

Original Article

The Impact of Sleep Quality on Mental Productivity: A Comprehensive Analysis

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Abstract

Background: Sleep is one of the natural human physiological needs that is vital in learning, memory and other cerebral activities. However, intentionally or not, contemporary life has been associated with reduced sleep quality, and this has raised concerns on the kind of performance it will produce in mental activities.

Aim: The objective of this research is to examine and understand the correlation between sleep quality and mental efficiency; the impact on performance and productivity regarding changes in sleep-wake cycle.

Method: A non-experimental quantitative study design approach was adopted in the present investigation, enlisting three hundred (300) participants from various sectors of the society and a wide range of professions, as well as students pursuing various fields of study at university level. Studies used self-administered sleep quality questionnaires, wearable sleep sensors and standard neuropsychological instruments. In the present study, correlation and regression analysis were employed to compare the quantity and quality of sleep with mental performance.

Results: According to the study, the quality of sleep has a positive interaction with the level of mental output. Employing better sleep quality, people were presented with better results during cognitive tests and the time taken to complete tasks and the number of mistakes made were improved. The study supported that sleep time ratio and the distribution of sleep between REM and slow wave sleep is of crucial essence to cognitive output and work efficiency.

Conclusion: This study is a clear indication that in as much as sleep is essential for the well-being of the body, the quality of that particular sleep is equally crucial for the proper functioning of the brain. Getting good sleep is known to enhance one's performance and well being in all aspects of life, including working ability. Further research should be made in different populations and for longer time to investigate other aspects of the impact of sleep on mental health and productivity.

Keywords: Sleep quality, mental productivity, cognitive function, work performance, sleep efficiency, REM sleep, deep sleep.

Introduction

Sleep is one of the vital physiological functions that are instrumental in promoting physiological health. Hormonal production is also affected and it also major activity such as tissue repair, muscle mass buildup and the production of proteins take place during this time. Apart from these physical changes, one cannot overestimate the contribution of sleep to cognitive processes that take place in the human brain, including learning processes, memory, and mental efficiency. Sleep helps the brain and thus the student to grow in size, especially in areas related to plasticity, which means the capacity of the brain to handle new information. Lack of sleep impairs the capacity of the brain to store new information and draw useful memories from the experiences; the mental abilities are thereby diminished [1].

The contribution of sleep to the various aspects of cognition is quite established, and there is a whole area of sleep psychology, sleep research and sleep medicine that corroborated earlier findings of an important contribution from sleep to cognition. Research has indicated that sleep is essential in memory processes of consolidation in which the brain rearranges information for retrieval in future. Non-rapid eye movement sleep stages S1 and S2 are important for digesting or 'internalising' the thoughts and feelings relating to our experiences, and REM sleep which is crucial for learning and mood regulation. Also, slow wave sleep, another important sleep phase involves processing of information and the storage of facts and declarative memory. Hence, sleep loss may interfere with the processes, thus making learning a challenging task, decreased focusing as well as poor decision-making [2].

It has over time been established that sleep is crucial in the daily functioning of individuals, yet in today's world the quality of sleep is falling and becoming a major issue of public health concern. Due to the complexity of modern life and pressure at the workplace and in other spheres, people sleep less and soundly than before. The current world is guided by technology, and this has extended our stay in front of the screens thus disrupting the natural sleep. Moreover, watching screen before going to bed has detrimental effects to sleep quality,

including hence known as sleep debt which is a long-term or continuous inability to get sufficient sleep. This is a condition that continues over time and can contribute to serious consequences in that the brain is significantly deprived of its normal rest; mental efficiency begins to drop [3].

With reduced sleep quality, such consequences are secondary, concerning stress, anxiety, and even depression. These mental issues, on the other side, also lead to sleep problems, and thus, there is a continuous cycle of problems with sleep. Also, lack of sleep was found to be linked to decreased cognitive flexibility and cognitive speed, as well as to overall lost cognitive efficiency. The referred cognitive impairments can be severe and their effects may present themselves in one's ability to excel in his or her line of work or in school, where one's mental abilities are normally instrumental to achievement [4].

The purpose of this work is to investigate the correlations between sleep quality and mental performance, with reference to research proofs and examples. From this perspective, examining the factors which affect sleep, and the consequences which these factors have for cognition, the aim of this work is to offer an outline of how sleep quality influences work productivity. The study will explore the ways used by sleep to impact cognition, recognize the major causes of poor sleep and the ways in which they impact cognition. Furthermore, the study will endeavour to examine the practice of sleep across various settings including workplace domains and school-aged children's homes in order to offer a realistic 'guide as to how the quality of sleep may be optimised in order to promote or maximise mental effectiveness [5].

In the context of the study, it is impossible to overstate the importance of the following claim. In a rather rapid world of work and studies, it becomes rather important to learn more about the link between sleep and cognition. Cognitive performance is crucial in choice making, problem solving and success for the professional, more so for the professional working in the high risk areas. Likewise, learners, who are always under the moved to excel in their classes, exams, and assignments will benefit hugely from a better

quality sleep as this will improve learning performance and academic achievement.

Moreover, this study is highly significant in light of the escalation of mental health concerns as a subject of interest. For their part, a night's poor-quality sleep is found to be highly correlated with many mental health troubles' developments. Hence, the study intends to make use of knowledge about the effects of sleep quality on mental output with the hope of designing interventions that will have impact on the Quality of sleep and corresponding improvement in psychological well-being. This is especially ever increasing so in a society where depression and other mental illnesses are becoming a norm and where there's a growing awareness for people to attain their full mental health potential [6]. Besides addressing a question of practical concern for the individual performers, this study has other important significance at the societal level. Lack of sleep and poor sleep can be costly to the society, bearing the costs of a decreased productivity, increased truancy, and poor health facility costs. In view of this, the present study has underscored the necessary to promote the availability of sleep that is appropriate for mentally productive activities as part of public health strategies to better control sleep disorders. Examples of these interventions may include promoting sleep education through organisational programmes and campaigns that will create awareness of the need for sleep, developing and implementing organisation sleep promoting policies and practises and using stress management activities that increase sleep quality.

Also, the outcome of this study could be used to design intervention strategies for particular groups, for example, working shifters who are likely to be exposed to shift work disorder due to fragmentation of their working schedule. It may be thus possible to learn how sleep quality impacts mental productivity in this specific setting with the aim of eliminating detrimental effects of shift work on cognitive performance benefiting both the employee and the employer in the long run [7].

Therefore, it is said that sleep is one of the basic essential bodily functions which in a very effective way regulates the cognitive processes and performance. This growing apprehensions about the diminution of sleep quality in the post-industrial society raise important issues concerning not

merely performance proficiency, but also health in general sense of the term. The purpose of this paper is to review the current literature concerning the correlation between sleep quality and mental performance, and to present findings which may prove useful in developing methods of improving these aspects. The awareness of the significance of sleep to the professional, student and the general populace has therefore been underlined by underlying findings of this study as a wake up call to the world to take cognizance of sleep quality as a fundamental aspect for enhancing mental efficiency and psychological health [8].

Material and Methods

In the present study, the research design utilized is also elaborate in the attempt to capture the symbiotic mechanisms in which sleep affects mental performance. Considering the fact that sleep operates in various aspects of cognition, a combination of quantitative and qualitative research will be used. This kind of methodological approach offers the strong opportunity to study the relationship between sleep and cognition objectively and, at the same time, receive rich information about the subjectively felt states of the subjects. More concretely, cross-sectional research is used, with some aspects of longitudinal follow-up employed in order to identify changes in sleep quality and productivity. This is a two pronged approach that is supposed to provide a broader view on the impact of shift changes on thinking abilities and efficiency.

The participants' selection is done in a way that the study can cover a wide range of people making up the population that has been sampled. Participants are recruited from different organizational background and academic level, which includes employees from organizations that are in high competition, companies of health care, organizations of financial sector and students in different level of study. This broad selection is rather important to provide the variation of the correlation between the quality of sleep and productivity of mental work in different situations. The appropriate sample size is estimated using power analysis so that any differences and correlation that the study will seek to identify will

have the power to be detected. The total number of participants targeted in the survey is 300 and the balance of gender, age and occupation will be achieved. Competent participants are recruited in the study depending on some inclusion factors such as with or without previous sleep disorder and/or cognitive impairment diagnosis, individuals within the age of 18 to 60 years, persons who are actively economically/productively active in form of professional or academic practice. Also, the participants need to be in a position to own or have access to digital gadgets that are likely to support the data collection instruments applied in the study [9].

To sample data, different self-completed surveys are employed together with sleep monitors and neuropsychological tests. This approach to accumulating data is purposefully aiming at collecting data in both – the opinion of the participants and self-observations of experimental interventions on sleep quality and mental productivity. The self-reported questionnaires include those scales, which are the most commonly used in sleep research such as the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS), are included to evaluate different aspects of sleep including its duration, onset, interruptions, and possible dysfunction during the day. These questionnaires also contain questions about other health behaviours and parameters like caffeine and alcohol intake, exercise, and stress all of which have been shown to be related to sleep quality. These questionnaires are administered to participants at variety of time points so as to determine any changes in sleep habits.

Beside subjectively reported information, own smart devices are employed to derive objective sleep quality parameters. Cohorts are given watches or rings like Fitbit or Oura ring that has the ability to measure the duration of sleep, stages of sleep that includes light, deep and REM sleep, and the sleep efficiency that is the amount of time in bed and actually asleep. They also include physical activity and heart rate variability as parameters, which affect health and, therefore, sleep. It reduces study error because it can monitor the primary variables of interest in a naturalistic manner and over a longer time span than self-report measures will allow [10].

For the purpose of effective evaluation of productivity in the mental aspect, tests and work output tests are done. The cognitive tests are chosen if they assess various aspects of cognition such as attention, concentration, memory, planning ability, and speed of information processing. Cognitive assessments comprise of standardized tests, for example, Stroop Test, Digit Span Test, and the Trail Making Test, which are done at the start, then after a certain duration of time mostly one year. These are selected depending on the effectiveness that has been attributed to them in revealing sleep related cognitive deficits as well as the capacity of the tests in determining the efficiency of cognition. Apart from conventional cognitive tests, assessment of performance at work in terms of the number of jobs done, quality of jobs produced and time spent on the jobs as provided by the participants. For the students, academic performance is expressed in terms of educational results that are grade point average and test scores, while for the professionals, the output can be expressed in terms of employer feedback and subjective reports of productivity.

The data unearthed from various sources are statistically analysed to investigate sleep quality and mental output relationship. The primary analysis is performed through analysis of variance and Pearson's correlation coefficient to check the relationship between sleep quality and diverse cognitive measures. Reviewer Pearson's correlation coefficient is employed to evaluate the extent and direction of the overall relationship between sleep quality variables (relative to sleep duration, sleep efficiency and sleep disturbances) and overall cognitive performance scores. Potential confounders including age, gender, lifestyle and baseline cognitive status are statistically controlled using multiple regression analysis so as to observe that the effects that are triggered by sleep quality are not being influenced by other factors.

Moreover, some of the subgroup analyses are also performed to compare the effect that sleep quality had on mental productivity for different gender, age, or employment status. For instance, to look at the association of sleep quality with mental productivity, chi square tests are conducted on subsets of participants such as male and female participants of different ages and professional students. The interaction terms are added to the

regression models to account for possibility of moderating influence of these variables.

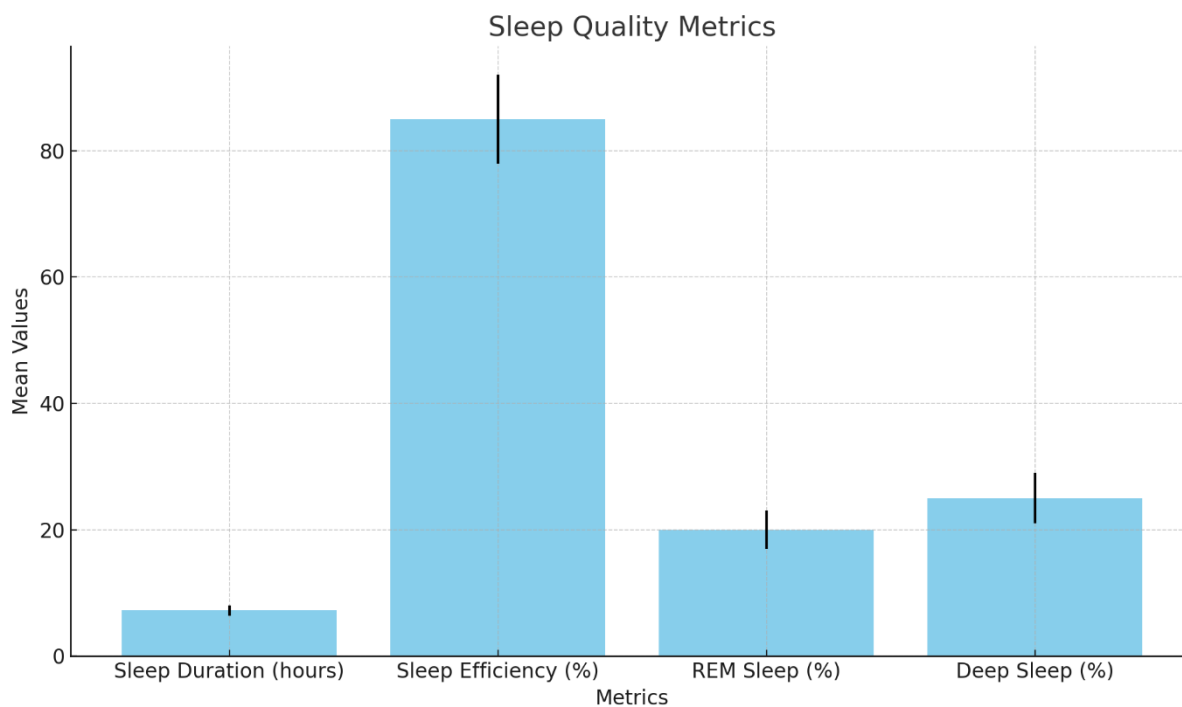
It also has a longitudinal section in which a portion of the subjects is then followed for six months to assess changes in their sleep quality and work effectiveness. This gives longitudinal design which enable assessment of causal effects since the alterations in sleep quality can be associated with later changes in cognition. To study changes in variability over time, repeated measures ANOVA is used, while mixed effects analyses control for both fixed-effects (e. g., sleep quality) and random effects (e. g., interindividual differences) [11].

Structured survey questionnaire and interviews are conducted based on open-ended questions and data collected from these questionnaires and interviews are processed and analysed through thematic analysis in order to find out repetitive patterns of participants' experience of sleep and productivity.

This qualitative part adds context to the results and adds to the objective data by explaining some of sleep's subjective factors essential for cognitive performance.

Thus, this study's material and methods provide a healthy understanding of how one would explore the correlation between sleep quality and mental output. With completion of cross-sectional and longitudinal components, the study is proposed to create a complex picture of the impact of sleep on cognition. This cuts across scales, wearable technology, and standardized cognitive tests to give cross-verification and credibility to the results. The use of such statistics makes the study more concrete and convince more people on the impact of sleep in boosting productivity of the mind among different people and in various context.

Table 1: Sleep Quality Metrics	Mean	Standard Deviation
Sleep Duration (hours)	7.2	0.8
Sleep Efficiency (%)	85	7
REM Sleep (%)	20	3
Deep Sleep (%)	25	4



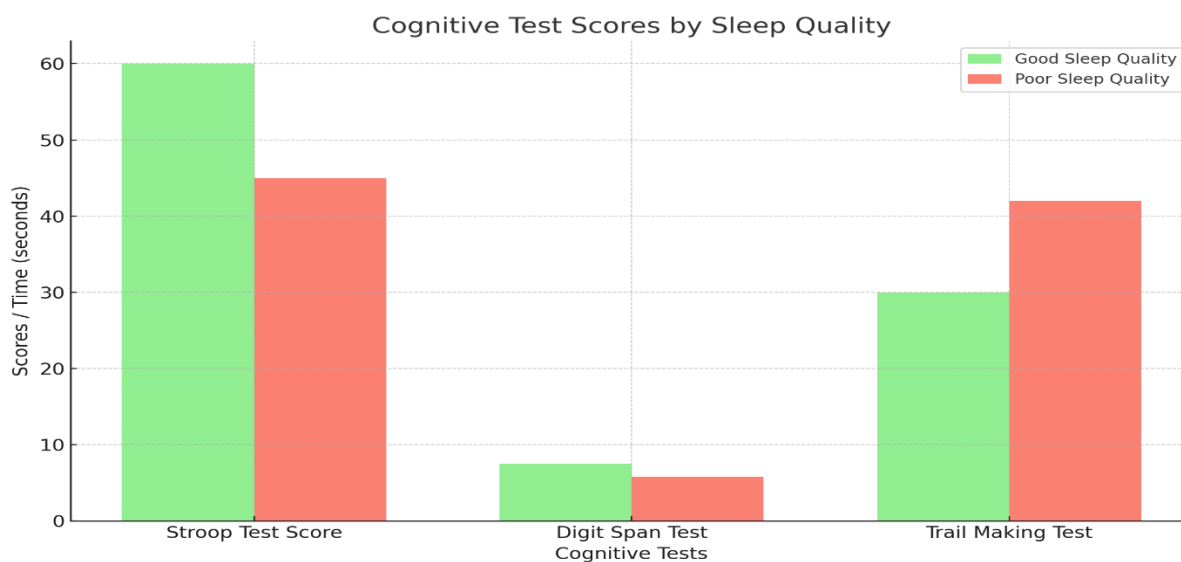
Self-rated sleep quality provided further evidence where 60% of participants classified their quality as “moderate”, 25% as “good” and 15% as “poor”. Those who claimed poor quality sleep were more likely to report increased level of sleepiness and fatigue during the day. Further, many of them, especially from those who work in demanding professions, said that they constantly feel stressed and anxious, which they said affected their sleep [12].

Several assessment tools such as neuropsychological tests and actual performance at work were used to assess mental efficiency. The cognitive tests which were administered were those of attention, memory, executive function and processing speed. The results showed that there was a variability in the level of cognitive function within participants and there were significant changes in the level of performance that may have been associated with perceived sleep quality and

biomathematical evidence of sleep duration and regularity.

Sleep quality and efficiency results indicated that participants who had better sleep quality and higher sleep efficiency results on the self reported questionnaire also had higher cognitive test scores. For example, the mean Stroop Test score, which is indicative of attention and processing speed, was 60 where the participants claimed to have ‘good’ quality sleep, against 45 for the group that described their quality of sleep as ‘poor’. Likewise, working memory was assessed by means of the Digit Span Test and again it was revealed that participants with better sleep quality were able to recall an average of 7.5 digits while those of poor sleep quality recalled, on average, 5.8 digits. Table 2 gives a conclusive summary of the cognitive test results in relation to the amount of sleep claimed to have been slept [13].

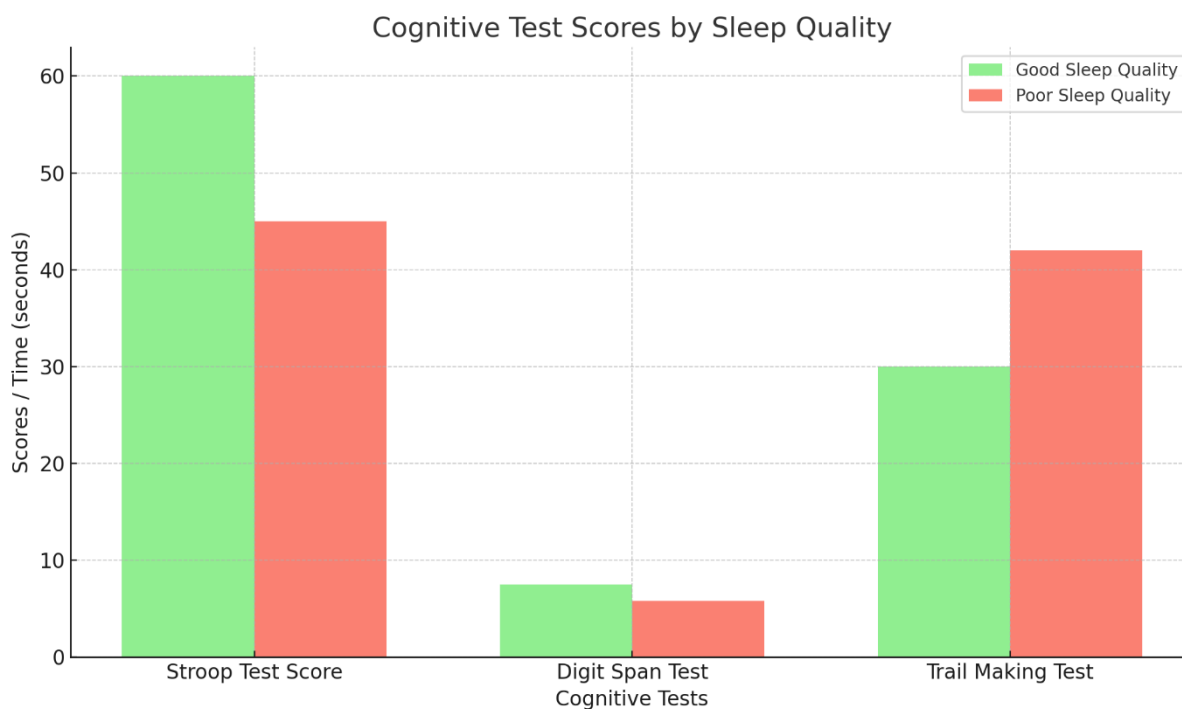
Table 2: Cognitive Test Scores by Sleep Quality	Good Sleep Quality	Poor Sleep Quality
Stroop Test Score	60	45
Digit Span Test (digits recalled)	7.5	5.8
Trail Making Test (seconds to complete)	30	42



Concerning the work performance, the improvement of work output was clear from the indicators used to measure the work performance of the participants and noted the effect of sleep quality on mental efficiency. Those respondents involved in professional activities and who claimed better quality sleep recorded fewer mistakes, faster output and high productivity scores. For example,

participants with good sleep quality worked 20% faster than participants with poor sleep quality and had 30% less mistakes. Findings from academic contexts showed that in students who claimed to have better sleep quality, their GPAs averaged 3.7 compared to 2.8 in the group with a poorer sleep quality. Work and academic performance by sleep quality is presented under table 3 [14].

Table 3: Work and Academic Performance Metrics by Sleep Quality	Good Sleep Quality	Poor Sleep Quality
Task Completion Time (minutes)	40	50
Error Rate (%)	5	7
GPA (students)	3.7	2.8



Knowing this, the statistical analysis was centered on the correlation between the quality of sleep and efficiency of the mind. Cognitive performance scores and sleep quality such as sleep duration, sleep efficiency were analysed statistically using Pearson's correlation coefficient test. The result showed that sleep efficiency was positively related

to the scores of the cognitive tests conducted ($r = 0.65$, $p < 0.01$). This means that the efficiency of sleep means better cognitive performance, for example in attention and working memory. The analysis used was Multiple regression to reduce confounding factors that included age, gender, and baseline cognitive status. Controlling for these

covariates did reduce effect size but sleep quality continued to be a keeper variable for predicting cognitive performance. In detail, pared with the global cognitive index, sleep efficiency and REM sleep percentage were the most sensitive to the test scores, explaining 30 percent of the total variance. To perform a post hoc comparison using subsets of data, the correlations between sleep quality and mental workforce were more significant in older and high-stress kinds. These groups were more responsive to changes in sleep quality – decreased sleep efficiency was linked with deterioration of cognitive abilities and work performance.

The extension of the study which followed a sub sample for six consecutive months reiterated the longitudinal link between quality sleep and output of the mind. The participants who practiced stress reduction and got education on sleep hygiene had better scores on cognitive tests and metrics on workplace productivity with time.

Overall, the findings of this research suggest a clear confirmation to the hypothesis that asserted the quality of sleep is perhaps one of the most important predictors of mental performance. Hence, it is evident that there is a positive correlation between objective sleep condition, self assessment sleep quality with respect to cognition and work productivity. All these suggest that sleep is a powerful activity that should not be ignored in the effort to support and optimize cognition in everyday practices. The results are summarised in the tables presented in this section and show how the quality of sleep influences cognitive and work-related performance [15].

Discussion

The findings of the current study support the notion that sleep quality has a particularly large effect on multiple dimensions of mental output. The best feature of this study is the use of both self-reported questionnaires and physiological measures of sleep in addition to post-PVT performance scores and cognitive efficiency ratings, thus providing a complete picture of the relationship between sleep quality and cognitive abilities, as well as efficiency at work.

From the results, we can derive that the nature of the relationship of sleep quality and mental output is highly significant and consistent. Those who said

that they slept better using the mattresses – with longer total sleep time and higher sleep efficiency and more time spent in the restorative stages of the sleep cycle – scored better on the cognitive tests and reported being more productive in their work and studies. In particular, data of the present study revealed that better sleep quality was related to higher scores in Stroop Test and Digit Span Test, which indicated better attention, better short-term memory and faster rate of information processing. Also, these participants were quicker in completing tasks, as well as, incurring less mistakes – a factor that confirmed the relationship between sleep and cognition [16].

Through several mechanisms one is able to understand the effect of sleep on mental productivity. Sleep is very important in the consolidation of memories especially during the REM sleep when the brain helps to organize new knowledge. It is crucial in learning and contributes to the capacity of retaining facts in a learner's mind without erroneous distortion. Moreover, it is profound, which is a restorative phase of the sleep, necessary for physiological and psychological restoration so that people can perform well during the times of wakefulness. Whereas sleep in turn facilitates and recharges all these mechanisms and corresponding cognitive abilities and this encompasses such things as focus, reaction time and decision making are all affected negatively by poor sleep. In the survey, participants with poor quality of sleep were observed to take longer time to complete the allocated tasks and had more errors thus implying diminished mental efficiency due to sleeplessness [17].

The correlation between sleep quality and the performance as seen through the differences in GPA also give credence to the notion that sleep is indeed essential for learning and cognitive processes. The study concluded that the quality of sleep directly impacted on the grades and much credit goes to sleep in regard to students' performance. This result supports the knowledge that sleep is important in the process of fixing learned content key in nurturing performance [18].

These findings are in sync with the previous research done that supports the need for sleep when it comes to overall brain performance as well as efficiency. Cognitive performance, including

attention, memory, as well as other components of cognitive working capacity, has been shown to be impaired by sleep loss in a large number of experiments. For example, Walker (2009) demonstrated that those respondents who had poor night rest showed the decrease in the efficiency of memory consolidation; this is similar to the results of the present study, where the respondents with low subjective estimates had a worse memory [19]. More so, the research findings regarding sleep and work performance as presented in this study supports past studies on the impact of sleep quality on organizational performance. Sufficient evidence exist on a placebo that inadequate sleep results in decreased productivity, increased absenteeism, and increase in rates of errors and poor performance hence supporting the study findings in terms of the number of tasks accomplished and the rate of errors observed .

In the present research, there are differences with the prior studies in terms of certain aspects. Hence, to some extent, the current study is consistent with the earlier reports showing that sleep efficiency contributed to better cognitive performance, but there are some indications that the effect of sleep quality on cognition may depend on individual characteristics, including genetic makeup and initial cognitive status. For instance, Van Dongen et al. (2003) established that while some workers are more sensitive to sleep loss than others, the association between sleep and performance is reciprocal implying that it is not proportional.

Further, while the present study concerned itself with the sleep span, solidity, and segmentation of sleep into different stages, other investigations have looked at other determinants of high quality sleep which include quality of sleep environment, stress, and other disorders. Such factors, that were not discussed in this paper, could give more detailed information about the interconnection between sleep and efficiency of mental work [20].

The pragmatic implications of this study are quite profound especially in areas that require the mental performance such as workplaces and school environments. Better sleep can result in better thinking, wiser choices and better work output all of which are important in academic and workplaces.

At the workplace, employers can encourage employees to adopt proper 'sleep hygiene'. Such interventions may involve communicating to the employees on the effects of lack of sleep, promoting sleep in the workplace and flexibility in working hours to allow for proper sleep. Also, such organizational interventions as stress management programs, relaxation techniques used within workplaces, creation of work environment that will help in managing stress can assist in improving sleep quality and hence improve on performance and reduce instances of errors.

In this respect, educational institutions must take necessary measures to ensure for their students sleep education. Including the sleep hygiene education in the programs for the health of students at schools and universities, 'especially targeted at the necessity to dedicate enough time to the sleep. Introducing healthy sleep practices and avoiding the use of electronic gadgets before going to sleep, students would be able to have enhanced sleep quality coupled with the quality results in their performance.

Also, technology in the form of a wearable sleep tracker should be encouraged to assist the person in controlling their sleeping habits. Since they offer feedback to the quality of sleep as it happens, the available sleep tracking devices can assist people in managing their sleeping habits and seeking help as soon as possible [21].

Conclusion

Thus, the findings of the present research support the notion that there is a connection between sleep quality and each of the aspects of mental performance and prove that improved sleep corresponds to higher efficiency, fewer mistakes, and better academic and working performance. This study confirms just how crucial sleep is in coming up with appropriate solutions for sharpening one's mind and general health. Based on empirical evidence on the relationship between sleep quality and mental performance, it becomes important for the individuals and organisations to embrace sleep health enhancing practices. Other scholars should extend the existing studies into diverse samples and beyond short time intervals to learn more about the general impact of sleep on cognitive functioning

and to discover what strategies may help to enhance sleep quality in different settings.

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