 to obtain the average sodium intake over the previous month. Sodium intake exceeding 2,000 mg per day was categorized as high sodium consumption, while intake below 2,000 mg per day was considered as normal. The list of sodium-rich foods included in the SQ-FFQ was shown in Table 1.

Sleep quality was measured using the PSQI, which included both subjective and objective aspects of sleep quality with a total score ranging from 0 to 21. A global PSQI score >5 indicated poor sleep quality. The PSQI questionnaire components was depicted in Table 2.

Data were analyzed using statistical software. Univariate analysis was performed to describe respondent characteristics and variable distributions. The association between high-sodium food consumption and sleep quality was analyzed using Fisher's Exact tests. Statistical significance was set at $p < 0.05$.

Results

A total of 122 respondents met the inclusion and exclusion criteria, and 107 respondents were randomly selected according to the proportional sample distribution for each year of medical study. Most respondents were female (68.2%), while males accounted for 31.8%. The mean age of respondents was 19.84 ± 0.91 years, with a proportional

Table 1 Sodium-Rich Food Items Adapted from the Indonesian Food Composition Table

Food Item	Sodium Content (mg/100 g)
Kacang kedelai (Soybean)	3,492
Misoa	3,064
Daging sapi asap (Smoked beef)	1,620
Dendeng paru sapi	1,547
Keju (Cheese)	1,410
Kerupuk kemplang	1,307
Ampela ayam goreng (Fried chicken gizzard)	980
Chicken teriyaki	959
Bihun goreng instan (Instant fried rice vermicelli)	928
Paru sapi goreng (Fried beef lung)	923
Empal (Sweet beef fry)	848
Kerupuk cumi (Squid crackers)	837
Sayap ayam goreng Kentucky (Kentucky fried chicken wings)	807
Sayap ayam goreng Texas (Texas fried chicken wings)	771
Sosis daging sapi (Beef sausage)	765
Mie kering (Dried noodles)	760
Mie bakso (Meatball noodle soup)	760
Tahu telur (Tofu omelette)	755
Ayam goreng Kentucky dada (Kentucky fried chicken breast)	741
Sosis hati sapi (Beef liver sausage)	654
Pempek kapal	628
Kalio (gulai) otak (Brain curry)	604
Beef burger	572
Kalio (gulai) ayam (Chicken curry)	534
Roti tawar putih (White bread)	530
Mie pangsit (Wonton noodles)	530
Kalio (gulai) kikir (Cow skin curry)	519
Shabu-shabu	514
Bulgogi	509
Ayam taliwang	507
Sop buntut (Oxtail soup)	490
Pempek adaan	488
Asinan Bogor	483
Telur asin bebek (Salted duck egg)	483
Susu bubuk skim (Skim milk powder)	470
Kerupuk udang (Shrimp crackers)	449
Pempek telur	448
Kacang hijau (Mung beans)	447
Sop kaki sapi (Beef trotter soup)	435

Table 1 Continued

Food Item	Sodium Content (mg/100 g)
Sukiyaki	426
Beef yakiniku	409
Plecing kangkung	409
Capcay sayur (Mixed vegetable stir-fry)	405
Moon tahu	393
Sop daging sapi (Beef soup)	391
Beef teriyaki	377
Soto jeroan (Offal soup)	363
Ikan cakalang (Skipjack tuna)	360
Sop kambing (Mutton soup)	348
Keripik kentang (Potato chips)	712

distribution based on their study year as depicted in Table 3.

The mean frequency of high-sodium food

consumption among all respondents was 39 ± 20.99 times per month. Males respondents reported a higher frequency of consumption

Table 2 Indonesian Version of the Pittsburgh Sleep Quality Index (PSQI)

No	Question
1	Jam berapa biasanya Anda mulai tidur pada malam hari?
2	Berapa lama biasanya Anda membutuhkan waktu untuk tertidur setiap malam?
3	Jam berapa biasanya Anda bangun pada pagi hari?
4	Berapa lama Anda tidur pada malam hari?
5	Seberapa sering masalah berikut mengganggu tidur Anda? <ol style="list-style-type: none"> Tidak dapat tertidur dalam waktu 30 menit setelah berbaring Terbangun di tengah malam atau terlalu dini Terbangun untuk pergi ke kamar mandi Tidak dapat bernapas dengan nyaman Batuk atau mendengkur Merasa kedinginan pada malam hari Merasa kepanasan pada malam hari Mengalami mimpi buruk Merasa nyeri Alasan lain yang mengganggu tidur Seberapa sering Anda mengalaminya
6	Dalam satu bulan terakhir, bagaimana Anda menilai kualitas tidur Anda secara keseluruhan?
7	Dalam satu bulan terakhir, seberapa sering Anda mengonsumsi obat (dengan atau tanpa resep dokter) untuk membantu Anda tidur?
8	Dalam satu bulan terakhir, seberapa sering Anda mengalami kesulitan untuk tetap terjaga atau tidak merasa mengantuk saat berkendara, makan, atau melakukan aktivitas sosial?
9	Dalam satu bulan terakhir, apakah Anda mengalami kesulitan berkonsentrasi atau mempertahankan antusiasme untuk menyelesaikan pekerjaan atau tugas?

Table 3 Respondents Characteristics (n=107)

Variables	Category	Number of Respondents (n)	Percentage (%)	p-value
Gender	Male	34	31.8	
	Female	73	68.2	
High sodium food consumption status	Normal	68	63.6	
	High	39	36.4	
Average sodium intake	All respondents	2,013±SD mg/day		0.260
	Male	2,262±SD mg/day		
	Female	1,897±SD mg/day		
Frequency of high-sodium food consumption	All respondents	39±20.99 times/month		0.248
	Male	42.5 times/month		
	Female	37.4 times/month		
Sleep quality status	Good	83	77.6	
	Poor	24	22.4	
Average PSQI score	All respondents	3.7±1.94		0.066
	Male	4.21±2.08		
	Female	3.47±1.83		

(42.5 times/month) compared with females (37.4 times/month), although the difference was not significant (p=0.248). The mean daily sodium intake among respondents was 2,013 mg/day, slightly exceeding the WHO recommendation of less than 2,000 mg/day. Overall, 36.4% of respondents were categorized as having high sodium intake (>2000 mg/day). Male respondents had a higher average sodium intake (2,262 mg/day) compared with female respondents (1,897 mg/day), however, the difference was not statistically significant (p=0.260)

Sleep quality assessment using the PSQI showed that 22.4% of respondents had poor sleep quality (PSQI score >5). The average PSQI score for respondents was 3.7±1.94. Male respondents had a slightly higher average PSQI

score (4.21±2.08) compared with females (3.47±1.83), although the difference was not statistically significant (p=0.066)

Interestingly, there was a significant relationship between high-sodium food consumption and sleep quality (p=0.000). Among respondents with high sodium intake, 51.3% had poor sleep quality, while only 5.9% of respondents with normal sodium intake experienced poor sleep quality (Table 4).

Discussion

In this study, female participants exhibited a lower frequency of high-sodium food consumption compared with male participants. This finding may reflect greater

Table 4 Association Between High-Sodium Food Consumption and Sleep Quality

High Sodium Food Consumption Status	Sleep Quality				Fisher's Exact
	Good		Poor		
	Number (n)	Percentage (%)	Number (n)	Percentage (%)	p-value
Normal	64	94.1	4	5.9	0.000
High	19	48.7	20	51.3	
Total	83		24		

awareness among women regarding dietary sodium restriction, consistent with a previous study involving medical students in Malaysia that reported female students were more likely to limit salt intake and adopt healthier dietary behaviours.⁹ practice of salt consumption, awareness, perception, attitude of dietary salt intake. Results: A total of 362 respondents participated. The majority had good awareness on salt intake (98.1% Recording sodium consumption frequency is important because it provides insights into daily, weekly, and monthly dietary patterns, which may assist in developing targeted nutritional intervention.

This study revealed that the average sodium intake among respondents was 2,013 mg/day. This value was slightly lower than the national average reported in previous Indonesian study,¹⁰ and still exceeded the WHO recommended limit of 2,000 mg/day. Differences between studies may be explained by variations in study population, sample size, age range, and dietary assessments methods. This study specifically focused on young adults aged 18–22 years, whereas national surveys generally include broader age categories.

Male respondents had higher sodium intake than female respondents, consistent with previous study conducted in Jakarta showing that adult males consumed more sodium daily than female.⁴ Another study also reported that women were more likely to monitor salt content on food packaging, substitute salt with spices, and avoid adding salt during cooking, while men were more frequently added salt during food preparation.¹¹

This study found that 36.4% of respondents consumed sodium exceeding the recommended limit (2000 mg/day). This prevalence was lower than findings from the 2014 Individual Food Consumption Survey (SKMI) reporting excessive sodium intake in 55.7% of adolescents aged 13–18 years and 54.8% of adults aged 19–59 years.¹⁰ The lower prevalence observed in this study may be attributable to difference in food items included in the SQ-FFQ and differences in dietary habits among medical students. Furthermore, this study mainly evaluated sodium intake from commonly consumed foods and may not have fully captured all dietary sodium sources.

Sleep quality is particularly critical among medical students because inadequate sleep has been associated with impaired academic performance and reduced cognitive function.¹² In this study, the average PSQI score was 3.7, indicating generally good sleep quality among

respondents. This finding differs from studies in Bangladesh and several other countries, where the prevalence of poor sleep quality among medical students was considerably higher¹³

Male respondents demonstrated slightly poorer sleep quality than females, although the difference was not statistically significant. Similar findings were reported in a study from Yemen involving medical students⁸ Hormonal differences may partly explain this pattern. Estrogen has been reported to improve sleep regulation and quality, while lower estrogen levels are associated with sleep disturbances and depressive symptoms.¹⁴

Furthermore, this study has shown a relationship between high sodium intake and poor sleep quality. This finding aligns with a study in Korea showing that higher daily sodium intake correlates with poorer sleep quality and increased sleep disturbances.⁵ A study in Thailand also revealed similar results, indicating that respondents who added high-sodium sauces and seasonings to their dishes experienced difficulty maintaining sleep.¹⁵ A study conducted in Malaysia also demonstrated a direct association between increased sodium intake and overall PSQI scores, subjective sleep quality, and reduced sleep efficiency.¹⁶

Several physiological mechanisms may explain the relationship between excessive sodium intake and sleep disturbance. High sodium intake increases extracellular fluid volume and activates the renin–angiotensin–aldosterone system, contributing to fluid retention and elevated blood pressure.^{3,17,18} Excessive sodium intake increases extracellular fluid volume, which in turn can affect blood pressure and kidney function.¹⁹ Redistribution of retained fluid to the neck region during sleep may increase the risk of obstructive sleep apnea.⁷ Other studies have also shown that excessive sodium intake may also increase thirst, causing individuals to wake up more frequently at night to urinate. Consequently, sleep duration is reduced and sleep quality is further impaired.^{5,20}

In addition, excessive sodium intake may affect neurotransmitter pathways involved in sleep regulation, particularly dopamine activity as observed in experimental animal study showing that high-sodium diets increased dopaminergic neuron activity, contributing to increased wakefulness and sleep disturbances.²¹ This finding supports the theory that excessive sodium intake may negatively impact the physiological and neurological pathways regulating sleep.

Poor sleep quality among students also has the potential to reduce cognitive abilities and academic performance.²² Adequate and quality sleep is essential to support memory function, concentration, and learning productivity.¹² Therefore, improving sleep quality through healthier dietary habits may contribute not only to physical health but also to academic performance and psychological well-being. This study has several limitations. First, the SQ-FFQ did not include all possible sodium-containing foods commonly consumed by students, which may have led to underestimation of sodium intake. Second, other nutritional components, including macronutrients and micronutrients that may influence sleep quality were not specifically analyzed. Third, external factors affecting sleep quality, such as stress levels, environmental condition, physical activity, caffeine intake, and screen time, were not fully controlled.

In conclusion, high sodium intake is associated with poorer sleep quality among medical students. These findings highlight the importance of promoting healthier dietary habits and reducing sodium-rich food consumption among university students. Universities may support these efforts by providing healthier food options, implementing nutritional education programs, and raising awareness about the importance of adequate sleep and balance nutrition to support both academic achievement and overall well-being.

Authors' Contributions

AAG conducted the study, performed data collection and data analysis, and drafted the manuscript. LL dan VV conceived and designed the study and contributed to data interpretation, manuscript drafting and review. ND and PKS contributed to data interpretation and manuscript review. All authors approved the final version of manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Funding

This study received no external funding.

Generative AI Disclosure Statement

The authors used ChatGPT (OpenAI) to assist with English language editing, grammar correction, and translation of the manuscript. The authors reviewed and verified all outputs and take full responsibility for the final content.

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