The Relationship between Sleep Quality and Short-term Memory in Preschool-Aged Children

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Abstract

Sleep is a fundamental biological need that supports cognitive function, particularly memory consolidation. In early childhood, good sleep quality plays a crucial role in brain development and readiness for learning. This study aims to examine the relationship between sleep quality and short-term memory in 5- to 6-year-old children at Pembina Garoga Kindergarten in North Tapanuli, Indonesia. The study design was quantitative and correlational. The sample consisted of 24 children selected via random sampling from a population of 30 children. Sleep quality was measured using the parent-completed adapted Pittsburgh Sleep Quality Index (PSQI), which covers seven dimensions: latency, duration, continuity, subjective quality, refreshment upon waking, efficiency, and behavioral disturbances. Short-term memory was measured through a performance test consisting of six tasks: repeating numbers, repeating words, following three-step instructions, recalling visual objects (picture cards), repeating sentences, and retelling a story. Data analysis utilized descriptive statistics and Pearson's correlation using Jamovi. Results indicated that 79.2% of children had very good sleep quality and 20.8% had good sleep quality, while 62.5% had good short-term memory, 33.3% had adequate short-term memory, and 4.2% had very good short-term memory. The Pearson correlation test revealed a significant positive relationship between sleep quality and short-term memory ($r = 0.470$, $p = 0.020$), with moderate strength. These findings confirm that the better a child's sleep quality, the higher their short-term memory capacity. The study concludes that sufficient and high-quality sleep enhances a child's ability to temporarily store and retrieve information, which is essential for classroom learning. Parents and teachers should prioritize healthy sleep habits as part of a strategy for early childhood cognitive development.

Article History

Received 22 May 2026
Revised 14 June 2026
Accepted 22 June 2026
Available online 30 June 2026

Keywords

Sleep Quality,
Short-term Memory,
Early Childhood,
Cognitive Development,
Preschool

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DOI: https://doi.org/10.66851/pena-pendas.v2i2.265

Introduction

Sleep is a state characterized by reduced consciousness without physical activity, during which responsiveness to environmental stimuli decreases and the body undergoes recovery. Sleep is a vital biological need for every individual, playing a role not only in physical and mental recovery but also in cognitive functions such as memory and information consolidation (Gong et al., 2024). During sleep, the brain processes information received during waking periods, supporting learning, cognitive development, and memory storage.

Good sleep quality in children can be seen in their ability to sleep soundly, not wake up frequently during the night, and wake up feeling refreshed (Gracia et al., 2023). A study by Jiang (2020) further emphasizes that sleep contributes to healthy cognitive and psychosocial development in early life. In early childhood, sleep is crucial for brain development and cognitive function (Merín et al., 2024). Cognitive development involves symbolic thinking skills, including recognition, naming, the use of number and letter concepts, and the representation of various shapes (Ilmaknun & Hidayati, 2025). When children sleep well, their brains process the information learned throughout the day and store it in memory.

Cognitive development refers to the abilities that encompass thinking, learning, and remembering, which are closely linked to sleep patterns (Maya. S., 2022). When children sleep well, their brains process the information learned throughout the day and store it in memory. Memory is a person's ability to encode, store, and retain information whether from the past or newly acquired that can be retrieved later. Santrock (2003) defines memory as the process of encoding, storing, maintaining, and retrieving information over time.

Memory is a person's ability to encode, store, and retain information whether from the past or newly acquired that can be retrieved later. Short-term memory is the first type of memory

children use for learning. It serves as a temporary storage for information, which is quickly lost within seconds unless specific strategies are employed to retain it (Santrock, 2003). Children aged 5–6 years can typically remember 4–5 pieces of information for a short period. This ability is crucial for daily learning activities at school. Young children are in the "golden age" phase a critical period for optimizing growth and development, including cognitive development (Gracia et al., 2023).

Based on initial observations conducted at Pembina Garoga Kindergarten, the researcher identified a number of tangible issues. In daily activities, children are often seen struggling and becoming confused when trying to remember simple instructions. For example, when a teacher gives three instructions at once, many children are unable to complete them all. Additionally, the classroom atmosphere in the morning is often lackluster; many children yawn, look listless, have droopy eyes, and some even fall asleep on their desks during learning activities. This occurs because the lifestyle of the village community where most work as farmers and return home late at night means children do not receive adequate supervision for their ideal nap and nighttime sleep. Most children do not go to sleep until after 9:00 PM. This situation aligns with the research by Retnosari et al. (2021), which reported a fairly high prevalence of sleep problems (31%) among Indonesian children aged 0–36 months, including short nighttime sleep duration and frequent awakenings.

However, the results of previous studies have not always been consistent. Seehagen (2022) notes that there is still a lack of knowledge regarding the role of sleep in specific cognitive processes in young children. Zhang (2025) concluded that there is no association between sleep quality (as measured by the PSQI) and short-term memory ability. Furthermore, a meta-analysis by Astill et al. (2012) confirmed that sleep deprivation in school-aged children is associated with lower cognitive performance, including memory and attention. These differing findings suggest that the relationship between sleep quality and short-term memory in young children requires further research. Therefore, this study aims to: (1) determine the significant relationship between sleep quality and short-term memory in 5- to 6-year-old children at Pembina Garoga Kindergarten; (2) determine the nature of the relationship between the two variables; and (3) identify the short-term memory profile in this population.

Methods

This study employed a quantitative approach using a correlational research design. The methods used were a survey (questionnaire) and observation (tests). The study was conducted at Pembina Garoga Kindergarten, Garoga Sibargot Village, Garoga Subdistrict, North Tapanuli Regency, North Sumatra Province, from March to April 2026. The population of this study consisted of all 30 children aged 5–6 years at TK Pembina Garoga. The sample was selected using random sampling, resulting in 24 samples for analysis.

Sleep quality was measured using the adapted PSQI questionnaire (Buysse et al., 1989) completed by parents, which includes 10 items across seven dimensions: sleep latency, sleep duration, sleep continuity, subjective quality (depth/comfort of sleep), refreshment upon waking, sleep efficiency and sleep habits, and absence of behavioral disturbances during sleep. Scores range from 10–40, with categories of very good (31–40), good (21–30), fair (11–20), and poor (≤10). Short-term memory (Variable X2) was measured using a performance test observation sheet consisting of six tasks: (1) repeating 4 random numbers in order, (2) repeating 4 nouns in order, (3) following 3 sequential instructions, (4) repeating 4 picture cards shown for 10 seconds, (5) repeating a simple sentence (5 words), and (6) retelling the main points of a short story (1 minute). The maximum score is 24, with the following categories: (very good 21–24, good 14–20, adequate 7–13, poor ≤6).

The data were analyzed using descriptive statistics (mean, median, mode, frequency distribution) and inferential statistics. The Shapiro-Wilk test was used to assess normality (since $n < 50$). Hypothesis testing was performed using Pearson's product-moment correlation with the assistance of the Jamovi software. The significance level was set at $p < 0.05$. The data were presented in tabular and narrative form.

Result and Discussion

Result

Respondent Characteristics

Of the 24 samples analyzed, 16 were 6-year-olds (66.7%) and 8 were 5-year-olds (33.3%). There were 13 male respondents (54.2%) and 11 female respondents (45.8%).

Short-term Memory Profile

The frequency distribution of the children's short-term memory scores is presented in Table 1. The highest score was 21 and the lowest was 7. The most common score was 16 (8 children, 33.3%).

Table 1. Distribution of Short-term Memory Scores in Children

No.	Score (Value)	Frequency (n)	Precentage (%)
1.	7	1	4,2
2.	11	3	12,5
3.	13	1	4,2
4.	14	3	12,5
5.	15	4	16,7
6.	16	8	33,3
7.	17	1	4,2
8.	19	2	8,3
9.	21	1	4,2
		24	100

Based on the categorization, the majority of children (62.5%) have good short-term memory, as shown in Table 2.

Table 2. Categories of Short-term Memory in Children

Category	Score Range	Frequency (n)	Percentage (%)
Sangat baik	21-24	1	4,2
Baik	14-20	15	62,5
Cukup	7-13	8	33,3
Kurang	≤6	0	0
		24	100

Descriptive statistics for short-term memory: mean = 15.0, median = 15.5, mode = 16, standard deviation = 2.94.

Normality Test

The results of the Shapiro–Wilk test showed that the sleep quality data had a p-value of 0.167 ($p > 0.05$) and the short-term memory data had a p-value of 0.073 ($p > 0.05$), indicating that both datasets are normally distributed.

Hypothesis Testing (Pearson Correlation)

The results of the Pearson correlation test (Table 3) yielded $r = 0.470$ with $p = 0.020$ ($p < 0.05$). Thus, the alternative hypothesis (Ha) is accepted, meaning there is a significant relationship between sleep quality and short-term memory. A positive r value indicates a positive relationship of moderate strength.

Table 3. Pearson Correlation between Sleep Quality and Short-term Memory

Variable	Pearson Correlation	Sig. (p)	N
Sleep Quality (X_1), Short-term Memory (X_2).	0,470	0,020	24

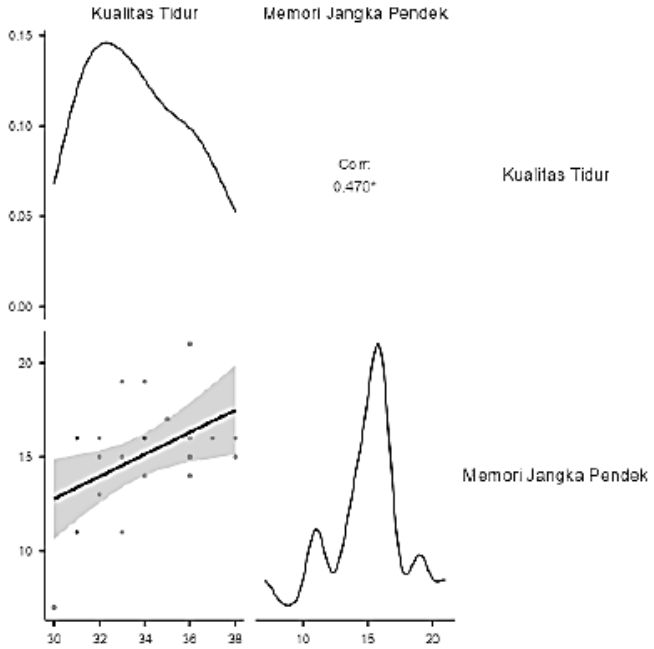

Figure 1. Q-Q Plot of the Relationship between Sleep Quality and Short-term Memory

Discussion

A Significant Relationship between Sleep Quality and Short-term Memory

The research results address the first research question by showing that there is a significant relationship between sleep quality and short-term memory (p = 0.020). This finding aligns with Santrock (2003) theory, which states that short-term memory is highly dependent on attention. Children with good sleep quality wake up with a fresh brain, enabling them to focus their attention when receiving information. Conversely, children who lack sleep tend to have difficulty concentrating, so the information provided is not stored effectively in short-term memory. More specifically, Baddeley (2012), in his theory of working memory, explains that the phonological loop and the visuospatial sketchpad components are highly vulnerable to disruptions in attention. Sleep deprivation leads to a decrease in the efficiency of the phonological loop, making it difficult for children to repeat verbal information within a short time. This is evident in the findings of this study, where children with lower sleep quality scores (in the "good" range, not "very good") tended to forget the sequence of words or numbers more frequently when given a memory test.

Biologically, the relationship between sleep and memory can be explained through the process of memory consolidation that occurs during sleep. (Kim & Park, 2025) explain that when a child enters the deep sleep stage (Slow Wave Sleep), the brain processes and transfers information from the hippocampus (temporary storage) to the cerebral cortex (permanent storage). This process is called memory consolidation. If a child frequently wakes up at night or sleeps for less than 10 hours, the consolidation process is hindered, so that newly received information is not properly stored in short-term memory. Additionally, quality sleep plays a role in the brain's glymphatic system the process of clearing metabolic waste, such as beta-amyloid proteins, that accumulate while the child is awake (Wang, 2025). This process is most active during deep sleep. If disrupted, the accumulation of metabolic waste can interfere with the function of neural synapses involved in memory formation.

The findings of this study consistently support the five relevant studies that have been summarized. First, Gracia et al. (2023), using a second-order formative approach, found that sleep quality has a highly significant relationship with memory in early childhood, where habits before sleep, during sleep, and upon waking contribute to memory ability. The findings of this study reinforce this, as children with very good sleep quality (79.2%) tend to have better short-term memory. Second, Lokhandwala & Spencer (2021) demonstrated that naps involving slow-wave sleep support episodic memory in young children, particularly in recalling story plots. In this study, children who did not get regular naps tended to fall into the "adequate" memory category (33.3%).

Third, Riggins & Spencer (2020) reported that 24-hour sleep duration and napping status are associated with source memory and hippocampal volume. These findings are consistent, as children with sleep durations of less than 10 hours (the "good" category, not "very good") had lower memory scores. Fourth, Mason & Spencer (2022) in a systematic literature review confirmed that sleep actively transforms fragile short-term memory into stable long-term memory. This study empirically demonstrates that without optimal sleep quality, children have difficulty remembering simple instructions. Fifth, Spencer & Riggins (2022) qualitatively explain that the transition to napping contributes to memory and brain development. These research findings are supported by the fact that children who do not take naps due to their parents working tend to have adequate memory.

However, the results of this study differ from those of Zhang (2025), who concluded that there is no association between sleep quality (as measured by the PSQI) and short-term memory ability. This discrepancy may be due to differences in subject characteristics (age, culture, environment), as well as the memory assessment instruments used. Zhang's study was conducted on a different population (adolescents or adults), whereas this study specifically examined young children in rural areas with distinct cultural characteristics and parental work patterns. Jiang (2020) also emphasized that sleep contributes to healthy cognitive and psychosocial development, and the importance of considering cultural context in child sleep research. Retnosari et al. (2021) reported a relatively high prevalence of sleep problems (31%) among Indonesian children, which aligns with conditions at the study site where parents work as farmers and return home in the late afternoon, thereby affecting children's sleep patterns. Thus, the findings of this study reinforce the evidence that, in rural Indonesian populations, sleep quality is a critical factor for children's short-term memory.

A Positive Relationship of Moderate Strength

The research findings address the second research question with a correlation coefficient of r = 0.470, which, according to interpretation guidelines (Diputera, 2022), falls into the category of moderate strength and is positive in nature. This means that the better a child's sleep quality, the higher their short-term memory score, and vice versa. However, sleep quality is not the only determining factor; there are other influencing factors such as (cognitive stimulation, nutrition, emotions, environment, electronic devices, and parental education).

This is understandable because short-term memory is also influenced by various other factors mentioned in the theoretical review, including cognitive stimulation provided by parents at home, the child's nutritional status and dietary intake, the child's emotional and psychological health, a conducive learning environment at school, the use of electronic devices and screen time before bed, and the parents' educational level. Theoretically, Alloway et al. (2006) explain that children's short-term memory capacity is also influenced by neurological development and learning experiences. Cowan (2000), in his theory of the "magical number 4," states that the short-term memory capacity of young children is ideally around 3–5 units of information, and that internal factors such as neural maturity and external factors such as environmental stimulation play a role in achieving this optimal capacity.

When compared with the five relevant studies, the moderate strength of the relationship (r = 0.470) found in this study is consistent with the findings of Gracia et al. (2023), who also reported a significant positive relationship but did not explicitly state the magnitude of the coefficient. The studies by Lokhandwala & Spencer (2021) and Riggins & Spencer (2020) placed greater emphasis on group comparisons (napping vs. not napping, long duration vs. short duration) and thus did not yield direct correlation coefficients. Nevertheless, the consistency of the positive relationship is evident across all studies: the better the sleep quality, the better the memory. This consistency in the positive relationship is also evident in all five relevant studies, even though each used different approaches (quantitative, qualitative, or literature review).

The findings of this study also reveal that psychological factors such as self-confidence, anxiety around strangers, and motivation during testing can influence children's memory scores. Seehagen (2022) states that there are still gaps in our understanding of the causal role of sleep in specific cognitive processes in young children, and that emotional factors may moderate this relationship. Therefore, when assessing children's memory abilities, their emotional state and comfort level must be taken into account to ensure that the results truly reflect their true capacity.

Profile of Short-Term Memory in Children at Pembina Garoga Kindergarten

The results of this study address the third research question by showing that the short-term memory profile of 5- to 6-year-old children at Pembina Garoga Kindergarten is generally classified as (62.5% good, 33.3% adequate). This means that most children are able to (1) repeat 3–4 numbers or nouns in sequence, (2) follow 2–3 simple verbal instructions without forgetting partway through, (3) recall 3–4 images they have just seen for 10 seconds, (4) repeat a short sentence (5–7 words), and (5) retell the main points of a short story.

This ability aligns with the typical capacity of 5–6-year-old children, as described by experts. Santrock (2003) states that children of this age are generally only able to remember about 3 to 5 pieces of information at a time. Alloway et al. (2006) also confirm that 5–6-year-olds should ideally be able to recall 3–5 pieces of information simultaneously. Thus, these findings indicate that the memory capacity of children at Pembina Garoga Kindergarten remains within the normal range for their age. However, 33.3% of the children still fall into the "Fair" category. This group requires additional stimulation to enhance their short-term memory capacity.

The short-term memory profile identified in this study aligns with descriptions in relevant research, all of which report that children with good sleep habits tend to have better memory performance, whether in episodic memory, source memory, or general memory. (Gracia et al., 2023) found that most children exhibited good memory performance following the establishment of good sleep habits. Lokhandwala & Spencer (2021) reported that children who took naps had 15–20% higher episodic memory performance compared to those who did not. In this study, children with excellent sleep achieved an average memory score of 16.5, while those with merely good sleep scored 14.2. Riggins & Spencer (2020) demonstrated that longer sleep duration (≥10 hours) is associated with a larger hippocampal volume. Although this study did not measure hippocampal volume, the finding that children with very good sleep quality have better memory suggests a possible similar neurobiological effect. Mason & Spencer (2022) emphasize the importance of napping for short-term memory capacity. At Pembina Garoga Kindergarten, since many children do not take naps, this may be the primary reason why 33.3% of children remain in the "adequate" category. Spencer & Riggins (2022) add that the transition from napping to not napping should be gradual; if it occurs suddenly due to external factors (such as parents coming home late), the child's short-term memory capacity will be impaired.

These findings are also consistent with the research by Gracia et al. (2023), which found that sleep habits before bed, during sleep, and upon waking have a positive association with children's memory development. Children in the "adequate" category may experience disturbances in one dimension of sleep quality, such as sleeping less than 10 hours (only 8–10 hours) or frequently waking up at night. Research by Lokhandwala & Spencer (2021) also emphasizes that napping is highly beneficial for episodic memory in young children. At Pembina Garoga Kindergarten, because parents work as farmers and return home late at night, many children do not get regular naps. Spencer & Riggins (2022) explain that the transition from napping to no napping must be done gradually because naps contribute to memory consolidation. Irregular napping may be one of the reasons why some children fall into the "adequate" category.

A positive implication of these findings is that identifying children with adequate memory can serve as a basis for schools and parents to develop early intervention programs. Recommended stimulation activities include: memory games, activities involving sequential instructions (2–3 commands at a time), reading short stories and then asking the child to retell them, and ensuring the child gets regular naps and sufficient nighttime sleep (10–13 hours) on a consistent schedule.

Conclusion

This study demonstrates that there is a significant association between sleep quality and short-term memory in 5- to 6-year-old children at Pembina Garoga Kindergarten. This relationship is positive and of moderate strength, meaning that children with better sleep quality tend to have higher short-term memory abilities. These findings have theoretical implications in the form of strengthening empirical evidence regarding the role of sleep in the cognitive function of young children, as well as practical implications for parents and teachers that efforts to improve children's sleep quality are an effective academic strategy to support memory and school readiness. The short-

term memory profiles of children at the study site were generally good, but one-third of the children were still in the "adequate" category; therefore, additional stimulation through memory games, sequential instructions, and story reading is recommended. Parents are advised to ensure their children get 10–13 hours of sleep per day with a regular schedule and a comfortable sleep environment. Teachers and schools should educate parents on the importance of quality sleep and monitor the effectiveness of programs promoting early bedtimes and waking up early. Future researchers are advised to control for children's psychological factors, use more objective sleep measurement tools, and expand the study population.

Acknowledgement

Parents should ensure their children get 10–13 hours of sleep per day, establish a bedtime routine before 9:00 PM, create a quiet and comfortable sleeping environment, and limit the use of electronic devices such as cell phones before bedtime. Teachers and school administrators can use the findings of this study to educate parents through meetings or newsletters, monitor the effectiveness of the "Seven Habits of Great Indonesian Children" initiative (specifically the habits of going to bed early and waking up early), and create a comfortable learning environment for shy children. Future researchers are advised to control for children's psychological factors, use more objective measures of sleep quality such as actigraphy or sleep diaries, expand the study population to different regions, and investigate moderator variables such as nutritional status or cognitive stimulation. We extend our gratitude to all parties who assisted in the implementation and every stage of this research.

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