



Coffee and caffeine consumption and their association with cognitive function, sleep, and academic performance among adolescents: a narrative review

Konsumsi kopi dan kafein serta hubungannya dengan fungsi kognitif, tidur, dan prestasi akademik pada remaja: tinjauan naratif

Miftahul Jannah^{1*}, Wahyu Aulia Hasibuan², Prananingrum Kinasih³, Honey Yahdillah⁴, Jihan Alfira⁵

¹ Nutrition Program, Faculty of Health and Science, Batam International University, Batam, Indonesia.

E-mail: miftahul.jannah@uib.ac.id

² Nutrition Program, Faculty of Health and Science, Batam International University, Batam, Indonesia.

E-mail: wahyu.hasibuan@uib.ac.id

³ Nutrition Program, Faculty of Health and Science, Batam International University, Batam, Indonesia.

E-mail: prananigrum.kinasih@uib.ac.id

⁴ Nutrition Program, Faculty of Health and Science, Batam International University, Batam, Indonesia.

E-mail: honey.yahdillah@uib.ac.id

⁵ Nutrition Program, Faculty of Health Sciences, Bina Bangsa University, Serang, Indonesia.

E-mail: jihan.alfira@binanbangsa.ac.id

*Corresponding Author:

Nutrition Program, Faculty of Health and Science, Batam International University, Batam, Indonesia.

E-mail: miftahul.jannah@uib.ac.id

Article History:

Received: July 09, 2026; Revised: July 27, 2026; Accepted: August 07, 2026; Published: September 15, 2026.

Publisher:



Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

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Abstract

Caffeinated beverage consumption is common among adolescents and may influence their attention, sleep, and academic functioning. This study aimed to synthesize evidence on the relationship between coffee and caffeine consumption and cognition, attention, sleep, and academic performance among adolescents. This literature review searched PubMed and ScienceDirect for English-language, peer-reviewed articles published from July 2016 through June 2026. Eleven articles were retained: five adolescent studies, one multi-population systematic review used as background evidence, and five young adult studies used as contextual comparators. The findings were synthesized narratively by outcome domain. Results: Acute caffeine administration was associated with dose-dependent improvements in sustained attention. In contrast, habitual or late-day food intake is associated with poor sleep quality or short sleep duration. Young adult studies have shown similar patterns, although their findings are not directly generalizable to adolescents. Evidence directly linking caffeine intake to adolescent academic performance is limited and largely observational. In conclusion, caffeine may provide short-term attentional benefits; however, intake timing and habitual use may compromise sleep, which is an important determinant of adolescent functioning. More rigorous adolescent-specific studies are required.

Keywords: Academic performance, adolescents, caffeine, cognition, sleep quality

Abstrak

Konsumsi minuman berkafein umum dijumpai pada remaja dan dapat berkaitan dengan perhatian, tidur, serta fungsi akademik. Studi ini bertujuan untuk mensintesis bukti mengenai hubungan konsumsi kopi dan kafein dengan fungsi kognitif, perhatian, tidur, dan prestasi akademik pada remaja. Metode, tinjauan pustaka ini menelusuri PubMed dan ScienceDirect untuk artikel berbahasa Inggris yang ditelaah sejawat dan terbit pada Juli 2016-Juni 2026. Sebelas artikel dipertahankan: lima penelitian remaja, satu tinjauan sistematis multipopulasi sebagai bukti latar, dan lima penelitian dewasa muda sebagai pembanding kontekstual. Temuan disintesis secara naratif berdasarkan domain luaran. Hasil, pemberian kafein akut berkaitan dengan peningkatan perhatian berkelanjutan yang bergantung pada dosis. Sebaliknya, konsumsi rutin atau mendekati waktu tidur berkaitan dengan kualitas tidur yang lebih buruk atau durasi tidur yang lebih pendek. Penelitian pada dewasa muda menunjukkan pola serupa, tetapi temuannya tidak dapat langsung digeneralisasi pada remaja. Bukti yang secara langsung menghubungkan asupan kafein dengan prestasi akademik remaja masih terbatas dan

terutama bersifat observasional. Kesimpulan, kafein dapat memberikan manfaat perhatian jangka pendek, tetapi waktu dan pola konsumsi dapat mengganggu tidur yang penting bagi fungsi remaja. Diperlukan penelitian khusus remaja dengan rancangan yang lebih kuat.

Kata Kunci: Kafein, kognisi, kualitas tidur, prestasi akademik, remaja

Introduction

Caffeinated beverages are widely consumed by adolescents, although their prevalence varies substantially by beverage type, setting, and population. A global systematic review and meta-analysis of 192 studies estimated pooled lifetime energy drink use at 54.7%, with a particularly high prevalence among adolescents and young adults, while also documenting pronounced heterogeneity across regions and measurement periods (Aonso-Diego et al., 2024). In a cross-sectional study of Polish adolescents aged 16-18 years, the mean caffeine intake was 95.54 mg/day; 12.2% exceeded 3 mg/kg/day, and tea, cola beverages, and chocolate were important sources in addition to coffee and energy drinks (Błaszczuk-Bębenek et al., 2021). In the BREDA project in Spain, involving 1,250 secondary school students aged 13-18 years, reported consumption was 57.7% for carbonated soft drinks, 27.2% for sports drinks, and 11.8% for energy drinks; regular energy drink consumption was more common among upper-secondary than lower-secondary students (Cachero-Rodríguez et al., 2026). In an earlier BEENIS study of nearly 4,800 students in Sabadell, Spain, 49.2% reported energy drink consumption, mostly during leisure time and sometimes in combination with alcohol (Cruz-Muñoz et al., 2020). Among college students in North America, 92% reported consuming caffeine from at least one source during the previous year, primarily to stay awake or improve their concentration (Mahoney et al., 2019). Collectively, these findings indicate substantial exposure in selected adolescent and young adult populations but do not support a uniform global prevalence estimate for all caffeinated products.

Digital marketing may contribute to the normalization of caffeine-containing products among young audiences. A content analysis of the game-streaming platform Twitch found frequent food and nonalcoholic beverage marketing cues in content commonly viewed by adolescents (Evans et al., 2024), while energy drink advertising in esports commonly uses

performance imagery and celebrity endorsement (Kerr et al., 2025). In a longitudinal study of 6,902 German adolescents, more frequent exposure to energy drink advertising predicted initiation one year later, and energy drink use was also associated with poorer school performance and other risk indicators (Galimov et al., 2019). Reviews of evidence involving children and young people likewise identify peer influence, taste, availability, marketing, and performance-related expectations as recurring drivers of use, although most of the underlying studies are cross-sectional (Ajibo et al., 2024; Visram et al., 2016). These findings reinforce the need for age-specific evaluations of caffeine consumption patterns and health-related outcomes.

Regarding consumption safety, a systematic review covering adults, pregnant women, adolescents, and children concluded that intakes up to approximately 2.5 mg/kg body weight/day in children and adolescents were not consistently associated with adverse effects across the evaluated outcomes (Wikoff et al., 2017). A later child- and adolescent-focused review similarly concluded that typical moderate intake appears relatively safe for most healthy young people, while emphasizing uncertainty regarding vulnerable individuals, high-dose products, and long-term exposure (Temple, 2019). Interindividual variation in CYP1A2-mediated metabolism and ADORA2A-related sensitivity may partly explain why sleep, anxiety, and other responses differ at comparable doses (Nehlig 2018). Accordingly, the absence of consistent effects below the proposed threshold should not be interpreted as proof of safety for every product, intake pattern, or individual.

Caffeine consumption among adolescents may also be associated with other health behaviors. In the Canadian COMPASS study of nearly 47,000 secondary school students, more frequent caffeinated beverage consumption was associated with a greater likelihood of current cigarette smoking or e-cigarette use (Fagan et al., 2020). Systematic reviews have similarly linked energy drink use in children and

adolescents with substance use, risk-taking, poorer school-related outcomes, and psychological or socio-educational difficulties (Marinoni et al., 2022a, 2022b). In a nationally representative sample of 68,043 Korean adolescents, energy drink intake was associated with sleep dissatisfaction, severe stress, depressive mood, and suicidality, with stronger associations among frequent consumers (Park et al., 2016). Because these studies are predominantly observational, the findings indicate behavioral clustering and possible shared determinants rather than proof that caffeine or energy drinks directly cause associated behaviors.

These findings support a focused review of the relationship between coffee and caffeine consumption and cognitive function, attention, sleep, and academic performance among school-aged adolescents. Experimental evidence suggests that caffeine can acutely improve sustained attention in a dose-dependent manner (Cooper et al., 2021), consistent with evidence that adenosine receptor antagonism can enhance alertness, vigilance, attention, and reaction time at low-to-moderate doses, while effects on memory and higher-order executive function are less consistent (McLellan et al., 2016). Conversely, evening caffeine exposure may impair sleep architecture and alter circadian timing (Reichert et al., 2021), and a meta-analysis of experimental studies found reductions in total sleep time and sleep efficiency after caffeine consumption (Gardiner et al., 2023). This trade-off is relevant because population-based and systematic review evidence links inadequate or poor-quality sleep with weaker academic functioning in adolescents, although effect sizes and measurements vary (Hysing et al., 2016; Musshafen et al., 2021). Previous syntheses have generally addressed caffeine safety, energy drink use, and sleep as separate topics (Ajibo et al., 2024; Temple, 2019; Visram et al., 2016). No review has jointly synthesized adolescent-specific evidence across cognition, attention, sleep, and academic performance using a structured, transparent methodology.

Accordingly, this review aimed to synthesize the evidence on the relationship between coffee and caffeine consumption and cognition, attention, sleep, and academic performance among adolescents. It also

examined whether sleep may represent a plausible explanatory pathway and used evidence from college students and young adults only for contextual comparison. This review aimed to clarify the nutrition and public health implications of caffeine dose, timing, and consumption patterns while identifying gaps in adolescent-specific evidence.

National evidence provides a useful contextual contrast. Among Indonesian medical students, caffeine use was common, but the mean intake was modest, and coffee was the dominant source (Br Ginting et al., 2022). Studies on adolescent and university populations have reported both significant and nonsignificant associations between caffeine or coffee consumption and sleep outcomes (Agustiana & Nafisah, 2024; Budiayanti & Wijaya, 2023; Lioe et al., 2025; Nafi'awani & Adyani, 2023). These findings were not added to the primary evidence set because the present search retained only English-language articles; however, they help demonstrate the need for culturally and product-specific research in Indonesia.

Methods

Study Design

This literature review aimed to summarize and synthesize the evidence on the relationship between coffee and caffeine consumption and cognition, sleep, and academic performance among adolescents.

Research Question Framework (PECO)

The research question was structured using a Population, Exposure, Comparator, and Outcome (PECO) framework adapted from established eligibility-framing approaches for evidence reviews (Amir-Behghadami & Janati, 2020). The population comprised adolescents or school-aged students aged 10-19 years.

The exposures were coffee, caffeine, or caffeinated/energy beverage consumption, including acute experimental administration and habitual dietary intake. Comparators included non-consumers, lower exposure groups, placebo conditions, or baseline/pre-intervention conditions. The outcomes included cognitive function (e.g., sustained attention and working memory), sleep quality or duration, and academic performance. Studies of college

students or young adults aged 18-25 years were considered separately as contextual comparator evidence and were not treated as direct evidence for adolescents. Eligible study designs included randomized trials, crossover experiments, cohort studies, and cross-sectional studies.

Literature Search Strategy

The search was conducted in PubMed and ScienceDirect in July 2026 and covered publications from July 2016 to June 2026. PubMed was used as the principal biomedical bibliographic database, and ScienceDirect was used as an additional publisher-platform source. The following search terms were developed from the PECO framework and adapted to the search functionality of each source.

PubMed:

("caffeine" OR "coffee" OR "energy drink") AND ("adolescent" OR "teenager*" OR "high school student*" OR "secondary school student*") AND ("academic performance" OR "cognitive function" OR "working memory" OR "attention" OR "sleep quality" OR "sleep duration" OR "productivity")*

ScienceDirect:

"caffeine consumption adolescent productivity"; "coffee caffeine adolescent cognitive performance"; "caffeine adolescent sleep quality academic"; "energy drink consumption adolescent academic performance"

No language filter was applied at the database search stage; however, only English-language articles were retained during screening because of the review team's language competency. The review was limited to peer-reviewed journal articles, including original research and review articles published in English. Grey literature, conference abstracts, dissertations, and book chapters were excluded from the study. Database-specific filters for publication period, population, and article type were applied, where available, to target the stated review period from July 2016 to June 2026 (Figure 1).

Eligibility Criteria

Primary evidence studies were eligible if they included school-aged adolescents aged 10-19 years, assessed exposure to coffee, caffeine, or caffeinated/energy beverages, and measured at least one outcome related to cognition, attention, working memory, sleep quality or duration, or

academic performance. Studies limited to adults, elite athletes, or clinical populations, such as individuals with attention-deficit/hyperactivity disorder, were excluded from the primary evidence set because age and underlying health status could affect the associations of interest. Studies focusing exclusively on physical performance, migraine, or pharmacokinetics were also excluded. Studies of college students or young adults aged 18-25 years were retained only as contextual comparator evidence and were synthesized separately; their findings were not considered directly generalizable to school-aged adolescents.

Study Selection Process

Study selection was conducted in two sequential stages. First, the titles and abstracts were screened against the eligibility criteria. Second, the full texts of potentially relevant articles were assessed to determine their final inclusion. The process is summarized using a PRISMA 2020 flow diagram (Figure 1) (Page et al., 2021).

All records retrieved from PubMed (n = 36) and ScienceDirect (n = 336) were compiled, yielding 372 records. Duplicate records were removed, resulting in 321 unique records screened for eligibility criteria. Title and abstract screening led to the exclusion of 310 records from the study. The primary reasons for exclusion were population mismatch, namely samples that did not consist of school-aged adolescents or, for the comparison group, college students or young adults, such as adult-only, elite athlete, or specific clinical populations (n = 219); outcome mismatch, namely outcomes unrelated to cognition, sleep, or academic/productivity performance, such as pure pharmacokinetics, bio accessibility, physical sport performance, or marketing-interest outcomes (n = 73); and review-type articles that were not primary empirical studies and fell outside the scope of in-depth data extraction (n = 18). This left 11 records for the full-text eligibility assessment.

Full-text assessment resulted in an evidence set of 11 articles: four studies of school-aged adolescents assessing cognition, attention, or sleep as primary evidence; one additional school-aged adolescent study assessing a consumption-behavior outcome (smoking and e-cigarette use) as adolescent contextual evidence; one multipopulation systematic review used only as background evidence on caffeine safety; and five

studies of college students or young adults used as contextual comparators. These evidence groups were synthesized separately because they did not serve equivalent inferential roles in the study. The selection process is illustrated in Figure 1.

Data Extraction

Data were extracted using a structured framework that included study identification, population characteristics, study design, caffeine exposure, outcomes, key findings, and selected methodological quality indicators of the included studies. The framework was used to consistently organize information across the 11 retained articles and to support the narrative synthesis. Table 1 summarizes the extracted domains and items of the study.

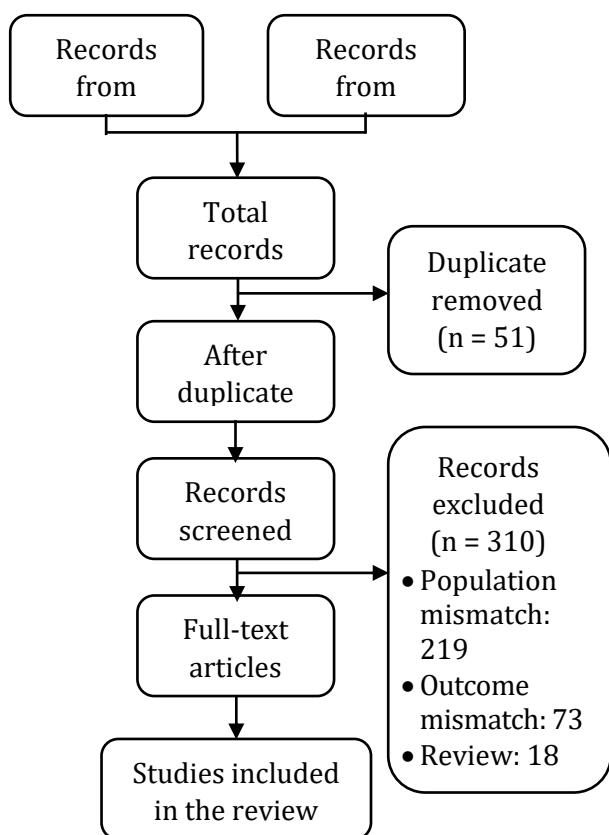


Figure 1. PRISMA 2020 flow diagram of the study selection process.

Table 1. Domains and items recorded in the structured data extraction form.

Domain	Information Extracted
Study identification	Author(s), year of publication, journal name, country where study was conducted
Population characteristics	Population category (school-aged adolescent or college student/young

Domain	Information Extracted
Methodology	adult comparator), age range or mean age, sample size, sex distribution, habitual caffeine consumption status Study design (randomized crossover trial, cross-sectional survey, cohort/longitudinal, systematic review), exposure assessment method (experimental dosing versus self-reported habitual intake), source of caffeine assessed (coffee, tea, energy drink, or combined), duration of exposure or observation period
Outcome measure(s)	Type of outcome assessed, namely cognitive/attention performance, sleep quality or duration, or academic/productivity-related performance; instrument or tool used (e.g., sustained attention task, Pittsburgh Sleep Quality Index, self-reported GPA, psychometric model)
Key findings	Main results, direction of association (positive, negative, or no significant association), quantitative data where available (e.g., odds ratio, percentage, dose-response effect)
Quality indicators	Presence of control or comparison group, randomization or crossover design, statistical adjustment for confounders (e.g., socio-demographic factors), and disclosure of funding or conflict of interest

Data Synthesis

Quantitative meta-analysis was not appropriate for this review because of substantial clinical and methodological heterogeneity among the included studies, including differences in caffeine exposure measurement, ranging from acute experimental dosing in some studies to self-reported habitual intake in others; differences in outcome instruments, including sustained attention tasks, sleep quality questionnaires, self-reported academic grades, and psychometric models; and differences in study design, ranging from randomized crossover trials to cross-sectional surveys. This combination of differences meant that effect sizes across studies could not be meaningfully compared or statistically pooled into a single valid summary measure. Findings were synthesized narratively according to three dimensions: outcome domain (cognition/attention, sleep quality or duration, and academic performance), population (school-aged adolescents versus college students or young adults), and study design (experimental versus observational). Evidence from the

adolescent population was treated as the primary evidence base, whereas findings from college students and young adults were used only as contextual comparisons rather than being generalized directly to school-aged adolescents. To strengthen this synthesis process, a simple critical appraisal was conducted for each included study, considering methodological indicators such as sample size, presence of a control or comparison group, use of randomization or crossover design, statistical adjustment for confounders such as sociodemographic characteristics, and disclosure of funding sources. This critical appraisal was used to qualify the strength of the findings within the synthesis, for instance, by assigning more cautious interpretive weight to self-reported cross-sectional studies compared with randomized experimental studies, rather than treating all included studies as evidence of equal strength.

For cognition and attention outcomes, the findings were compared according to the direction and consistency of the associations and, where reported, caffeine dose or exposure level. For sleep outcomes, the synthesis considered the timing and dosage of intake in relation to sleep quality, duration, and architecture. Sleep has been discussed as a potential explanatory pathway linking caffeine exposure with academic or daytime functioning, but not as a confirmed mediator unless formally tested. Findings from college students and young adults were synthesized separately and not generalized directly to school-aged adolescents. The study design, sample size, comparison

groups, and adjustment for confounding factors were considered when interpreting the strengths and limitations of the evidence.

Result and Discussion

Eleven articles were retained for narrative synthesis: four adolescent studies assessing cognition, attention, or sleep as primary evidence; one additional adolescent study assessing consumption patterns and behavioral clustering as contextual evidence; one multipopulational systematic review used only as background evidence; and five studies of college students or young adults used as contextual comparators. Most of the retained studies were cross-sectional. Two adolescent studies used randomized experimental designs: a dose-response trial evaluating sustained attention and a crossover trial evaluating caffeine-related sleep effects.

Across the heterogeneous evidence set, an emerging pattern distinguished acute attentional effects from sleep-related effects. Experimental adolescent studies have suggested short-term improvements in sustained attention after caffeine exposure, whereas observational and experimental evidence has linked habitual or later-day caffeine use with poorer sleep-related outcomes. Evidence directly addressing academic performance in adolescents is limited, and findings from young adult comparator studies were interpreted separately. Table 2 summarizes the characteristics and key findings of these articles.

Table 2. Characteristics and key findings of the 11 articles retained for narrative synthesis

Author (Year)	Characteristics and Methods	Outcome(s)	Key Findings
Cooper et al. (2021)	Primary adolescent studies. Adolescents aged 12–17 years (n = 31); randomized dose-response experiment.	Sustained attention	Acute caffeine intake improves sustained attention in a dose-dependent manner. The higher dose (3 mg/kg) resulted in faster target detection compared to the lower dose.
Reichert et al. (2021)	Primary adolescent study. Male adolescents aged 14–17 years (n = 18); randomized crossover trial.	Sleep and circadian timing	Evening caffeine intake increases subjective alertness but reduces slow-wave sleep and may delay circadian timing.
Shimura et al. (2018)	Primary adolescent studies. High school students aged 15–17 years (n = 344); cross-sectional survey.	Sleep disturbance and daytime sleepiness	Nighttime caffeine consumption was significantly associated with sleep disturbance, with an effect comparable to screen use before bedtime.
Glasbeek et al. (2022)	Primary adolescent study. Adolescents with a mean age of 13.3 years (n = 972) were included in the cross-sectional analysis of baseline data from a randomized controlled trial.	Sleep duration	Caffeine use, as an indicator of poor sleep hygiene, mediated the relationship between sociodemographic factors and reduced sleep duration in women.
Fagan et al. (2020)	Primary adolescent consumption pattern	Cigarette	More frequent consumption of

Author (Year)	Characteristics and Methods	Outcome(s)	Key Findings
	study. Students in grades 9–12 (n = 46,957); cross-sectional analysis from the COMPASS Study.	smoking and e-cigarette use	caffeinated beverages was associated with a greater likelihood of current cigarette smoking and e-cigarette use among adolescents.
Wikoff et al. (2017)	Background evidence involves multiple populations. Adults, pregnant women, adolescents, and children: a systematic review.	Adverse health effects	Caffeine intake of up to approximately 2.5 mg/kg/day is generally not associated with consistent adverse health effects; however, evidence specific to adolescents remains limited.
Mahoney et al. (2019)	A comparator study involving college students. College students (n = 1,248); cross-sectional survey.	Caffeine consumption patterns and motives	Overall, 92% of the participants reported caffeine consumption in the previous year. The most frequently reported motives were staying awake (79%) and improving their concentration (31%).
Alshakhs et al. (2022)	A comparator study involving university students. University students (n = 523) cross-sectional survey.	Caffeine-related knowledge and consumption	Awareness of the alertness-enhancing effects of caffeine was associated with higher coffee consumption.
Fathima and Ahmed (2026)	A comparator study involving university students. University students (n = 996); cross-sectional survey with psychometric modeling.	Insomnia and academic performance	Caffeine consumption was identified as a major predictor of poor academic performance in the predictive model (area under the curve = 0.96).
Mushkani et al. (2026)	Comparator study involving university students. University students in Kabul; sample size not reported in the abstract; cross-sectional survey.	Energy drink consumption, sleep duration, and perceived effects	The prevalence of energy-drink consumption was 89.97%. Habitual consumers reported greater reductions in sleep duration and were more likely to use energy drinks as study aids compared to occasional consumers.
Elsahoryi and Alhaj (2026)	A comparator study involving young adults. Healthy women aged 18–25 years (n = 40); pilot randomized controlled trial.	Sleep quality, leptin levels, and cardiovascular risk markers	Short-term Turkish coffee consumption is associated with poor sleep quality, low leptin levels, and increased cardiovascular risk markers.

Table 3. Methodological quality assessment of the 11 included studies using JBI critical appraisal checklists

Author (Year)	Study Type	Appraisal Tool Used	Key Domain Judgments	Key Findings
Cooper et al. (2021)	Randomized dose-response experiment	JBI Checklist for RCTs	Randomization: Yes. Blinding of participants: Yes (double blinding). Allocation concealment: unclear (not reported). Outcome assessor blinding: unclear. Groups were treated identically. Appropriate statistical analysis: yes.	Low-to-moderate risk (strong design, small sample)
Reichert et al. (2021)	Randomized crossover trial	JBI Checklist for RCTs	Randomization: Yes. Blinding of participants: Yes (double-blind). Allocation concealment: unclear. Outcome assessor blinding: Unclear. Groups treated identically: Yes (cross-over). Appropriate statistical analysis: Yes.	Low-to-moderate risk (strong design, very small sample, n=18)
Shimura et al. (2018)	Cross-sectional survey	JBI Checklist for Analytical Cross-Sectional Studies	The inclusion criteria were clear. Exposure measured validly: unclear (self-report). Confounders identified: Yes (other lifestyle habits). Confounders addressed: partially (logistic regression). Outcome measured validly: Yes (validated sleepiness scale).	Moderate risk
Glasbeek et al. (2022)	Cross-sectional (RCT baseline data)	JBI Checklist for Analytical Cross-Sectional Studies	Inclusion criteria clear: Yes. Exposure measured validly: unclear (self-report). Confounders identified: Yes (sociodemographic factors). Confounders addressed: Yes (mediation analysis). Outcome measured validly: Yes (validated questionnaire).	Low-to-moderate risk
Fagan et al. (2020)	Cross-sectional (COMPASS study)	JBI Checklist for Analytical Cross-Sectional Studies	The inclusion criteria were clear. Exposure measured validly: unclear (self-report). Confounders identified: Partially. Confounders addressed: Yes (regression, very large sample size). Outcome measured validly: Yes (validated survey instruments).	Moderate risk (large sample; outcome outside primary review scope)

Author (Year)	Study Type	Appraisal Tool Used	Key Domain Judgments	Key Findings
Wikoff et al. (2017)	Systematic review (multi-population)	Not formally appraised	Used only as background/contextual evidence on dosage safety; not treated as primary evidence contributing to the outcome synthesis, and therefore excluded from individual study risk-of-bias rating.	Not applicable (background evidence)
Mahoney et al. (2019)	Cross-sectional survey	JBIChecklist for Analytical Cross-Sectional Studies	Checklist for Analytical Cross-Sectional Studies Inclusion criteria clear: Yes. Exposure measured validly: unclear (self-report). Confounders identified: Not reported. Confounders addressed: No. Outcome measured validly: Yes (a structured survey).	Moderate-to-high risk (no confounding control)
Alshakhs et al. (2022)	Cross-sectional survey	JBIChecklist for Analytical Cross-Sectional Studies	The inclusion criteria were clear. Exposure measured validly: Unclear (self-report). Confounders identified: Not reported. Confounders addressed: No. Outcome measured validly: Yes.	Moderate-to-high risk (no confounding control)
Fathima and Ahmed (2026)	Cross-sectional, psychometric modeling	JBIChecklist for Analytical Cross-Sectional Studies	Inclusion criteria clear: Yes. Exposure measured validly: Unclear (self-report). Confounders identified: Partially (model covariates). Confounders addressed: partially (no external validation reported; overfitting risk not addressed). Outcome measured validly: Yes.	Moderate risk (predictive model, unvalidated externally)
Mushkani et al. (2026)	Cross-sectional survey	JBIChecklist for Analytical Cross-Sectional Studies	Inclusion criteria clear: Yes. Exposure measured validly: Unclear (self-report). Confounders identified: Not reported. Confounders addressed: No. Outcome measured validly: Yes (a structured questionnaire).	Moderate-to-high risk (male-only sample, no confounding control)
Elsahoryi and Alhaj (2026)	Pilot randomized controlled trial	JBIChecklist for RCTs.	Randomization: Yes. Blinding: Unclear (not reported in this pilot design). Groups were similar at baseline: Yes (reported). Appropriate statistical analysis: Yes, but underpowered, given the pilot sample.	Moderate risk (pilot study, limited precision)

Caffeine Consumption Patterns Among Adolescents

Sources of caffeine among adolescents are diverse and vary according to food culture and product availability. A global meta-analysis by Aonso-Diego et al. (2024) found high energy drink exposure, particularly among adolescents and young adults, but also substantial between-study heterogeneity. In Poland, Błaszczuk-Bębenek et al. (2021) showed that tea, cola beverages, and chocolate contribute significantly to adolescent caffeine intake, illustrating why studies limited to coffee or energy drinks can underestimate total exposure. Data from the BREDa project in Spain showed an appreciable use of carbonated soft drinks, sports drinks, and energy drinks, with regular energy drink consumption more common among upper-secondary students (Cachero-Rodríguez et al., 2026).

The BEENIS study likewise reported energy drink use among nearly half of respondents, mainly during leisure time and sometimes with alcohol (Cruz-Muñoz et al., 2020). In the Canadian COMPASS study, caffeinated beverage consumption was

associated with cigarette and e-cigarette use (Fagan et al., 2020), supporting the interpretation that caffeine-related behaviors may form part of a broader lifestyle pattern.

This level of consumption cannot be separated from the marketing and social contexts. Twitch content commonly viewed by adolescents contains frequent food and non-alcoholic beverage marketing cues (Evans et al., 2024), and esports advertising often presents energy drinks as performance-enhancing products through striking imagery and celebrity endorsements (Kerr et al., 2025). Longitudinal evidence from German schools strengthens concerns about this pathway because advertising exposure predicted the subsequent initiation of energy drink use (Galimov et al., 2019). Reviews involving children and adolescents also identified peer norms, taste, accessibility, branding, and perceived functional benefits as recurring influences (Ajibo et al., 2024; Visram et al., 2016). At the university level, students commonly report using caffeine to stay awake, concentrate, or meet study demands (Alshakhs et al., 2022; Mahoney et al., 2019; Mushkani et al., 2026). These young adult

findings are contextual rather than directly generalizable to school-aged adolescents, but they illustrate how academic demands may reinforce caffeine use over time.

Short-Term Effects on Cognition and Attention

Experimental evidence in school-aged adolescents suggests that caffeine may provide short-term cognitive benefits to them. In a randomized dose-response experiment involving 31 adolescents aged 12-17 years, caffeine acutely improved sustained attention during a prolonged, monotonous task, and the 3 mg/kg dose produced faster target detection than the 1 mg/kg dose (Cooper et al., 2021). This effect is biologically plausible because caffeine antagonizes adenosine receptors and can improve alertness, vigilance, attention, and reaction time; however, its effects on memory and complex executive functions are less consistent (McLellan et al., 2016). Variations in metabolism and receptor sensitivity may further modify individual responses (Nehlig, 2018). A national narrative review has discussed the possible memory-related benefits of coffee, but the heterogeneity of the included evidence and the contribution of non-caffeine coffee compounds limit direct inference for adolescents (Damayanti et al., 2023).

These acute cognitive findings should be interpreted cautiously because the outcomes were measured within hours of consumption and do not necessarily represent learning, academic achievement, or sustained productivity in daily life. Wikoff et al. (2017) found no consistent adverse effects at intakes up to approximately 2.5 mg/kg body weight/day in children and adolescents across the outcomes evaluated; however, adolescent-specific evidence is limited. Temple (2019) similarly emphasized that moderate intake may be tolerated by many healthy young people, but higher doses, concentrated energy drink formulations, individual susceptibility, and co-use with other substances require caution.

Sleep as a Potential Explanatory Pathway

In contrast to short-term attentional effects, evidence suggests that caffeine intake, particularly later in the day, impairs adolescent sleep. In a double-blind randomized crossover trial of 18 male adolescents aged 14-17 years, 80 mg of caffeine administered four hours before

bedtime increased subjective alertness but reduced slow-wave sleep and may have delayed circadian timing (Reichert et al., 2021). A cross-sectional study of 344 high school students in Tokyo found that habitual nighttime caffeine consumption was associated with sleep disturbance (Shimura et al., 2018). More recently, a latent-class analysis of 1,404 adolescents found that the mixed use of several caffeinated products was associated with greater difficulties in initiating or maintaining sleep, daytime dysfunction, and shorter school-day sleep than lower-use patterns (Sancho-Domingo et al., 2025). These findings align with the broader systematic evidence that caffeine impairs sleep in a dose- and timing-sensitive manner (Clark & Landolt, 2017; Gardiner et al., 2023).

In a study of 972 adolescents in the Netherlands, caffeine use was one component of sleep hygiene practices that statistically mediated associations between sociodemographic factors and sleep reduction (Glasbeek et al., 2022). Indonesian adolescent studies illustrate the uncertainty inherent in cross-sectional evidence: Agustiana and Nafisah (2024) reported a significant association between coffee consumption and poor sleep among 81 senior high school students, whereas Nafi'awani and Adyani (2023) found no statistically significant association between caffeine intake and sleep quality among 215 students. University studies in Indonesia have generally reported associations between caffeine exposure and disturbed sleep, although differences in exposure assessment, dose, timing, and individual tolerance constrain comparison (Budiayanti & Wijaya, 2023; Lioe et al., 2025). These mixed findings support the careful measurement of total caffeine dose and timing rather than classifying exposure solely as consumption versus non-consumption. In Indonesian middle-aged and older adults, sedentary behavior was associated with obesity, whereas sleep quality and diet quality were not (Kinasih et al., 2024). Although not directly generalizable to adolescents, these findings underscore the need to consider broader lifestyle factors when interpreting sleep-related health outcomes.

The proposed sleep-academic performance pathway is supported more strongly by sleep research than by direct caffeine-academic studies. In a large population-based adolescent

study, later bedtimes, short sleep, and sleep deficits were associated with poor school performance (Hysing et al., 2016). A systematic review and meta-analysis of US secondary school students found only small or negligible pooled associations, underscoring inconsistent definitions and measurements across studies (Musshafen et al., 2021). Objective monitoring in college students, nevertheless, showed that longer, better-quality, and more consistent sleep across weeks was associated with stronger academic performance (Okano et al., 2019). Young adult comparator studies have also linked caffeine-related exposure with insomnia or poorer sleep, but their findings cannot establish the same pathway in school-aged adolescents (Elsahoryi & Alhaj, 2026; Fathima & Ahmed, 2026). Thus, sleep remains a plausible explanatory pathway, but mediation should not be claimed unless caffeine exposure, sleep, and academic outcomes are measured longitudinally and tested using the same model.

Energy Drinks and Health Considerations Beyond Caffeine

Coffee, tea, caffeinated soft drinks, and energy drinks should not be treated as interchangeable exposures because their caffeine dose, serving size, added sugar content, and other bioactive ingredients vary substantially. This distinction is also relevant from a broader nutritional perspective, as diets high in ultra-processed foods, which are typically characterized by high energy, sugar, sodium, and saturated fat content, have been associated with an increased risk of metabolic syndrome and its components (Kinasih & Jannah, 2026).

The updated systematic review by Ajibo et al. (2024) and two reviews by Marinoni et al. (2022a, 2022b) indicate that energy drink use among young people is repeatedly associated with physical symptoms, psychological difficulties, poorer school-related outcomes, substance use, and other risk behaviors, although causal inference remains limited. Consistent with this pattern, Korean adolescents who reported energy drink use also reported more sleep dissatisfaction, stress, depressive mood, and suicidality (Park et al., 2016). Among Kabul University students, habitual consumers more frequently reported reduced sleep duration, palpitations, and insomnia than occasional consumers (Mushkani et al., 2026). A cardiovascular

review described transient effects on blood pressure, heart rate, and catecholamines, particularly at higher doses or among susceptible individuals (Turnbull et al., 2017), while a Chilean university study reported associations with anxiety, depression, and stress symptoms without establishing their directionality (Castillo et al., 2026).

Cross-Country Variation in Consumption Patterns and Social Context

Caffeine consumption patterns vary across countries and are shaped by culture, product availability, socioeconomic conditions, and the food environment. A study of young adults in Saudi Arabia described beverage choices influenced by local preferences and campus availability (Islam et al., 2020).

Indonesian data also suggest that the source and level of exposure depend on context: among medical students, coffee was the principal caffeine source, and the average intake remained relatively low despite the high prevalence of use (Br Ginting et al., 2022), while adolescent studies have produced both significant and nonsignificant sleep associations (Agustiana & Nafisah, 2024; Nafi'awani & Adyani, 2023). Because much of this evidence comes from single institutions and self-reported cross-sectional surveys, locally relevant guidance should consider typical products, serving sizes, doses, timing, and co-consumption rather than importing a single universal exposure threshold.

Strengths and Limitations

This review used explicit eligibility criteria, a documented search strategy, and a structured data extraction. However, the synthesis was limited by the use of only two search sources, restriction to English-language publications, inclusion of heterogeneous study designs and age groups, and the absence of a formal risk-of-bias assessment.

Most outcome evidence was observational, and small adolescent experimental studies limited precision and generalizability. The inclusion of college students and young adults provides context but cannot substitute for evidence specific to adolescents. These limitations should be considered when interpreting the apparent patterns and formulating recommendations.

Conclusion

Current evidence suggests that caffeine may acutely improve sustained attention in adolescents, whereas habitual or late-day intake is more consistently associated with poorer sleep. Evidence directly linking caffeine intake to academic performance in adolescents remains limited and largely observational. Therefore, sleep should be considered a plausible explanatory pathway rather than a confirmed mediator. The overall certainty of evidence for these associations was judged to be low to moderate, reflecting the small number of adolescent studies, substantial heterogeneity in exposure and outcome measurements, predominantly observational designs, and the methodological limitations identified in the critical appraisal.

Nutrition and public health guidance for adolescents should emphasize the dose, timing, and avoidance of caffeine as a substitute for adequate sleep. Future evidence syntheses should use a clearly defined review design and formal critical appraisal, while primary studies should prioritize prospective designs, objective exposure measures, and validated cognitive, sleep, and academic outcome measures.

Acknowledgements

The authors gratefully acknowledge the financial support provided by the Research and Community Service Institute (LPPM) of the Universitas Internasional Batam (UIB). The authors also thank the individuals and institutions whose support facilitated the completion of this review.

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