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AThe Effect of Sleep Deprivation on Memory Functions in the Morning Sleep Pattern

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Abstract

The present study was conducted to investigate the effect of sleep deprivation on memory functions, as assessed by the Wechsler Memory Scale, among female university students with an evening chronotype residing in dormitories in Kermanshah, Iran. This study employed a quasi-experimental research design with a pretest–posttest protocol and included a non-equivalent control group. The statistical population consisted of all female dormitory-resident students in Kermanshah. The initial sample comprised 200 participants who were selected through convenience sampling. From this initial pool, 35 individuals who were classified as having a definite evening-type sleep pattern—according to the standardized scoring criteria of the Morningness–Eveningness Questionnaire (MEQ)—were identified as the final sample. The research instruments included the Wechsler Memory Scale and the Horne and Östberg Morningness–Eveningness Questionnaire, both of which are validated measures for assessing memory performance and chronotype, respectively. Data were analyzed using analysis of covariance (ANCOVA) to control for pretest differences between the experimental and control groups. The findings from the ANCOVA indicated that sleep deprivation had a statistically significant negative effect on memory functions among evening-type participants. the results revealed significant impairments in the following domains: total memory score, orientation to personal and everyday issues, general orientation, mental control, logical memory, forward digit span, backward digit span, visual memory, and paired-associate learning ($P < 0.001$ for all comparisons). Even a single sleep deprivation episode can cause widespread cognitive deficits in evening-preference individuals. the results of this study demonstrate that sleep deprivation causes considerable disruption across multiple memory domains in evening-type individuals. The observed impairments encompass not only global memory capacity but also more specific cognitive functions, including orientation abilities, mental manipulation of information, verbal working memory, visual-spatial recall, and associative learning processes. These findings highlight the critical role of adequate sleep in maintaining optimal cognitive performance, particularly for individuals with an evening chronotype who may be more vulnerable to the adverse effects of sleep loss. The study underscores the need for sleep hygiene interventions and tailored scheduling strategies in academic settings, especially for students living in dormitory environments where sleep patterns may be easily disrupted.

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Extended Abstract

Introduction

Sleep and memory are fundamental to human cognitive functioning and psychological health, attracting substantial scholarly attention across psychology, neuroscience, and sleep medicine. In contemporary fast-paced societies, sleep patterns have notably altered, with a growing proportion of individuals—particularly university students facing academic and social pressures—experiencing insufficient or irregular sleep. This trend threatens higher-order cognitive processes, especially memory. As one of the most intricate cognitive faculties, memory underpins learning, decision-making, problem-solving, and social interaction; consequently, any impairment produces pervasive negative effects on quality of life. Given that memory formation proceeds through encoding, consolidation, and retrieval, and that sleep plays an indispensable role in each phase, investigating sleep deprivation and memory dysfunction is of theoretical and practical importance. Although previous research has examined this association, targeted studies assessing acute total sleep deprivation's differential impact on specific chronotypes—particularly evening-type individuals—remain limited. Accordingly, this study had two principal aims: to identify preferred sleep patterns among university students and to empirically evaluate one night of total sleep deprivation's effect on various memory functions in students with a definite evening chronotype. The core research question was whether acute sleep deprivation, independent of confounders, would produce significant memory impairments and whether such effects would be especially pronounced in evening-type individuals. The findings were expected to yield evidence-based recommendations for improving sleep hygiene and enhancing cognitive health and academic outcomes in student populations.

Method

This study employed a quasi-experimental design with a pre-test–post-test control group framework. The target population comprised 200 female university students residing in dormitories, selected via convenience sampling. In the screening phase, the Morning-Evening Sleep Questionnaire—a standardised self-report instrument for assessing circadian typology—was administered to all participants. Based on scoring guidelines, 35 participants classified as having a "definite evening type" (showing clear preference for later sleep onset and awakening) constituted the final sample. All provided written informed consent and were informed of their right to withdraw without penalty. Ethical principles, including confidentiality, anonymity, and respect for autonomy, were strictly observed. The 35 participants were randomly assigned to experimental (n = 18) or control (n = 17) groups. In an introductory session, objectives and procedures were fully explained to the experimental group. A pre-test was then administered to both groups using the Wechsler Memory Scale (WMS), a well-validated instrument assessing verbal, visual, spatial, and working memory. Following the pre-test, the experimental group underwent one night of total sleep deprivation under continuous supervision, kept awake through films and moderated discussions while strictly prevented from sleeping. The control group followed their regular sleep routine. Post-test was administered to both groups using the same WMS version. Data were analysed descriptively (means, standard deviations) and inferentially using multivariate analysis of covariance (MANCOVA) via SPSS, chosen to control for pre-test differences and examine sleep deprivation's net effect on multiple dependent memory variables.

Results

MANCOVA results revealed a statistically significant and robust effect of sleep deprivation on memory performance among evening-type participants. A significant difference emerged between

post-test memory scores of the experimental and control groups. The significance level ($P < 0.001$) indicates high significance with over 99% confidence, ruling out chance or random error. Practically, sleep-deprived students exhibited marked declines across WMS subscales—immediate recall, delayed recall, working memory, and semantic memory—compared to well-rested controls. This provides compelling evidence that even one night of total sleep deprivation acts as an acute stressor substantially disrupting memory functioning. Overall, results unequivocally demonstrate that sleep deprivation leads to cognitive memory impairments, reaffirming sleep's critical and irreplaceable role in maintaining and enhancing memory capabilities.

Discussion and Conclusion

These findings align with previous research, collectively underscoring that adequate, high-quality sleep is biologically necessary for optimal brain function. Insufficient sleep, especially in evening chronotypes, produces serious cognitive consequences. Sleep deprivation affects memory multi-dimensionally: during encoding, it reduces attentional resources and impairs new information registration; during consolidation—largely dependent on slow-wave and REM sleep—it disrupts memory trace stabilisation and integration into long-term storage; and during retrieval, it hampers access to stored information, slowing processing and increasing errors. Detrimental effects extend beyond memory to diminished learning, reduced academic and occupational performance, emotional instability, weakened immunity, and elevated long-term risks for diabetes, hypertension, obesity, depression, and anxiety. Contributing factors include poor sleep hygiene, lifestyle choices, and medical conditions. Raising public awareness—particularly among students—about sufficient sleep's benefits and neglect's consequences is crucial. Furthermore, targeted interventions improving sleep hygiene and regulating circadian rhythms are cost-effective strategies for promoting general health and optimising cognitive performance. In sum, this study reinforces that sleep is an active, dynamic process vital for cognitive restoration and memory consolidation, and disregarding it imposes heavy costs on individual well-being and societal productivity.

Author Contributions: Authors 1, 2, and 3 were responsible for the conceptualization and supervision of the entire research project. Author 2 developed the study design, collected the data, and carried out the statistical analyses. All authors participated in discussing and interpreting the results. Author 4 critically revised the manuscript and gave final approval for submission.

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Ethical Approval: All procedures performed in this study were carried out in full compliance with the ethical principles and standards for research conduct.