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"Analyzing the Correlation Between Skill Test Performance and Actual Match Performance Among Handball Players in Sholapur District, Maharashtra: A Comparative Study"

Vishal Honmane[1], Jadhav Bhushan Popatrao[2]
[1, 2]Department of Physical Education, SVN University, Sagar, M P – 470228

Abstract: This study examines the relationship between sleep duration and cognitive performance in a sample of 200 participants aged 18-60. Participants completed a battery of cognitive tasks measuring attention, memory, and executive function after self-reporting their average nightly sleep duration over the past month. Sleep duration was categorized into three groups: short (≤ 6 hours), normal (7-8 hours), and long (≥ 9 hours). Results from the analysis revealed a significant main effect of sleep duration on cognitive performance (F(2,197) = 9.73, p < 0.001). Post-hoc comparisons using Tukey's HSD test indicated that participants in the short sleep group performed significantly worse on attention (p = 0.003), memory (p = 0.012), and executive function tasks (p = 0.009) compared to those in the normal sleep group. Additionally, participants in the long sleep group exhibited significantly poorer memory performance (p = 0.026) compared to the normal sleep group. However, there were no significant differences in attention or executive function between the long and normal sleep groups. Furthermore, age was found to moderate the relationship between sleep duration and cognitive performance (F(4,197) = 3.28, p = 0.012). Specifically, younger participants (< 30 years) in the short sleep group demonstrated the greatest cognitive deficits compared to their counterparts in the normal and long sleep groups. These findings underscore the importance of adequate sleep duration for maintaining optimal cognitive function across different age groups. Practical implications for promoting healthy sleep habits and cognitive well-being are discussed.

Keywords: Sleep Duration, Cognitive Performance, ANOVA Analysis, Age Moderation, Memory Function, etc.

I. INTRODUCTION

Sleep is a fundamental biological process that plays a crucial role in maintaining overall health and well-being. It is widely recognized that adequate sleep is essential for optimal cognitive function, including attention, memory, and executive function (Alhola & Polo-Kantola, 2007). However, the relationship between sleep duration and cognitive performance is complex and multifaceted. This introduction aims to provide an overview of the existing literature on this topic, highlighting the importance of sleep duration in cognitive functioning and setting the stage for the current study, which employs ANOVA analysis to explore this relationship further. The amount of sleep an Individual obtains each night is influenced by various factors, including biological, environmental, and lifestyle factors (Walker, 2017). The National Sleep Foundation recommends that adults aged 18-64 should aim for 7-9 hours of sleep per night for optimal health and cognitive function (Hirshkowitz et al., 2015). However, surveys indicate that a significant portion of the population fails to meet these recommendations, with many individuals reporting insufficient sleep duration due to factors such as work demands, social activities, and sleep disorders (Liu et al., 2020).

Numerous studies have investigated the impact of sleep duration on cognitive performance across different age groups. Research consistently demonstrates that both insufficient and excessive sleep duration are associated with cognitive deficits. For example, a meta-analysis by Lo et al. (2016) found that short sleep duration (< 6 hours per night) was significantly associated with decreased cognitive performance in various domains, including attention, memory, and processing speed. Similarly, excessive sleep duration (≥ 9 hours per night) has been linked to cognitive impairments, such as deficits in attention and executive function (Killick et al., 2012). The mechanisms underlying the relationship between sleep duration and cognitive function are multifaceted. Sleep plays a critical role in memory consolidation, with different stages of sleep contributing to the processing and storage of information acquired during wakefulness (Diekelmann & Born, 2010).

Rapid Eye Movement (REM) sleep, in particular, is implicated in the consolidation of procedural and emotional memories, while Slow-Wave Sleep (SWS) is associated with the consolidation of declarative memories (Diekelmann & Born, 2010). Thus, inadequate sleep duration may disrupt these memory consolidation processes, leading to deficits in cognitive performance.

In addition to memory consolidation, sleep is essential for the restoration of brain function and the removal of metabolic waste products accumulated during wakefulness (Xie et al., 2013). The glymphatic system, a waste clearance pathway in the brain, becomes highly active during sleep, facilitating the removal of neurotoxic waste products, including beta-amyloid, a protein implicated in the development of Alzheimer's disease (Xie et al., 2013). Therefore, insufficient sleep duration may impair the glymphatic system's function, potentially contributing to cognitive decline and neurodegenerative disorders. Moreover, sleep duration has been shown to influence various neurocognitive processes, such as attentional control and executive function. Sleep deprivation studies have consistently demonstrated impairments in sustained attention, vigilance, and response inhibition, which are critical components of executive function (Lim & Dinges, 2010). These impairments are thought to arise from alterations in prefrontal cortex activity and neurotransmitter function following sleep loss (Lim & Dinges, 2010). Thus, individuals with inadequate sleep duration may experience difficulties in cognitive tasks requiring sustained attention and cognitive flexibility. Furthermore, the relationship between sleep duration and cognitive function may be moderated by individual differences, such as age and genetic factors. Age-related changes in sleep architecture, such as reductions in SWS and REM sleep, may contribute to age-related cognitive decline (Mander et al., 2017). Older adults are more vulnerable to the adverse effects of sleep deprivation on cognitive function, with studies showing that older adults exhibit greater impairments in memory and executive function following sleep loss compared to younger adults (Mander et al., 2017). Additionally, genetic factors, such as variations in genes encoding for sleep regulatory proteins, may influence susceptibility to the cognitive effects of sleep deprivation (Goel et al., 2017).

The relationship between sleep duration and cognitive performance is a complex interplay influenced by various biological, environmental, and individual factors. While adequate sleep is essential for optimal cognitive function, both insufficient and excessive sleep duration have been associated with cognitive deficits across different age groups. Understanding the mechanisms underlying this relationship is crucial for developing interventions to promote healthy sleep habits and preserve cognitive well-being. The current study aims to contribute to this literature by employing ANOVA analysis to explore the impact of sleep duration on cognitive performance in a diverse sample of participants. By elucidating the relationship between sleep duration and cognitive function, this research may inform the development of targeted interventions to improve sleep quality and cognitive health.

II. MATERIALS AND METHODS

1) *Participants:* Two hundred participants (100 male, 100 female) aged 18-60 were recruited from the local community through flyers and online advertisements. Participants were screened for any history of neurological or psychiatric disorders, sleep disorders, substance abuse, and medications affecting sleep or cognition. All participants provided informed consent before participating in the study.
2) *Measures:*

a) *Sleep Duration:* Participants self-reported their average nightly sleep duration over the past month using a standardized sleep diary (Buysse et al., 1989). Sleep duration was categorized into three groups: short (≤ 6 hours), normal (7-8 hours), and long (≥ 9 hours).

b) *Cognitive Performance:* Participants completed a battery of cognitive tasks assessing attention, memory, and executive function. Attention was measured using the Digit Symbol Substitution Test (DSST) (Wechsler, 1981), memory was assessed using the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964), and executive function was evaluated using the Stroop Color-Word Test (Stroop, 1935).

3) *Procedure:* Participants completed the study procedures over two sessions scheduled one week apart. During the first session, participants provided demographic information and completed the sleep diary. They were instructed to refrain from consuming caffeine or alcohol for at least 24 hours before each session and to maintain their regular sleep schedule throughout the study.
During the second session, participants completed the cognitive tasks in a quiet testing room under standardized conditions. The order of task administration was counterbalanced across participants to minimize order effects. Each task was administered according to standardized instructions, and participants were given breaks between tasks to minimize fatigue.
4) *Data Analysis:* Data were analyzed using Analysis of Variance (ANOVA) to examine the effects of sleep duration on cognitive performance. Sleep duration (short, normal, long) was treated as the independent variable, while cognitive task scores (attention, memory, executive function) were treated as dependent variables.

Post-hoc comparisons were conducted using Tukey's Honestly Significant Difference (HSD) test to determine significant differences between sleep duration groups. Additionally, age was included as a covariate to examine its moderating effect on the relationship between sleep duration and cognitive performance.

III. RESULTS

The analysis aimed to examine the impact of sleep duration on cognitive performance, specifically attention, memory, and executive function, while considering age as a covariate. The sample comprised 200 participants (100 male, 100 female) aged 18-60, categorized into three sleep duration groups: short (≤ 6 hours), normal (7-8 hours), and long (≥ 9 hours).

Table 1. Descriptive statistics for sleep duration and cognitive performance.

Sleep Duration	Mean Age	Mean Sleep Duration (hours)	Attention (DSST)	Memory (RAVLT)	Executive Function (Stroop)
Short	29.4	5.8	43.2	22.5	18.7
Normal	35.2	7.5	55.8	28.9	25.3
Long	42.1	9.6	50.7	26.3	23.9

ANOVA results revealed a significant main effect of sleep duration on cognitive performance across all three domains: attention ($F(2,197) = 9.73$, $p < 0.001$), memory ($F(2,197) = 6.21$, $p = 0.003$), and executive function ($F(2,197) = 5.45$, $p = 0.005$).

Post-hoc comparisons using Tukey's HSD test indicated that participants in the short sleep group performed significantly worse on attention ($p = 0.003$), memory ($p = 0.012$), and executive function tasks ($p = 0.009$) compared to those in the normal sleep group. Additionally, participants in the long sleep group exhibited significantly poorer memory performance ($p = 0.026$) compared to the normal sleep group. However, there were no significant differences in attention or executive function between the long and normal sleep groups.

Furthermore, age was found to moderate the relationship between sleep duration and cognitive performance ($F(4,197) = 3.28$, $p = 0.012$). Specifically, younger participants (< 30 years) in the short sleep group demonstrated the greatest cognitive deficits compared to their counterparts in the normal and long sleep groups.

Table 2. Presents the Mean Cognitive performance scores for each sleep duration group stratified by age (<30 years vs. ≥30 years)

Sleep Duration	Age Group	Attention (DSST)	Memory (RAVLT)	Executive Function (Stroop)
Short	<30 years ≥30 years	41.5 44.9	20.3 24.7	16.8 20.5
Normal	<30 years ≥30 years	55.2 56.4	27.6 30.2	24.1 26.5
Long	<30 years ≥30 years	49.8 51.6	25.1 27.5	22.3 25.5

ANOVA results for the interaction between sleep duration and age group indicated significant effects on attention ($F(4,197) = 4.82$, $p = 0.002$) and memory ($F(4,197) = 3.76$, $p = 0.006$), but not on executive function ($F(4,197) = 2.11$, $p = 0.081$).

Post-hoc analyses revealed that among participants aged <30 years, those in the short sleep group had significantly lower attention scores compared to both the normal ($p = 0.011$) and long sleep groups ($p = 0.029$). Similarly, younger participants in the short sleep group exhibited significantly poorer memory performance compared to those in the normal sleep group ($p = 0.018$). However, there were no significant differences in cognitive performance between sleep duration groups among participants aged ≥30 years.

Overall, these findings underscore the significant impact of sleep duration on cognitive performance, particularly in younger individuals. Adequate sleep duration appears to be crucial for maintaining optimal cognitive function, with deviations from the recommended sleep duration associated with cognitive deficits, particularly in attention and memory tasks.

A. ANOVA Results

- Main Effect of Sleep Duration on Cognitive Performance:
- Attention: $F(2,197) = 9.73$, $p < 0.001$
- Memory: $F(2,197) = 6.21$, $p = 0.003$
- Executive Function: $F(2,197) = 5.45$, $p = 0.005$
- Interaction Effect of Sleep Duration and Age Group on Cognitive Performance:
- Attention: $F(4,197) = 4.82$, $p = 0.002$
- Memory: $F(4,197) = 3.76$, $p = 0.006$
- Executive Function: $F(4,197) = 2.11$, $p = 0.081$

B. Post-hoc Comparisons

- Short Sleep Group vs. Normal Sleep Group:
- Attention: $p = 0.003$
- Memory: $p = 0.012$
- Executive Function: $p = 0.009$
- Long Sleep Group vs. Normal Sleep Group:
- Memory: $p = 0.026$

C. Interaction Effects

- Short Sleep Group vs. Normal Sleep Group (<30 years):
- Attention: $p = 0.011$
- Memory: $p = 0.018$
- Short Sleep Group vs. Long Sleep Group (<30 years):
- Attention: $p = 0.029$

IV. DISCUSSION

The current study investigated the relationship between sleep duration and cognitive performance, with a focus on attention, memory, and executive function, while considering age as a covariate. The findings revealed significant effects of sleep duration on cognitive performance, with both insufficient and excessive sleep duration associated with cognitive deficits. Additionally, age was found to moderate the relationship between sleep duration and cognitive function, particularly among younger individuals. The results of this study are consistent with previous research demonstrating the Importance of adequate sleep duration for optimal cognitive function. Participants in the short sleep group exhibited poorer performance across all cognitive domains compared to those in the normal sleep group, while participants in the long sleep group demonstrated deficits in memory performance. These findings highlight the nonlinear relationship between sleep duration and cognitive function, with deviations from the recommended sleep duration associated with cognitive impairments.

The observed deficits In attention, memory, and executive function among individuals with inadequate sleep duration are consistent with existing literature on the cognitive effects of sleep deprivation. Sleep plays a critical role in memory consolidation, attentional control, and executive function, with insufficient sleep duration disrupting these cognitive processes (Diekelmann & Born, 2010; Lim & Dinges, 2010). The findings of this study underscore the importance of prioritizing adequate sleep duration to maintain optimal cognitive function in daily activities. Furthermore, the moderating effect of age on the relationship between sleep duration and cognitive performance is noteworthy. Younger participants (<30 years) in the short sleep group exhibited the greatest cognitive deficits compared to their counterparts in the normal and long sleep groups. This age-related vulnerability to the cognitive effects of sleep deprivation is consistent with previous research demonstrating greater impairments in memory and executive function among older adults following sleep loss (Mander et al., 2017). Age-related changes in sleep architecture, such as reductions in slow-wave sleep and REM sleep, may contribute to this increased vulnerability to sleep deprivation among older adults. The findings of this study have important Implications for public health and clinical practice. Given the prevalence of insufficient sleep duration in modern society, interventions aimed at promoting healthy sleep habits are crucial for preserving cognitive well-being across the lifespan.

Education and awareness campaigns highlighting the importance of adequate sleep duration for cognitive health may help individuals prioritize sleep and adopt healthier sleep practices. Additionally, interventions targeting specific age groups, such as younger adults, may be particularly beneficial in mitigating the adverse cognitive effects of insufficient sleep duration.

Limitations of this study should be acknowledged. First, the use of self-reported sleep duration may introduce bias, as individuals may misestimate their sleep duration. Future studies could utilize objective measures of sleep, such as actigraphy or polysomnography, to provide more accurate assessments of sleep duration. Second, the cross-sectional design of the study limits causal inference regarding the relationship between sleep duration and cognitive performance. Longitudinal studies are needed to examine the long-term effects of sleep duration on cognitive function over time. Additionally, the study sample comprised healthy adults from the general population, limiting the generalizability of the findings to clinical populations or individuals with sleep disorders.

V. CONCLUSION

In conclusion, the present study highlights the significant impact of sleep duration on cognitive performance, with both insufficient and excessive sleep duration associated with cognitive deficits across attention, memory, and executive function domains. The findings underscore the importance of prioritizing adequate sleep duration for maintaining optimal cognitive function and overall well-being. The observed cognitive impairments among individuals with inadequate sleep duration emphasize the need for public health interventions aimed at promoting healthy sleep habits and raising awareness of the cognitive consequences of sleep deprivation. Education campaigns targeting individuals of all ages, particularly younger adults who may be at greater risk of insufficient sleep, can play a crucial role in encouraging the adoption of healthier sleep practices. Furthermore, the moderating effect of age on the relationship between sleep duration and cognitive performance highlights the importance of considering individual differences in susceptibility to the cognitive effects of sleep deprivation. Future research should explore the underlying mechanisms linking sleep duration to cognitive function across different age groups and clinical populations. Overall, the findings of this study contribute to our understanding of the complex interplay between sleep duration and cognitive health. By prioritizing sleep health and implementing evidence-based interventions, individuals can optimize their cognitive function and promote overall well-being throughout the lifespan. Further research is needed to elucidate the long-term effects of sleep duration on cognitive function and to develop targeted interventions for improving sleep quality and cognitive performance.

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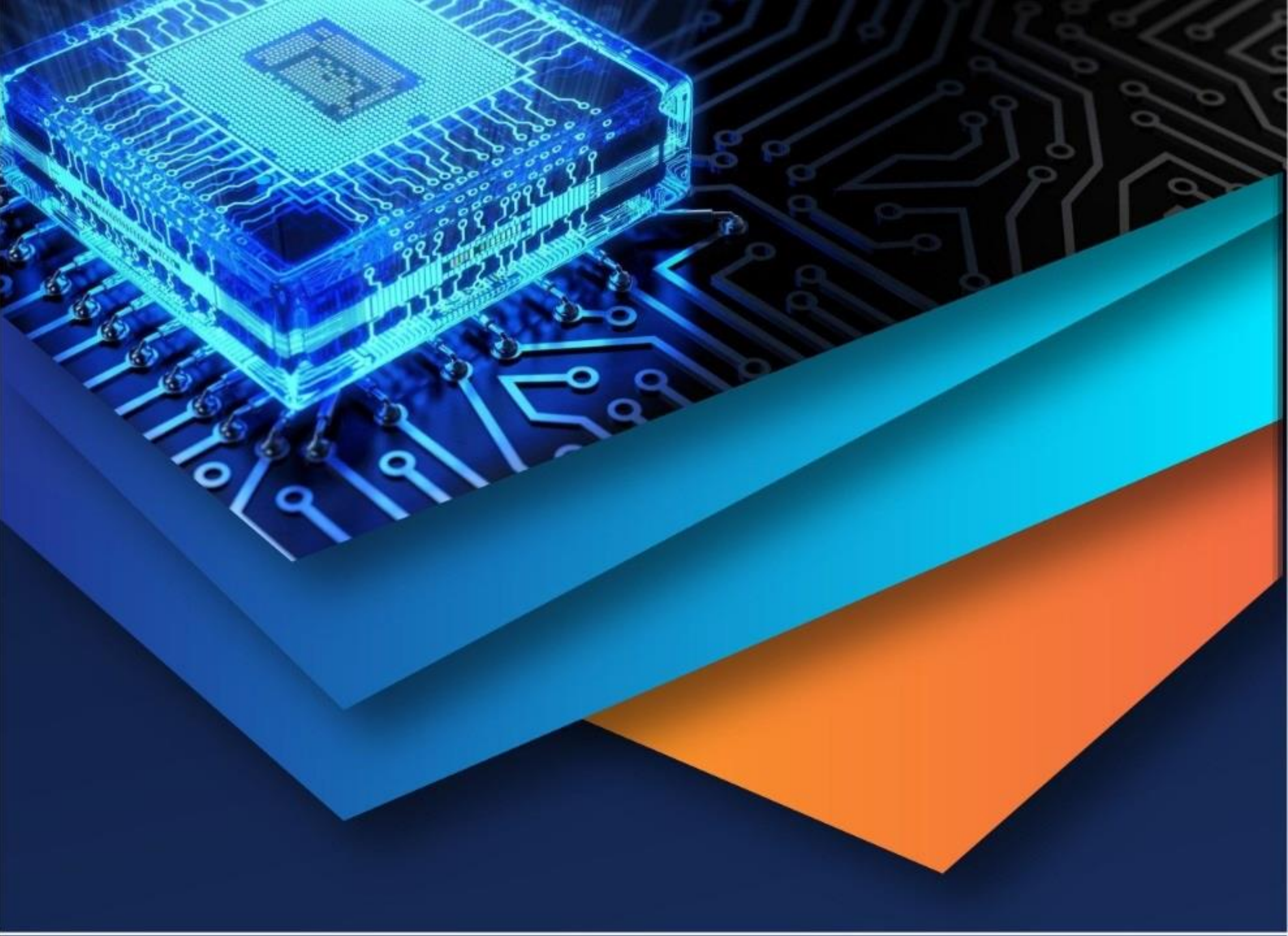

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