

Sleep Quality, Memory Functioning, and Academic Performance Among Adolescents: Examining the Mediating Role of Memory Functioning

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Abstract

Adolescence is a critical developmental period characterised by profound biological, cognitive, and psychosocial changes that substantially influence health and educational outcomes. Sleep plays an indispensable role in neurocognitive functioning, particularly memory consolidation, attention, and executive processes that underpin academic achievement. Increasing academic demands, extensive digital media exposure, irregular sleep schedules, and psychosocial stress have contributed to widespread sleep disturbances among adolescents worldwide. Despite growing evidence linking sleep quality with cognitive and educational outcomes, limited research has comprehensively examined the mechanisms through which sleep quality influences academic performance, particularly in the Indian context.

This study investigated the relationships among sleep quality, memory functioning, and academic performance among adolescents and examined whether memory functioning mediates the association between sleep quality and academic performance.

A quantitative cross-sectional design was employed among 102 adolescents selected using purposive sampling. Participants completed standardized questionnaires assessing sleep quality, memory functioning, and academic performance. Descriptive statistics, reliability analysis, Pearson's correlation, multiple regression, and mediation analyses were conducted using SPSS.

Sleep quality demonstrated significant positive associations with memory functioning and academic

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performance. Memory functioning was also significantly associated with academic performance and emerged as the strongest predictor in the regression model. Mediation analysis revealed a significant indirect effect of sleep quality on academic performance through memory functioning, indicating that improvements in sleep quality may enhance academic outcomes by strengthening memory processes.

The findings highlight memory functioning as an important cognitive pathway linking sleep quality with academic performance. The study underscores the importance of promoting healthy sleep behaviours among adolescents to support cognitive development and educational achievement. School-based sleep education, parental awareness, and early behavioural interventions may contribute substantially to improving both psychological well-being and academic success.

Keywords: Adolescents | Sleep Quality | Memory Functioning | Academic Performance | Cognitive Functioning | Mediation Analysis

I. INTRODUCTION

Adolescence represents one of the most dynamic periods of human development, characterised by rapid physical growth, neurological maturation, cognitive advancement, and increasing psychosocial responsibilities. During this developmental stage, the brain undergoes extensive structural and functional reorganisation that supports higher-order cognitive abilities, including learning, reasoning, emotional regulation, executive functioning, and memory. These developmental changes coincide with increasing academic expectations, greater independence, evolving social relationships, and heightened exposure to digital technologies, all of which may substantially influence adolescents' sleep patterns and cognitive functioning. (Carskadon, 2020; Fuligni & Hardway, 2024)

Sleep is increasingly recognised as a fundamental biological process essential for optimal physical health, psychological well-being, and cognitive performance. Beyond its restorative functions, sleep facilitates neuronal plasticity, emotional regulation, metabolic homeostasis, and immune functioning while enabling the consolidation of newly acquired information into long-term memory. Contemporary neuroscientific research demonstrates that sleep actively participates in strengthening neural connections established during wakefulness, thereby improving learning efficiency, problem-solving ability, and memory retention. (Rasch & Born, 2013a; Walker & Stickgold, 2004).

The importance of sleep assumes even greater significance during adolescence because of developmental alterations in circadian rhythm and sleep homeostasis. Physiological changes occurring during puberty delay melatonin secretion, causing adolescents to naturally prefer

later bedtimes while still being required to wake early for school. This biological mismatch frequently results in chronic sleep restriction, irregular sleep schedules, and poor sleep quality. Such sleep disturbances have become increasingly prevalent worldwide owing to academic pressure, excessive screen exposure, social media engagement, reduced physical activity, and heightened psychological stress. (Becker et al., 2021; Hale et al., 2026)

Recent international evidence suggests that insufficient or poor-quality sleep has emerged as a significant public health concern among adolescents. Global estimates indicate that a substantial proportion of adolescents fail to achieve the recommended 8–10 hours of nightly sleep, with prevalence rates of inadequate sleep continuing to rise over the past decade. (Paruthi et al., 2016) The consequences extend beyond daytime sleepiness and fatigue, affecting multiple domains of functioning, including emotional health, behavioural regulation, attention, memory, decision-making, and academic performance. (Chaput et al., 2020a; Gradisar et al., 2022)

Among the various cognitive functions influenced by sleep, memory occupies a particularly central role in educational success. Memory enables learners to encode, consolidate, store, and retrieve information necessary for classroom learning, examinations, and everyday problem-solving. Experimental and longitudinal studies consistently demonstrate that adequate sleep enhances declarative memory, procedural learning, working memory, and executive functioning, whereas sleep deprivation impairs encoding efficiency and reduces the ability to retrieve previously learned information (Cellini et al., 2021a; Crowley et al., 2024)

The neurobiological relationship between sleep and memory has been explained through the process of sleep-dependent memory consolidation. During slow-wave sleep and rapid eye movement (REM) sleep, recently acquired information is repeatedly reactivated and

integrated within existing neural networks, facilitating long-term storage and improving future recall. Consequently, inadequate sleep disrupts these consolidation processes, leading to poorer learning outcomes and reduced academic performance. (Klinzing et al., 2019a; Rasch & Born, 2013b)

Academic performance represents one of the most important developmental outcomes during adolescence because it influences future educational opportunities, career trajectories, and overall quality of life. Although academic achievement is shaped by multiple factors—including intelligence, motivation, socioeconomic status, teaching quality, parental involvement, and mental health—sleep quality has increasingly been recognised as an independent predictor of educational success. (Dewald et al., 2010; Musshafen et al., 2021) Adolescents experiencing chronic sleep difficulties often report reduced concentration, impaired classroom engagement, diminished motivation, slower information processing, and poorer examination performance compared with their well-rested peers.

Despite substantial evidence supporting the independent relationships among sleep quality, memory functioning, and academic performance, these variables are frequently examined in isolation. Much of the existing literature focuses either on the direct association between sleep and academic outcomes or on the influence of sleep on cognitive performance without investigating the underlying mechanisms connecting these constructs. Consequently, relatively little empirical attention has been directed towards understanding *how* sleep quality influences academic performance through intermediate cognitive processes such as memory functioning, particularly among adolescents.

Understanding these pathways is important because memory functioning constitutes one of the most direct cognitive mechanisms through which sleep may influence educational achievement. Sleep enhances the encoding and consolidation of newly acquired information,

while efficient memory processes facilitate learning, comprehension, and examination performance. Consequently, memory functioning may represent a critical mediator linking healthy sleep patterns with improved academic outcomes. Identifying such mediating mechanisms provides greater theoretical clarity and offers practical implications for interventions aimed at enhancing both cognitive functioning and educational achievement.

The need for further investigation is particularly evident within developing countries, including India. Indian adolescents experience unique educational pressures characterised by highly competitive academic environments, extended school hours, private tuition, examination-oriented curricula, and increasing digital engagement. These contextual factors often contribute to shortened sleep duration and poor sleep hygiene, potentially compromising cognitive development and academic success. Nevertheless, empirical studies simultaneously examining sleep quality, memory functioning, and academic performance among Indian adolescents remain relatively limited, and mediation-based investigations are especially scarce.

Recent educational and public health initiatives have increasingly emphasised adolescent mental health and holistic educational development. Within this context, understanding modifiable behavioural factors such as sleep assumes considerable practical significance. Unlike many determinants of academic achievement, sleep represents a behavioural factor that can be

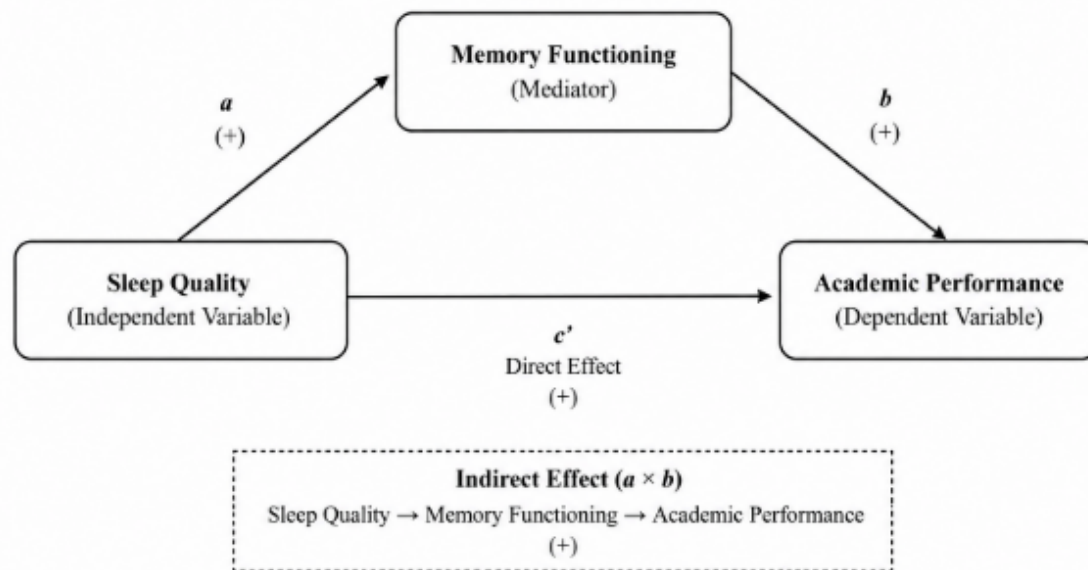
improved through relatively simple educational, familial, and school-based interventions. Establishing evidence for the cognitive mechanisms linking sleep quality with educational outcomes can therefore inform evidence-based programmes promoting adolescent well-being, healthy learning environments, and academic excellence.

The present study addresses these gaps by examining the relationships among sleep quality, memory functioning, and academic performance among adolescents and by investigating the mediating role of memory functioning in the relationship between sleep quality and academic performance. By integrating perspectives from sleep science, cognitive psychology, and educational psychology, this study seeks to advance understanding of the cognitive pathways through which healthy sleep contributes to successful academic functioning. The findings are expected to contribute to the growing body of adolescent health research while providing practical recommendations for educators, parents, school counsellors, psychologists, and policymakers seeking to enhance both cognitive development and academic achievement through evidence-informed interventions.

Figure 1 presents the conceptual framework that guided the study, illustrating the hypothesised relationships among sleep quality, memory functioning, and academic performance.

Figure 1

Conceptual Framework of the Proposed Mediation Model



Note. Sleep quality was hypothesised to exert both a direct effect on academic performance and an indirect effect through memory functioning. Memory functioning was conceptualised as the mediator linking sleep quality and academic performance.

II. LITERATURE REVIEW

2.1 Sleep Quality and Adolescent Development

Sleep is a fundamental biological process that supports physical growth, emotional regulation, cognitive functioning, and overall health throughout the lifespan. During adolescence, adequate sleep becomes particularly important because this developmental stage is characterised by rapid neurological maturation, hormonal changes, and increasing academic and social demands. Contemporary research consistently demonstrates that sleep quality, rather than sleep duration alone, is a critical determinant of adolescent well-being. Sleep quality encompasses multiple dimensions, including sleep latency, sleep continuity, sleep efficiency, nocturnal awakenings, and subjective satisfaction with sleep, each of which contributes to optimal cognitive and psychological functioning (Chaput et al., 2020b).

Adolescence is also marked by biological changes in circadian rhythm that delay the natural sleep–

wake cycle. While these physiological changes encourage later bedtimes, early school schedules often require adolescents to wake before completing adequate sleep. Consequently, many adolescents experience chronic sleep restriction and irregular sleep patterns, commonly referred to as "social jetlag." This mismatch has been associated with impaired daytime alertness, reduced concentration, emotional dysregulation, and diminished academic engagement (Hale et al., 2026; Lang et al., 2022).

Lifestyle factors further compound these biological challenges. Increased use of smartphones, prolonged screen exposure, online learning environments, social media engagement, and examination-related stress have contributed to declining sleep quality among adolescents worldwide. Systematic reviews indicate that excessive evening screen use suppresses melatonin secretion, delays sleep onset, and reduces sleep efficiency, thereby increasing the likelihood of daytime fatigue and impaired cognitive performance (Gradisar et al., 2022; Lang et al., 2022). These findings position sleep quality as a modifiable health behaviour with important implications for adolescent development and educational outcomes.

2.2 Sleep Quality and Memory Functioning

Memory is a multidimensional cognitive process involving the encoding, consolidation, storage,

and retrieval of information. Effective memory functioning underpins classroom learning, reasoning, problem-solving, and long-term knowledge acquisition. Accumulating evidence from cognitive neuroscience demonstrates that sleep plays an active role in facilitating these processes rather than merely providing passive rest for the brain (Rasch & Born, 2013c).

Sleep-dependent memory consolidation remains one of the most extensively investigated mechanisms linking sleep with cognition. During slow-wave sleep, newly encoded declarative memories are repeatedly reactivated and transferred from temporary hippocampal storage to long-term neocortical networks. Rapid eye movement (REM) sleep further strengthens procedural learning, emotional memory, and cognitive flexibility, enabling individuals to integrate newly acquired information with existing knowledge. Click or tap here to enter text.

Experimental studies consistently demonstrate that adolescents who obtain sufficient, high-quality sleep exhibit superior performance on tests of working memory, episodic memory, attention, and executive functioning compared with sleep-deprived peers. Conversely, inadequate sleep disrupts neural plasticity, reduces hippocampal activity, impairs encoding efficiency, and compromises memory retrieval, thereby limiting learning capacity (Cellini et al., 2021b; Hyndych et al., 2025). These findings highlight memory functioning as one of the principal cognitive pathways through which sleep influences educational performance.

Beyond neurobiological mechanisms, behavioural research indicates that poor sleep reduces sustained attention and information processing speed during classroom instruction. As a result, adolescents experiencing inadequate sleep may encode less information during learning sessions, thereby diminishing subsequent recall and academic performance. Consequently, sleep quality and memory functioning should be viewed as closely interconnected processes that jointly influence educational achievement.

2.3 Sleep Quality and Academic Performance

Academic performance is a multifaceted outcome shaped by cognitive ability, motivation, socioeconomic background, instructional quality, family environment, and psychological well-being. Among these determinants, sleep quality has emerged as an increasingly important behavioural predictor that directly and indirectly influences educational success.

Recent longitudinal and cross-sectional studies consistently report positive associations between healthy sleep patterns and higher academic achievement. Adolescents who maintain regular sleep schedules generally demonstrate better classroom participation, greater attentional control, improved executive functioning, and superior examination performance than those experiencing chronic sleep disturbances. (Dewald et al., 2010) Conversely, inadequate sleep has been associated with absenteeism, reduced motivation, behavioural difficulties, emotional distress, and lower academic grades.

Meta-analytic evidence further supports the relationship between sleep quality and educational outcomes. Although effect sizes vary across populations and educational settings, the overall pattern indicates that poor sleep is associated with reduced academic achievement through multiple pathways involving attention, emotional regulation, and cognitive functioning (Chaput et al., 2016; Matricciani et al., 2025). Importantly, researchers increasingly argue that interventions targeting adolescent sleep may yield educational benefits comparable to many traditional academic support programmes.

Within India, growing educational competition, extensive after-school coaching, prolonged study hours, and widespread digital device use have intensified concerns regarding adolescent sleep. Emerging Indian studies similarly report associations between poor sleep quality, psychological distress, reduced concentration, and lower academic performance, although relatively few investigations have simultaneously examined the cognitive mechanisms underlying these

relationships. This gap limits the development of evidence-based interventions tailored to Indian educational settings.

2.4 Memory Functioning as a Mediating Mechanism

Although direct relationships between sleep quality and academic performance have been widely documented, recent theoretical developments suggest that these associations may be partially explained through intermediate cognitive processes. Among these, memory functioning represents one of the most plausible mediating mechanisms because successful learning fundamentally depends upon the efficient encoding, consolidation, and retrieval of information.

The Active Systems Consolidation Theory proposes that sleep facilitates repeated reactivation of newly acquired memories, thereby strengthening long-term storage and improving subsequent recall. Similarly, Cognitive Information Processing Theory conceptualises learning as a sequence of information encoding, storage, and retrieval processes, all of which may be enhanced or disrupted by sleep quality. Together, these theoretical perspectives suggest that improvements in sleep quality should enhance memory functioning, which subsequently contributes to improved academic performance.

Empirical investigations examining mediation pathways remain comparatively limited, particularly among adolescents. Existing evidence nevertheless suggests that memory functioning explains a substantial proportion of the relationship between sleep and educational achievement. Adolescents experiencing high-quality sleep demonstrate improved working memory, better consolidation of newly learned material, and greater retrieval efficiency during examinations, thereby achieving superior academic outcomes (Cousins et al, 2023; Lowe et al., 2026).

The mediating role of memory also aligns with contemporary neurocognitive models that

emphasise the interaction between biological sleep processes and higher-order cognitive functioning. Rather than exerting an isolated influence on educational achievement, sleep appears to operate through multiple interconnected cognitive systems, with memory representing one of the strongest explanatory pathways. Investigating this mechanism therefore contributes both theoretical and practical value by identifying cognitive targets for intervention.

2.5 Research Gap

Despite considerable advances in sleep and cognitive research, several important gaps remain.

First, many previous studies have focused primarily on the direct relationship between sleep quality and academic performance, while comparatively few have explored the cognitive mechanisms through which this relationship operates. Understanding these mechanisms is essential for developing theory-driven educational and psychological interventions.

Second, although sleep and memory have each been independently associated with academic achievement, relatively few studies have simultaneously examined all three constructs within a single analytical framework. Consequently, the extent to which memory functioning mediates the relationship between sleep quality and academic performance remains insufficiently understood, particularly in adolescent populations.

Third, much of the existing evidence originates from North America, Europe, and East Asia, limiting its generalisability to culturally diverse educational settings. Indian adolescents experience distinctive academic pressures, examination-oriented educational systems, and rapidly changing digital lifestyles that may influence both sleep behaviour and cognitive functioning. Empirical evidence addressing these contextual factors remains relatively limited.

Finally, recent recommendations within adolescent health research emphasise the

importance of identifying modifiable behavioural determinants of educational success. Sleep quality represents one such determinant because it can be improved through behavioural interventions, school-based programmes, parental education, and public health initiatives. Examining its cognitive pathways therefore has direct implications for educational policy and adolescent mental health promotion.

The present study addresses these gaps by examining the relationships among sleep quality, memory functioning, and academic performance among adolescents while evaluating the mediating role of memory functioning within this relationship.

The present study was guided by the following objectives:

1. To assess the relationship between sleep quality and memory functioning among adolescents.
2. To examine the relationship between sleep quality and academic performance.
3. To investigate the relationship between memory functioning and academic performance.
4. To determine whether memory functioning mediates the relationship between sleep quality and academic performance.

H1: Sleep quality is significantly associated with memory functioning among adolescents.

H2: Sleep quality is significantly associated with academic performance among adolescents.

H3: Memory functioning is significantly associated with academic performance among adolescents.

H4: Memory functioning significantly mediates the relationship between sleep quality and academic performance.

III. METHODS

3.1 Study Design

The present study employed a quantitative, cross-sectional, correlational research design to investigate the relationships among sleep quality, memory functioning, and academic performance among adolescents. A cross-sectional approach was considered appropriate because it enabled the simultaneous assessment of the study variables within a naturally occurring educational setting while facilitating the examination of direct and indirect relationships through mediation analysis. The correlational design further allowed the identification of associations among variables without manipulating the study environment, thereby preserving ecological validity.

The conceptual framework was based on the assumption that sleep quality influences academic performance both directly and indirectly through its effect on memory functioning. Accordingly, memory functioning was examined as a potential mediator linking sleep quality with academic achievement.

3.2 Participants

The study was conducted among 102 adolescents enrolled in higher secondary educational institutions. Participants were selected using purposive sampling, which ensured the inclusion of adolescents meeting the predefined eligibility criteria and capable of providing reliable responses to the study instruments.

Adolescence represents a critical developmental period characterised by substantial neurocognitive maturation and increasing academic demands. Consequently, this population provides an appropriate context for examining the interaction between sleep, cognition, and educational performance.

Inclusion Criteria

Participants were included if they:

- were adolescents enrolled in higher secondary education;
- were able to understand and complete the study questionnaires independently;

- provided informed consent (and parental consent where applicable); and
- were present during the period of data collection.

Exclusion Criteria

Participants were excluded if they:

- reported a diagnosed neurological disorder or severe psychiatric illness that could substantially influence cognitive functioning;
- had documented learning disabilities requiring specialised educational interventions; or
- submitted incomplete questionnaires with substantial missing responses.

The final sample consisted of 102 complete responses, all of which were included in the statistical analyses.

3.3 Measures

Three standardized self-report instruments were used to assess the study variables.

Sleep Quality

Sleep quality was assessed using a structured questionnaire designed to evaluate multiple dimensions of adolescent sleep behaviour, including perceived sleep quality, sleep duration, sleep disturbances, sleep latency, and daytime functioning. Higher scores indicated better overall sleep quality.

The instrument demonstrated acceptable internal consistency within the present sample, with a Cronbach's alpha coefficient of approximately 0.63, indicating satisfactory reliability for research purposes.

Memory Functioning

Memory functioning was measured using a standardized self-report scale assessing everyday memory abilities, including attention-dependent memory, information retention, recall efficiency, and learning-related memory performance.

Participants rated statements describing common memory-related experiences encountered during daily academic activities. Higher scores reflected better perceived memory functioning.

The scale demonstrated good internal consistency, yielding a Cronbach's alpha coefficient of approximately **0.77**, indicating satisfactory reliability.

Academic Performance

Academic performance was assessed using a structured academic performance questionnaire measuring students' perceived learning effectiveness, classroom engagement, study behaviour, examination preparedness, and overall educational performance.

Higher scores represented better academic functioning.

The instrument demonstrated good internal reliability, with a Cronbach's alpha coefficient of approximately 0.78, supporting its suitability for subsequent analyses.

3.4 Procedure

Prior to data collection, permission was obtained from the respective educational institutions to conduct the study. Participants were informed about the objectives of the research, the voluntary nature of participation, and the confidentiality of their responses. Where required, parental consent was obtained in accordance with institutional ethical requirements.

Data were collected through structured questionnaires administered in classroom settings under the supervision of the researcher. Standardised instructions were provided to ensure uniform administration across participants. Respondents were encouraged to answer each question honestly and independently without discussing their responses with peers.

Completion of the questionnaires required approximately 20–25 minutes. The completed questionnaires were reviewed for completeness

prior to data entry. Responses containing substantial missing information were excluded from the analysis, resulting in a final dataset comprising 102 valid cases.

3.5 Ethical Considerations

The study adhered to established ethical principles governing research involving human participants. Participation was entirely voluntary, and respondents were informed that they could withdraw from the study at any stage without academic or personal consequences.

Participants were assured that:

- all information would remain confidential;
- responses would be used solely for research purposes;
- no identifying personal information would be disclosed in publications; and
- findings would be reported only in aggregated form.

All procedures were conducted in accordance with institutional ethical guidelines and the ethical principles outlined in the Declaration of Helsinki for research involving human participants.

3.6 Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS). Data screening was conducted prior to hypothesis testing to identify missing values, data entry errors, and potential outliers. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated to summarise participant characteristics and study variables.

The internal consistency of each measurement instrument was evaluated using Cronbach's alpha, with coefficients exceeding 0.60 considered acceptable and values above 0.70 indicating good reliability for psychological research. (Taber, 2018) Pearson's product-moment correlation coefficients were computed to examine the bivariate relationships among sleep quality, memory functioning, and academic performance.

Correlation coefficients were interpreted according to conventional effect size guidelines.

Multiple linear regression analysis was subsequently performed to determine the extent to which sleep quality and memory functioning predicted academic performance while estimating the relative contribution of each predictor.

To examine the hypothesised indirect relationship, mediation analysis was conducted using a regression-based approach. The indirect effect of sleep quality on academic performance through memory functioning was estimated, and statistical significance was evaluated using bootstrapped confidence intervals. A significant indirect effect, together with a reduction in the direct association between sleep quality and academic performance after inclusion of the mediator, was interpreted as evidence supporting mediation.

Statistical significance for all inferential analyses was established at $p < .05$, and confidence intervals were calculated at the 95% level.

IV. RESULTS

4.1 Participant Characteristics

A total of 102 adolescents participated in the study. Following data screening, no missing values or incomplete questionnaires were identified; therefore, all responses were retained for statistical analyses. The mean age of participants was 14.86 years ($SD = 1.47$). Male participants constituted 54.9% of the sample, while 45.1% were female. Most participants attended private schools (93.1%), and nearly two-thirds (64.7%) reported using electronic devices before bedtime.

Table 1

Demographic Characteristics of Participants (N = 102)

Variable	Category	n	%
Age (years)	13	19	18.6
	14	27	26.5
	15	30	29.4
	16	9	8.8
	17	9	8.8
	18	8	7.8

Gender	Male	56	54.9
	Female	46	45.1
School Type	Private	95	93.1
	Government	6	5.9
	Others	1	1.0
Device Use Before Sleep	Yes	66	64.7
	No	36	35.3

Note. Mean age = 14.86 years (SD = 1.47).

4.2 Descriptive Statistics

Descriptive statistics indicated that participants generally reported moderate-to-high levels of sleep quality, memory functioning, and academic performance. The distributions approximated normality, with skewness and kurtosis values falling within acceptable limits for parametric analyses.

Table 2

Descriptive Statistics of Study Variables

Variable	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Sleep Quality	34.98	5.97	21	49	−0.07	−0.43
Memory Functioning	34.65	5.95	18	49	0.26	−0.09
Academic Performance	35.92	6.74	18	49	−0.34	−0.34

4.3 Reliability Analysis

The internal consistency of the three instruments was assessed using Cronbach's alpha and McDonald's omega. Memory functioning and academic performance demonstrated acceptable reliability, whereas the sleep quality scale showed borderline but acceptable reliability for exploratory research.

Table 3

Reliability of the Study Instruments

Scale	Items	Cronbach's α	McDonald's ω	Interpretation
Sleep Quality	10	.629	.604	Borderline
Memory Functioning	10	.770	.767	Acceptable
Academic Performance	10	.775	.788	Acceptable

4.4 Assumption Testing

Normality, homoscedasticity, independence of residuals, and multicollinearity assumptions were examined prior to regression analysis. The Shapiro–Wilk tests were non-significant for all study variables, indicating approximate normality. Regression diagnostics further demonstrated acceptable values for Durbin–Watson, variance inflation factors, Cook's distance, and homoscedasticity, supporting the use of parametric analyses.

Table 4

Regression Assumption Diagnostics

Test	Result	Interpretation
Shapiro–Wilk (Sleep Quality)	W = .983, p = .226	Normal
Shapiro–Wilk (Memory Functioning)	W = .978, p = .085	Normal
Shapiro–Wilk (Academic Performance)	W = .980, p = .124	Normal
Durbin–Watson	1.664	Independent residuals
Breusch–Pagan	p = .388	Homoscedasticity satisfied
Maximum VIF	1.644	No multicollinearity
Maximum Cook's Distance	.062	No influential observations

4.5 Correlation Analysis

Pearson correlation analysis revealed statistically significant positive relationships among all study

variables. Sleep quality demonstrated a strong positive relationship with memory functioning ($r = .626$, $p < .001$) and a moderate positive relationship with academic performance ($r = .472$, $p < .001$). Memory functioning exhibited the strongest association with academic performance ($r = .679$, $p < .001$). These findings support the proposed hypotheses regarding the interrelationships among the study variables.

Table 5
Pearson Correlation Matrix

Variable	1	2	3
1. Sleep Quality	—		
2. Memory Functioning	.626***	—	
3. Academic Performance	.472***	.679***	—

Note. ** $p < .001$. $N = 102$.

4.6 Regression Analysis

Simple linear regression indicated that sleep quality significantly predicted academic performance, accounting for 22.3% of the variance. Memory functioning independently explained 46.2% of the variance in academic performance. In the multiple regression model, sleep quality and memory functioning jointly explained 46.5% of the variance. After controlling for memory functioning, the direct contribution of sleep quality was no longer statistically significant, whereas memory functioning remained a significant predictor.

Table 6
Regression Models Predicting Academic Performance

Predictor	B	SE	β	t	p
Model 1: Sleep Quality					
Sleep Quality	0.533	0.100	.472	5.358	<.001
Model 2: Memory Functioning					
Memory Functioning					

Memory Functioning	0.769	0.083	.679	9.261	<.001
Model 3: Combined Model					
Sleep Quality	0.087	0.106	.077	0.820	.414
Memory Functioning	0.715	0.107	.631	6.697	<.001

Model Summary

Model	R ²	Adjusted R ²	F	P
Sleep Quality	.223	.215	28.71	<.001
Memory Functioning	.462	.456	85.77	<.001
Combined Model	.465	.455	43.08	<.001

4.7 Mediation Analysis

A bootstrap mediation analysis (5,000 resamples) was conducted to determine whether memory functioning mediated the relationship between sleep quality and academic performance. Sleep quality significantly predicted memory functioning, and memory functioning significantly predicted academic performance. Although the total effect of sleep quality on academic performance was significant, the direct effect became non-significant after including memory functioning. Furthermore, the bootstrap confidence interval for the indirect effect did not include zero, confirming a statistically significant mediation effect. These findings indicate that memory functioning fully mediated the relationship between sleep quality and academic performance.

Table 7
Bootstrap Mediation Analysis

Path	B	SE	p	95% CI
Path a (Sleep → Memory)	0.624	0.078	<.001	[0.470, 0.778]

Path b (Memory → Academic)	0.71 5	0.107	<.00 1	[0.503, 0.926]
Total Effect (c)	0.53 3	0.100	<.00 1	[0.336, 0.731]
Direct Effect (c')	0.08 7	0.106	.414	[-0.124 , 0.298]

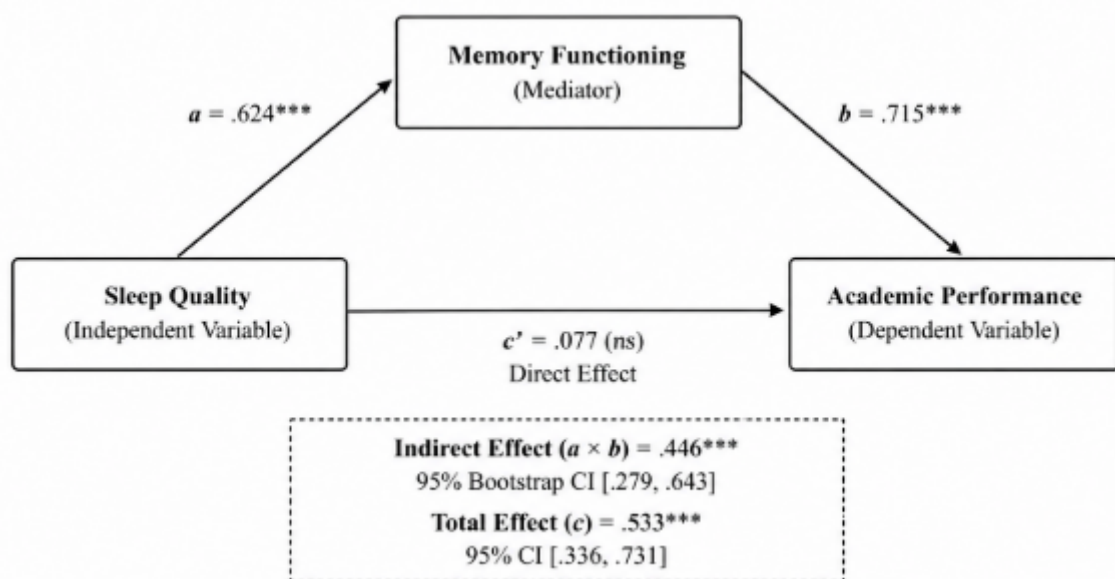
Indirect Effect (a × b)	0.44 6	Bootstra p	—	[0.279, 0.643]
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Note. Mediation is supported because the 95% bootstrap confidence interval for the indirect effect does not include zero.

The mediation model with standardized path coefficients is illustrated in Figure 2.

Figure 2

Mediation Model Showing the Relationships among Sleep Quality, Memory Functioning, and Academic Performance



Note. Values shown on the paths represent standardized regression coefficients (β). The indirect effect of sleep quality on academic performance through memory functioning was statistically significant (95% bootstrap CI = [.279, .643]), whereas the direct effect became non-significant after the inclusion of the mediator, indicating full mediation. *ns* = not significant. $^{**}p < .001$.

V. DISCUSSION

The present study investigated the relationships among sleep quality, memory functioning, and academic performance among adolescents, with particular emphasis on examining whether memory functioning mediates the relationship between sleep quality and academic achievement.

The findings provide empirical support for the proposed conceptual model, demonstrating that better sleep quality was associated with superior memory functioning and improved academic performance. Furthermore, memory functioning emerged as the strongest predictor of academic performance and significantly mediated the association between sleep quality and academic achievement. These findings contribute to the growing body of adolescent cognitive health research by demonstrating that the educational benefits of healthy sleep are largely realised through improvements in memory functioning.

5.1 Principal Findings

The first objective of the study was to examine the relationship between sleep quality and memory functioning. Consistent with the proposed hypothesis, adolescents who reported better sleep quality also demonstrated significantly

better memory functioning. The strong positive association observed in the present study supports contemporary neuroscientific evidence indicating that sleep facilitates memory encoding, consolidation, and retrieval. Sleep-dependent consolidation enables newly acquired information to be stabilised and integrated into long-term memory networks, thereby enhancing subsequent learning and recall. Consequently, adolescents experiencing healthy sleep patterns are more likely to demonstrate improved cognitive performance during classroom learning and examinations.

The second objective examined the association between sleep quality and academic performance. Sleep quality was positively related to academic achievement, indicating that adolescents with healthier sleep patterns generally reported better educational performance. Although the direct relationship was statistically significant, the magnitude of the association was moderate, suggesting that sleep influences academic outcomes through multiple cognitive and behavioural mechanisms rather than acting independently. This finding is consistent with contemporary educational psychology literature, which recognises sleep as an important behavioural determinant of learning, attention, classroom engagement, and examination performance.

The third objective investigated the relationship between memory functioning and academic performance. Memory functioning demonstrated the strongest association with academic achievement and accounted for nearly half of the variance in academic performance. This finding highlights the central role of memory in educational success and reinforces cognitive theories proposing that effective learning depends upon efficient information encoding, storage, and retrieval. Adolescents with stronger memory functioning are better able to retain instructional material, integrate new knowledge with prior learning, and retrieve relevant information during academic assessments.

The principal contribution of the present study lies in the mediation analysis. Although sleep quality significantly predicted academic performance when examined independently, its direct effect became statistically non-significant after memory functioning was included in the regression model. Simultaneously, the indirect pathway through memory functioning remained statistically significant. This pattern is consistent with full mediation, indicating that memory functioning represents an important cognitive mechanism through which sleep quality influences academic performance. Rather than directly improving educational outcomes, healthy sleep appears to enhance cognitive functioning, particularly memory processes, which subsequently facilitate improved academic achievement.

5.2 Comparison with Previous Literature

The findings of the present investigation are consistent with a growing body of international research demonstrating positive associations between sleep quality and cognitive functioning among adolescents. Recent longitudinal and experimental studies have consistently shown that adequate sleep enhances attention, executive functioning, working memory, and long-term memory consolidation, whereas chronic sleep restriction compromises hippocampal functioning and reduces learning efficiency. The observed relationship between sleep quality and memory functioning therefore reinforces current neurocognitive models emphasising the importance of sleep in maintaining optimal cognitive performance during adolescence.

The positive association identified between sleep quality and academic performance also corresponds with recent systematic reviews indicating that adolescents obtaining adequate, high-quality sleep consistently outperform sleep-deprived peers in educational settings. Better sleep has been associated with improved classroom participation, sustained attention, motivation, emotional regulation, and examination performance. Conversely, inadequate sleep has been linked to absenteeism, behavioural difficulties, psychological distress, and

declining educational achievement. The present findings therefore extend existing evidence by demonstrating that these educational benefits may largely operate through cognitive mechanisms rather than solely through behavioural pathways.

Perhaps the most important contribution of the present study concerns the mediating role of memory functioning. While previous investigations have independently established relationships among sleep, cognition, and academic performance, relatively few studies have empirically examined memory functioning as the mechanism connecting these constructs within adolescent populations. The present findings provide evidence supporting theoretical propositions derived from Active Systems Consolidation Theory and Cognitive Information Processing Theory, both of which propose that sleep facilitates memory consolidation, thereby improving learning outcomes. The statistically significant indirect effect observed in the mediation analysis strengthens these theoretical explanations and suggests that memory functioning should receive greater attention in future educational and cognitive research.

The findings also possess particular relevance within the Indian educational context. Adolescents in India frequently encounter intense academic competition, prolonged study schedules, private tuition, and increasing digital media exposure, all of which contribute to shortened sleep duration and irregular sleep habits. The present results suggest that interventions targeting healthy sleep behaviours may indirectly improve educational achievement by enhancing memory functioning. Consequently, educational institutions should consider sleep health as an integral component of academic success rather than solely a lifestyle behaviour.

5.3 Theoretical Implications

The present study contributes to the theoretical understanding of adolescent learning by integrating perspectives from sleep science, cognitive psychology, and educational psychology.

First, the findings support the proposition that sleep represents an active neurobiological process involved in cognitive development rather than merely a restorative physiological function. The significant association between sleep quality and memory functioning reinforces theories of sleep-dependent memory consolidation, demonstrating that cognitive benefits emerge through the reorganisation and stabilisation of newly acquired information during sleep.

Second, the mediation findings extend Cognitive Information Processing Theory by demonstrating that memory functioning operates as an intermediate cognitive mechanism linking behavioural health practices with educational outcomes. This integrated perspective advances existing theoretical models by illustrating how biological processes, cognitive functioning, and academic performance interact within adolescent development.

Finally, the findings contribute to adolescent educational research by emphasising that behavioural health factors should be incorporated into contemporary models of academic achievement. Traditional educational frameworks frequently emphasise intelligence, motivation, socioeconomic status, and instructional quality while giving comparatively limited attention to sleep health. The present findings suggest that healthy sleep behaviours should be recognised as an important component of comprehensive educational development.

5.4 Practical Implications

The findings possess several practical implications for educational practice, adolescent health promotion, and educational policy.

For schools, incorporating sleep education into health promotion programmes may improve both cognitive functioning and academic achievement. School counsellors and psychologists should educate students regarding healthy sleep hygiene, consistent sleep schedules, and strategies for reducing evening screen exposure. Such interventions may contribute to improvements in

concentration, classroom engagement, and examination performance.

Parents also play an essential role in establishing healthy sleep routines. Encouraging regular bedtimes, limiting electronic device use before sleep, creating supportive sleep environments, and recognising early signs of chronic sleep deprivation may substantially enhance adolescents' cognitive functioning and educational outcomes.

At the policy level, educational authorities should consider integrating sleep health within broader adolescent mental health initiatives. Increasing awareness regarding the cognitive consequences of inadequate sleep may assist schools in developing evidence-based programmes that support both academic achievement and psychological well-being. Future interventions should emphasise that improving sleep represents a relatively inexpensive and modifiable strategy capable of producing meaningful educational benefits.

5.5 Strengths and Limitations

The present study possesses several notable strengths. It simultaneously examined sleep quality, memory functioning, and academic performance within a single analytical framework while employing mediation analysis to investigate the underlying cognitive mechanism connecting these variables. The inclusion of reliability analyses, regression diagnostics, and bootstrapped mediation further strengthened the statistical robustness of the findings. Additionally, the study contributes valuable evidence from an Indian adolescent population, which remains comparatively underrepresented within the international sleep literature.

Several limitations should nevertheless be acknowledged. First, the cross-sectional design precludes causal inference. Although the proposed mediation model is theoretically supported, longitudinal and experimental studies are required to establish temporal relationships among sleep quality, memory functioning, and

academic performance. Second, the study relied primarily on self-report questionnaires, which may be influenced by recall bias and social desirability. Future investigations should incorporate objective measures such as actigraphy, polysomnography, standardised neuropsychological assessments, and official academic records. Third, participants were predominantly recruited from private schools, thereby limiting the generalisability of the findings to broader adolescent populations. Finally, although the sleep quality instrument demonstrated acceptable reliability for exploratory research, refinement of the measurement scale may further improve psychometric precision in future investigations.

5.6 Future Research Directions

Future studies should employ longitudinal designs to examine developmental changes in sleep quality, cognitive functioning, and academic performance across adolescence. Experimental interventions targeting sleep hygiene would further clarify whether improvements in sleep produce corresponding gains in memory functioning and educational achievement.

Researchers should also investigate additional mediating and moderating variables, including executive functioning, emotional regulation, stress, anxiety, physical activity, socioeconomic status, and digital media use. Comparative investigations involving government and private schools, urban and rural populations, and culturally diverse educational settings would further enhance understanding of adolescent sleep behaviour across different contexts.

The integration of wearable sleep-monitoring technologies, neurocognitive testing, and institutional academic records would strengthen methodological rigor and improve the ecological validity of future research.

VI. CONCLUSION

The present study demonstrates that sleep quality, memory functioning, and academic performance are closely interconnected among adolescents. Better sleep quality was associated

with superior memory functioning and higher academic performance, while memory functioning emerged as the strongest predictor of educational achievement. Most importantly, the mediation analysis revealed that memory functioning constitutes the principal cognitive mechanism through which sleep quality influences academic performance.

These findings underscore the importance of recognising healthy sleep as an essential component of adolescent cognitive development and educational success. Interventions aimed at improving sleep hygiene may enhance not only physical and psychological well-being but also memory processes that directly support learning and academic achievement. Consequently, collaborative efforts involving educators, parents, school counsellors, healthcare professionals, and policymakers are essential to promote healthy sleep behaviours and foster optimal educational outcomes during adolescence.

REFERENCES

1. Becker, et al, Dvorsky, M. R., Breaux, R., Cusick, C. N., Taylor, K. P., & Langberg, J. M. (2021). Prospective examination of adolescent sleep patterns and behaviors before and during COVID-19. *Sleep*, 44(8). <https://doi.org/10.1093/sleep/zsab054>
2. Carskadon, M. A. (2020). The Time has Come to Expand Our Studies of School Timing for Adolescents. *Journal of Biological Rhythms*, 35(4), 323–324. <https://doi.org/10.1177/0748730420940080>
3. Cellini, N., Conte, F., De Rosa, O., Giganti, F., Malloggi, S., Rey, M., Guillemin, C., Schmidt, C., Muto, V., & Ficca, G. (2021b). Changes in sleep timing and subjective sleep quality during the COVID-19 lockdown in Italy and Belgium: age, gender and working status as modulating factors. *Sleep Medicine*, 77, 112–119. <https://doi.org/10.1016/j.sleep.2020.11.027>
4. Chaput, J.-P., Dutil, C., Featherstone, R., Ross, R., Giangregorio, L., Saunders, T. J., Janssen, I., Poitras, V. J., Kho, M. E., Ross-White, A., & Carrier, J. (2020a). Sleep duration and health in adults: an overview of systematic reviews. *Applied Physiology, Nutrition, and Metabolism*, 45(10 (Suppl. 2)), S218–S231. <https://doi.org/10.1139/apnm-2020-0034>
5. Cousins et al. (2023). Update on Rapid-Eye-Movement Sleep Behavior Disorder (RBD): Focus on Its Strong Association with α -Synucleinopathies. *Clinical and Translational Neuroscience*, 7(3), 19. <https://doi.org/10.3390/ctn7030019>
6. Crowley, R., Alderman, E., Javadi, A.-H., & Tamminen, J. (2024). A systematic and meta-analytic review of the impact of sleep restriction on memory formation. *Neuroscience & Biobehavioral Reviews*, 167, 105929. <https://doi.org/10.1016/j.neubiorev.2024.105929>
7. Dewald, J. F., Meijer, A. M., Oort, F. J., Kerkhof, G. A., & Bögels, S. M. (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. *Sleep Medicine Reviews*, 14(3), 179–189. <https://doi.org/10.1016/j.smrv.2009.10.004>
8. Fuligni, & Hardway. (2024). Daily Variation in Sleep Duration, Affect and Emotions in Croatian Youth: An Ambulatory Assessment. *European Journal of Mental Health*, 19, 1–14. <https://doi.org/10.5708/EJMH.19.2024.0022>
9. Gradisar, M., Kahn, M., Micic, G., Short, M., Reynolds, C., Orchard, F., Bauducco, S., Bartel, K., & Richardson, C. (2022). Sleep's role in the development and resolution of adolescent depression. *Nature Reviews Psychology*, 1(9), 512–523. <https://doi.org/10.1038/s44159-022-00074-8>
10. Hale, Hartstein, L. E., & Zhou, C. (2026). Screens and Youth Sleep. *JAMA Pediatrics*, 180(5), 483. <https://doi.org/10.1001/jamapediatrics.2026.0253>
11. Hyndych, A., El-Abassi, R., & Mader, E. C. (2025). The Role of Sleep and the Effects of Sleep Loss on Cognitive, Affective, and Behavioral Processes. *Cureus*. <https://doi.org/10.7759/cureus.84232>
12. Klinzing, J. G., Niethard, N., & Born, J. (2019a). Mechanisms of systems memory consolidation during sleep. *Nature Neuroscience*, 22(10), 1598–1610. <https://doi.org/10.1038/s41593-019-0467-3>
13. Lang, C., Richardson, C., Micic, G., & Gradisar, M. (2022). Understanding Sleep-Wake Behavior in Late Chronotype Adolescents: The Role of Circadian Phase, Sleep Timing, and Sleep Propensity. *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsy.2022.785079>
14. Lowe, C. J., Shukla, U., & Morton, J. B. (2026). Cognitive Functions—An Overview of the Different Domains. In *The Handbook of Physical Activity and Cognitive Neuroscience* (pp. 46–64). Routledge. <https://doi.org/10.4324/9781003625179-5>
15. Matricciani, L., Clarke, J., Wiley, S., Williams, A., Baljak, G. R., Graham, K., Gum, L., Rogers, M., Howland, K., Stewart, K., Ruf, H., Marnie, C., Visvanathan, V., Singh, B., Banks, S., Kelly, M. A., & Peters, M. D. J. (2025). Sleep of Nurses: A Comprehensive Scoping Review. *Journal of Advanced Nursing*, 81(5), 2333–2344. <https://doi.org/10.1111/jan.16603>
16. Musshafen, L. A., Tyrone, R. S., Abdelaziz, A., Sims-Gomillia, C. E., Pongetti, L. S., Teng, F., Fletcher, L.

- M., & Reneker, J. C. (2021). Associations between sleep and academic performance in US adolescents: a systematic review and meta-analysis. *Sleep Medicine*, 83, 71–82.
<https://doi.org/10.1016/j.sleep.2021.04.015>
17. Paruthi, S., Brooks, L. J., D'Ambrosio, C., Hall, W. A., Kotagal, S., Lloyd, R. M., Malow, B. A., Maski, K., Nichols, C., Quan, S. F., Rosen, C. L., Troester, M. M., & Wise, M. S. (2016). Consensus Statement of the American Academy of Sleep Medicine on the Recommended Amount of Sleep for Healthy Children: Methodology and Discussion. *Journal of Clinical Sleep Medicine*, 12(11), 1549–1561.
<https://doi.org/10.5664/jcsm.6288>
 18. Rasch, B., & Born, J. (2013a). About Sleep's Role in Memory. *Physiological Reviews*, 93(2), 681–766.
<https://doi.org/10.1152/physrev.00032.2012>
 19. Rasch, B., & Born, J. (2013c). About Sleep's Role in Memory. *Physiological Reviews*, 93(2), 681–766.
<https://doi.org/10.1152/physrev.00032.2012>
 20. Walker, M. P., & Stickgold, R. (2004). Sleep-Dependent Learning and Memory Consolidation. *Neuron*, 44(1), 121–133.
<https://doi.org/10.1016/j.neuron.2004.08.031>