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Original Research Article

Evaluation of the correlation between serum magnesium and calcium levels and sleep quality among medical students: a cross-sectional study

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ABSTRACT

Background: Sleep disturbances are highly prevalent among medical students due to academic stress and lifestyle factors. Magnesium and calcium play important roles in neuronal regulation and sleep physiology; however, their relationship with sleep quality remains unclear.
Methods: A cross-sectional study was conducted among 124 undergraduate medical students aged 18–26 years. Sleep quality was assessed using the Pittsburgh sleep quality index (PSQI). Serum magnesium and calcium levels were measured using an automated biochemistry analyzer. Pearson or Spearman correlation tests were applied based on data distribution. A $p<0.05$ was considered statistically significant.
Results: The mean serum magnesium level was 2.59±0.40 mg/dl, and serum calcium was 8.88±0.33 mg/dl. The mean PSQI score was 5.80±3.64. No significant correlation was found between serum magnesium and PSQI ($r=0.088$, $p=0.331$) or serum calcium and PSQI ($r=0.108$, $p=0.234$). Additionally, no correlation was observed between serum magnesium and calcium ($r=-0.011$, $p=0.906$).
Conclusion: Serum magnesium and calcium levels do not significantly correlate with sleep quality among medical students. Sleep disturbances in this population are likely influenced more by psychosocial and lifestyle factors than by circulating mineral levels.

Keywords: Magnesium, Calcium, Sleep quality, PSQI, Medical students, Micronutrients

INTRODUCTION

Sleep is a fundamental biological process essential for physical restoration, cognitive performance, emotional regulation, and immune function. It is broadly divided into two primary types: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. NREM sleep includes three stages: light sleep (stage 1), intermediate sleep (stage 2), and deep or slow-wave sleep (stage 3). This deep sleep stage is critical for physical repair and immune system regulation. REM sleep, typically occurring in cycles throughout the night, is associated with vivid dreams, learning, and memory consolidation.[1,2] Sleep disturbances among medical students have become increasingly common due to high academic pressure, competitive environments, irregular meal and sleep patterns, and constant exposure to stress.[3-5]

Poor sleep is associated with significant health consequences such as reduced concentration, memory impairment, weakened immune response, emotional instability, increased risk of anxiety and depression, and decreased academic performance.[3-5]

Furthermore, chronic sleep deprivation increases the risk of cardio-metabolic disorders, such as obesity, hypertension, and impaired glucose tolerance.[6] Understanding factors that influence sleep is therefore

essential to preserving the physical and mental well-being of students.

Magnesium and calcium—key regulators of neuronal excitability and hormonal secretion—play physiologically important roles in sleep regulation. Emerging evidence has increasingly suggested that low levels of these minerals may be associated with sleep disturbances, increased sleep latency, and poor sleep efficiency.[7-13]

Globally, sleep disorders affect nearly one-third of the young adult population, with a higher prevalence documented among medical and health-science students. In India, medical students face demanding academic schedules, high psychological stress, and significant sleep restriction, leading to widespread complaints of poor sleep quality. At the same time, dietary deficiencies of magnesium and calcium are increasingly noted in young adults due to fast-paced lifestyles and changing eating habits.[14-16] These deficiencies, when combined with academic stress, may exacerbate sleep problems. Epidemiological identifying biochemical correlates of sleep quality is crucial because such factors are modifiable and can be corrected through dietary changes or supplementation. This places magnesium and calcium as potential biomarkers for sleep quality in vulnerable student populations.

Magnesium acts as a cofactor for more than 300 enzymes and supports muscle relaxation, nerve function, energy production, bone health. Normal blood level of magnesium is 1.7–2.2 mg/dl. Magnesium enhances GABAergic neurotransmission and inhibits NMDA receptor excitability, thereby reducing neuronal firing and promoting relaxation.[17] It also aids muscle relaxation and may influence melatonin synthesis via effects on pineal neurotransmitter release (Figure 1).[18-20]

Low magnesium status has been linked to poorer sleep quality, and supplementation may improve sleep in individuals with low baseline levels or insomnia, though effects in the general population are less consistent.

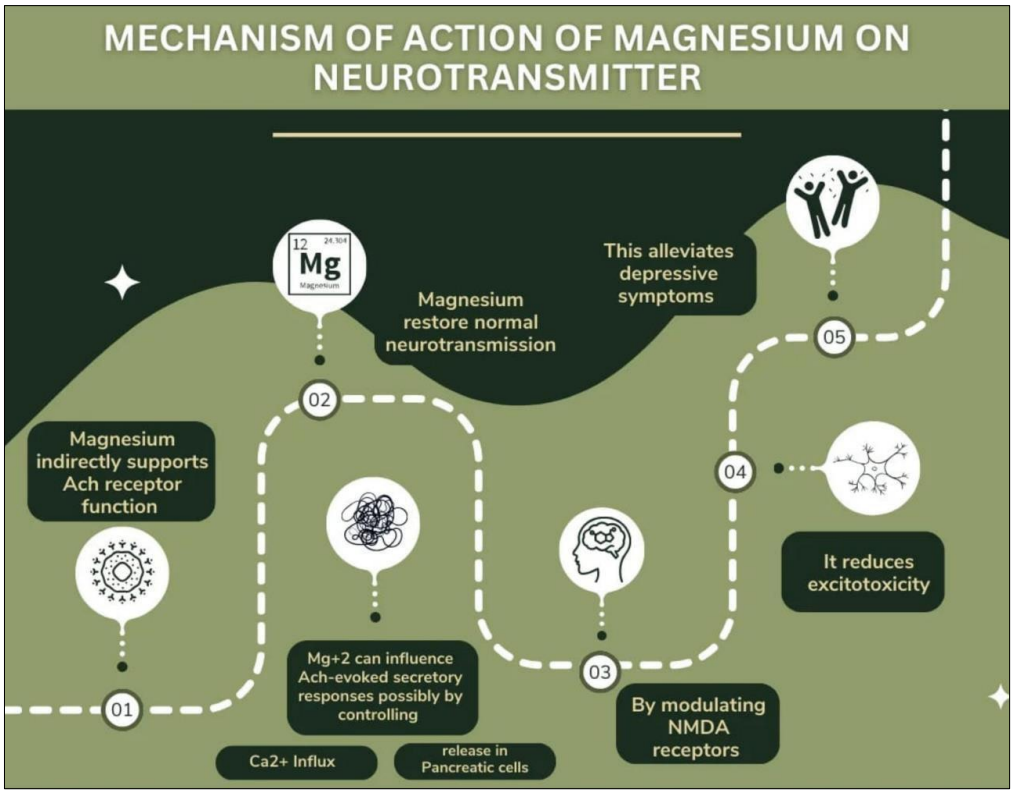

Figure 1: Mechanism of action of magnesium on neurotransmitter.

Calcium is a major minor that helps in building bones and teeth. It also aids in muscle contraction, nerve signals, blood clotting, and enzyme action. Normal values are 8.5-10.5 mg/dl. Calcium contributes to sleep regulation through its role in melatonin synthesis, mediated by calcium-dependent norepinephrine release in the pineal gland, which activates the rate-limiting enzyme arylalkyl amine N-acetyltransferase (AANAT). It also modulates neuronal excitability via T-type calcium channels and Ca^{2+}activated potassium channels, supporting NREM slow-wave activity.[21,22] Low serum calcium has been associated with longer sleep latency and poorer sleep quality, while adequate intake or supplementation may benefit deficient individuals.[23]

This topic was chosen because, despite the rising prevalence of sleep disturbances among medical students, there is limited research examining the biochemical factors

contributing to poor sleep quality in this group. Most available studies in India rely on questionnaires alone and do not correlate sleep scores with measurable biochemical parameters such as serum magnesium and calcium levels. Moreover, literature from Andhra Pradesh and surrounding regions is sparse, leaving a significant gap in understanding local trends. The available studies are insufficient to reach definitive conclusions about the relationship between mineral status and sleep in Indian medical students. Therefore, exploring this correlation is necessary to generate region-specific evidence that can support preventive and therapeutic strategies.

The study is feasible as the institutional biochemistry laboratory is well equipped with automated analyzers capable of performing accurate serum magnesium and calcium estimations. The required materials, sample handling procedures, and trained technical staff are already available. Additionally, the PSQI questionnaire is easy to administer, cost-effective, and well-validated for assessing sleep quality. The student population is easily accessible, ensuring adequate sample recruitment. The expected outcome of this study is to determine whether significant correlations exist between mineral levels and sleep quality, providing useful insights into modifiable risk factors. These findings may help design student wellness programs, nutritional interventions, and future supplementation strategies aimed at improving sleep and academic performance.

METHODS

Study design

This study was a cross-sectional, observational study conducted to assess the correlation between serum magnesium and calcium levels and sleep quality among undergraduate medical students.

Study population and study place

The study population consisted of undergraduate medical students aged 18–26 years from all academic year's students of Government Medical College, Rajamahendravaram, Andra Pradesh, India.

Study period

The present study was conducted from November 2025 to December 2025.

Sample size

A total of 124 students were included in the study.

Justification

The sample size of 120 was calculated using G*Power software with: power=80%, alpha=0.05, and expected medium effect size (r=0.3) (based on previously published data on magnesium, calcium, and sleep quality).

Sampling technique

A stratified random sampling method has been used to ensure proportional representation from each academic year.

Inclusion criteria

Undergraduate medical students aged 18–24 years, students willing to participate and provide written informed consent, students willing to participate and provide written informed consent, students willing to provide a fasting venous blood sample, and students not currently taking magnesium or calcium supplements were included.

Exclusion criteria

Students diagnosed with neurological or psychiatric disorders, students with chronic illnesses known to affect sleep (e.g., epilepsy, hypothyroidism), students on medications that influence mineral balance or sleep patterns, and students unwilling to provide blood samples or complete the PSQI questionnaire.

Data collection tools and instruments

Sleep quality assessment

Sleep quality will be assessed using the Pittsburgh sleep quality index (PSQI), a validated 19- item questionnaire comprising seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.

A global PSQI score >5 indicates poor sleep quality.

Biochemical analysis

Venous blood samples (2 ml) will be collected under aseptic conditions by trained phlebotomists. Serum magnesium and serum calcium are analyzed using a fully automated biochemistry analyzer.

Procedure

Students meeting the inclusion criteria were recruited after providing informed consent, venous blood sample was collected. Demographic details and lifestyle information (screen time, caffeine intake, study hours) will be recorded. Participants were asked to fill the proforma and the PSQI questionnaire.

Samples were processed immediately. All data was entered into Microsoft Excel for statistical analysis.

Statistical analysis

Data was analyzed using statistical package for the social sciences (SPSS) version 26.

Descriptive statistics such as mean and standard deviation are used for demographic variables, mineral levels, and PSQI scores.

The Shapiro–Wilk test has been used to assess normality of continuous data.

Depending on distribution

Pearson correlation coefficient has been used for normally distributed variables. Spearman correlation coefficient has been used for non-normal data. A $p<0.05$ is considered statistically significant.

RESULTS

The study examined 124 young medical students with complete data across all measured variables: serum calcium (serum Ca), serum magnesium (serum Mg), PSIQ, and age. There is no of missing of data across all variables (Table 1). The sample comprised relatively homogeneous young adults with a mean age of 20.3 years (95% CI: 20.0–20.5) and a standard deviation of 1.38 years. Ages ranged from 18 to 24 years, with a median of 20.0 years. The Shapiro-Wilk test $p<0.001$ indicates non-normal distribution, likely reflecting the structured nature of medical student cohorts where most participants cluster around the typical medical school enrollment age. The tight age range minimizes age-related confounding and strengthens the homogeneity of the study population (Table 1). Serum magnesium levels showed a mean of 2.59 mg/dl (95% CI: 2.52–2.66 mg/dl) with a standard deviation of 0.403 mg/dl. The range extended from 1.74 to 2.96 mg/dl, with a median of 2.78 mg/dl. The Shapiro-Wilk test returned a p value of less than 0.001, indicating significant deviation from normality (Table 1).

The participants demonstrated relatively homogeneous serum calcium levels, with a mean of 8.88 mg/dl (95% CI: 8.83–8.94 mg/dl) and a standard deviation of 0.334 mg/dl. The distribution was notably tight, ranging from 8.20 to 9.80 mg/dl, with a median of 8.90 mg/dl. The Shapiro-Wilk test yielded a p value of 0.040, indicating a borderline deviation from normal distribution at the 0.05 significance level. This slight deviation suggests the data is approximately normally distributed with minor skewness.

Table 1: Descriptives.

Descriptives	Serum Ca	Serum Mg	PSIQ	Age
N	124	124	124	124
Mean	8.88	2.59	5.80	20.3
Median	8.90	2.78	5.00	20.0
Standard deviation	0.334	0.403	3.64	1.38
Maximum	9.80	2.96	16	24
Shapiro-Wilk W	0.978	0.763	0.913	0.944
Shapiro-Wilk p	0.040	<0.001	<0.001	<0.001

The PSQI scores ranged substantially from 0 to 16, with a mean of 5.80 (95% CI: 5.15–6.45) and a standard deviation of 3.64. The median score of 5.00 was notably lower than the mean, indicating a right-skewed distribution with some participants reporting poor sleep quality.

The Shapiro-Wilk test confirmed significant non-normality ($p<0.001$). This distribution pattern is clinically meaningful, as it suggests that while many medical students report relatively good sleep quality, a subset experiences substantially impaired sleep. The broader range and higher variance in PSIQ scores compared to mineral levels reflects the multifactorial nature of sleep quality and its susceptibility to various physiological and psychological stressors.

Correlation analysis: serum magnesium and PSIQ

The Pearson correlation analysis between serum magnesium levels and the PSQI revealed a weak positive correlation of $r=0.088$ ($n=124$, $df=122$). This correlation coefficient demonstrates a negligible relationship between the two variables in the studied population (Table 2 and Figure 2).

Table 2: Correlation matrix of serum magnesium and PSIQ.

Characteristics	PSIQ	Serum Mg
PSIQ Pearson's r	-	
df		
P		
95% CI upper	-	
95% CI lower	-	
N	-	
Serum Mg Pearson's r	0.08	-
Df	122	-
P	0.33	-
95% CI upper	0.26	-
95% CI lower	0.09	-
N	124	

*p<0.05, **p<0.01, ***p<0.001

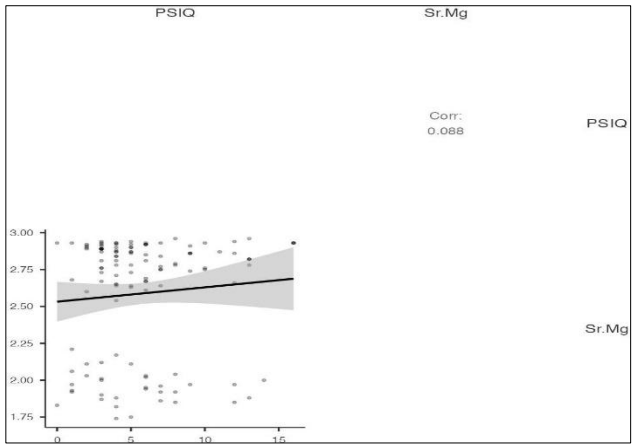

Figure 2: Scatter plot showing systematic clustering around a nearly horizontal regression line.

The scatter plot further confirmed this, showing minimal systematic clustering around a nearly horizontal regression line, reflecting minimal predictive power of serum magnesium for sleep quality scores (Figure 2).

Correlation analysis: serum calcium and PSIQ

The Pearson correlation analysis between serum calcium levels and the PSQI revealed a weak positive correlation of r=0.108 (n=124, df=122). This correlation coefficient, though statistically non-significant (p=0.234), provides important information about the relationship between these variables in the studied population (Table 3 and Figure 3).

Table 3: Correlation matrix of serum calcium and PSIQ.

Characteristics	PSIQ	Serum Ca
PSIQ Pearson's r	-	
df	-	
P	-	
95% CI upper	-	
95% CI lower	-	
N	-	
Serum Ca Pearson's r	0.18	-
df	122	-
P	0.234	-
95% CI upper	0.279	-
95% CI lower	-0.070	-
N	124	-

*p<0.05, **p<0.01, ***p<0.001

The magnitude of 0.108 represents a negligible relationship, falling below Cohen's small effect size benchmark of 0.10. This was visually supported by a scatter plot showing minimal systematic alignment of data points with the regression line, which was nearly flat, indicating minimal predictive value of serum calcium for sleep quality (Figure 3).

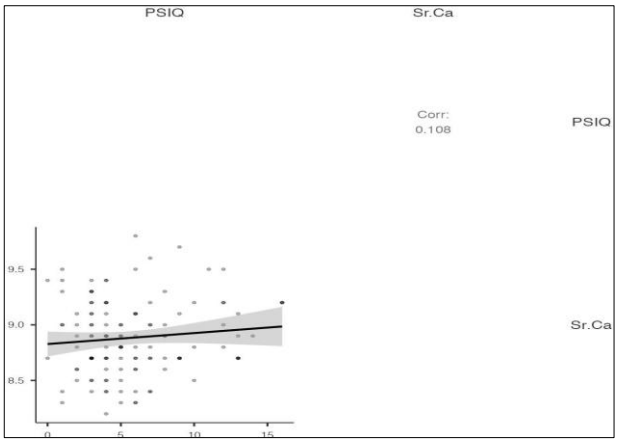

Figure 3: Scatter plot showing systematic alignment of data points with the regression line.

Table 4: Correlation matrix of serum calcium and serum magnesium.

Characteristics	Serum Mg	Serum Ca
Serum Mg Pearson's r	-	
df	-	
P		
95% CI upper	-	
95% CI lower	-	
N		
Serum Ca Pearson's r	-0.011	-
df	122	-
P	0.906	-
95% CI upper	0.166	-
95% CI lower	-0.187	-
N	124	-

*p<0.05, **p<0.01, ***p<0.001

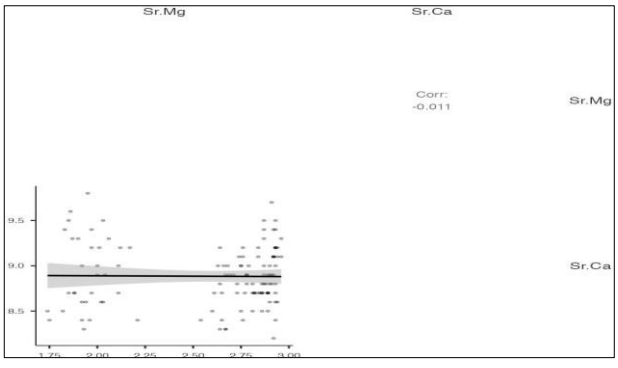

Figure 4: Scatter plot showing horizontal regression line with data points dispersed uniformly.

Correlation analysis: serum magnesium and serum Calcium

The Pearson correlation analysis between serum magnesium and serum calcium levels revealed a negligible negative correlation of r=−0.011 (n=124, df=122). This

correlation represents essentially no linear relationship between the two minerals in the studied population (Table 4 and Figure 4).

The correlation coefficient of -0.011 is effectively zero, demonstrating complete independence between these two variables. The scatter plot visually reinforced this finding, with data points dispersed uniformly and a nearly horizontal regression line, reflecting the absence of any systematic covariation.

DISCUSSION

This study found no significant correlation between serum magnesium, serum calcium, and sleep quality among medical students. Both serum magnesium and calcium demonstrated negligible correlation with PSQI scores, and no significant relationship was observed between serum magnesium and calcium levels. Despite relatively stable mineral concentrations, considerable variability in sleep quality was noted among participants.

Although magnesium and calcium are known to play important physiological roles in sleep regulation, their circulating serum concentrations may not accurately represent intracellular stores or functional activity at the neuronal level. Magnesium participates in regulation of N-methyl-D-aspartate (NMDA) receptors and gamma-aminobutyric acid (GABA) neurotransmission, both of which influence sleep initiation and maintenance. Calcium is involved in melatonin synthesis and regulation of neuronal excitability. However, serum concentrations of these minerals are tightly maintained through renal and hormonal homeostatic mechanisms, limiting their sensitivity as markers of subtle physiological disturbances in healthy individuals.

Sleep quality in medical students is multifactorial and likely influenced more strongly by academic stress, anxiety, irregular sleep schedules, prolonged screen exposure, caffeine consumption, and lifestyle habits than by minor variations in micronutrient status. Medical students represent a high-risk population for sleep disturbances due to demanding academic environments and altered circadian routines.

Several studies support the high prevalence of poor sleep quality among university students. Lund et al in 2010 reported that university students commonly experience insufficient sleep, daytime sleepiness, and irregular sleep patterns.[3] Giri et al in 2013 observed a high prevalence of poor sleep quality and excessive daytime sleepiness among Indian medical students, attributing these findings to academic burden and stress.[4] Similarly, Brick et al in 2020 demonstrated that psychological stress and academic demands significantly contributed to impaired sleep quality among medical students.[5]

Additionally, Grandner et al emphasized that behavioral and psychosocial factors, including stress, electronic media use, and irregular schedules, are major determinants of sleep disturbances in young adults.[6] This supports the findings of the present study, where lifestyle-related influences may have overshadowed any measurable effect of serum magnesium and calcium levels.

Abbasi et al demonstrated improvement in insomnia symptoms following magnesium supplementation in older adults, indicating that magnesium's influence on sleep may be more evident in deficient or clinically affected populations rather than healthy individuals with normal serum levels.[7]

Studies evaluating the association between micronutrients and sleep have produced inconsistent findings. Karacan et al in 2022 reported significantly lower serum magnesium and calcium levels among poor sleepers compared to good sleepers, suggesting a possible role of these minerals in sleep regulation.[23] However, other investigations in healthy young adults have shown weak or non-significant associations.

The absence of significant correlations in the present study may also be explained by the relatively healthy status of participants and the narrow physiological range of serum magnesium and calcium concentrations. Serum magnesium represents less than 1% of total body magnesium, and intracellular magnesium levels may better reflect biological activity. Similarly, serum calcium is tightly regulated by parathyroid hormone, vitamin D, and renal mechanisms, thereby limiting detectable variability.

Overall, the present findings suggest that serum magnesium and calcium levels alone may not serve as reliable biomarkers of sleep quality among healthy medical students. Future studies with larger sample sizes, assessment of intracellular magnesium, dietary intake analysis, stress evaluation, and longitudinal follow-up may provide better insight into the complex relationship between micronutrients and sleep quality.

Clinical implications

Routine mineral supplementation may not improve sleep quality in healthy students. Hence, focus should be on lifestyle interventions like sleep hygiene, stress management and reduced screen time. PSQI remains a useful screening tool.

Limitations

Limitations of the study include cross-sectional design, single-center study, no assessment of diet or lifestyle factors, and serum levels may not reflect intracellular status.

CONCLUSION

Serum magnesium and calcium levels do not significantly correlate with sleep quality among medical students. Sleep

disturbances in this population are more likely driven by behavioral and psychosocial factors rather than biochemical variations. For the young medical student population examined in this study, factors such as academic stress, irregular schedules, caffeine consumption, screen time, and psychological burden appear to substantially outweigh the influence of serum magnesium levels in determining sleep quality. Medical education is notoriously associated with sleep disruption and poor sleep quality; these factors are primarily driven by workload and psychological stressors rather than by nutritional or biochemical parameters operating within normal ranges. Future research should focus on lifestyle determinants and include larger, diverse populations with longitudinal designs.

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Conflict of interest: None declared
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