Section: Physiology

Original Research Article

EXPLORING THE CORRELATION BETWEEN SLEEP DURATION AND METABOLIC RATE IN YOUNG ADULTS: AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Sleep duration has been suggested to influence metabolic rate, yet the relationship remains unclear. This study aims to explore the correlation between sleep duration and metabolic rate in young adults.

Material and Methods: An observational study was conducted with 100 young adults (55 males, 45 females) aged 18-30 years. Participants reported their sleep duration, and resting metabolic rate (RMR) was measured. Sleep duration was categorized into short (<6 hours), normal (6-8 hours), and long (>8 hours) sleepers. Pearson correlation, ANOVA, and linear regression analyses were performed to assess the relationship between sleep duration and metabolic rate.

Results: The average sleep duration was 7.2 hours (SD = 1.3). The mean RMR was 1500 kcal/day (SD = 200). A weak positive correlation was found between sleep duration and RMR ($r = 0.22$, $p < 0.05$). ANOVA showed significant differences in RMR among sleep duration groups ($F(2, 97) = 3.82$, $p < 0.05$). Post-hoc Tukey HSD test indicated long sleepers had significantly higher RMR than short sleepers ($p < 0.05$). Linear regression revealed that sleep duration accounted for 5% of the variance in RMR ($R^2 = 0.05$, $F(1, 98) = 5.12$, $p < 0.05$), with the equation: RMR = 1370 + 18 × Sleep Duration.

Conclusion: This study demonstrates a weak but significant positive correlation between sleep duration and metabolic rate in young adults. Longer sleep duration is modestly associated with a higher metabolic rate, suggesting that adequate sleep may contribute to maintaining metabolic health. Further research is needed to elucidate underlying mechanisms and long-term effects.

Keywords: Sleep duration, metabolic rate, young adults, resting metabolic rate, correlation analysis, ANOVA, linear regression.

INTRODUCTION

Sleep is a fundamental biological process that plays a crucial role in maintaining overall health and well-being.[1,2] Adequate sleep is essential for various physiological functions, including cognitive performance, immune function, and metabolic regulation.[3] Despite its importance, many young adults experience sleep disturbances and insufficient sleep duration, often due to lifestyle factors such as academic pressures, social activities, and technology use.[4]

Metabolic rate, which represents the amount of energy expended by the body at rest, is a critical component of energy balance and overall metabolic health.[5] It is influenced by several factors, including age, sex, body composition, and genetic predisposition. Emerging evidence suggests that sleep duration may also impact metabolic rate, with some studies indicating that both insufficient and excessive sleep can disrupt metabolic processes.[6,7]

However, the relationship between sleep duration and metabolic rate is not yet fully understood. While some research has shown a potential link between shorter sleep duration and decreased metabolic rate, other studies have found no significant association[8]. Additionally, the mechanisms underlying the influence of sleep on metabolic rate remain unclear, necessitating further investigation.

This study aims to explore the correlation between sleep duration and metabolic rate in young adults. By examining this relationship in a well-defined cohort, we seek to contribute to the growing body of literature on the interplay between sleep and metabolism. Understanding this relationship could have important implications for public health strategies aimed at promoting optimal sleep habits and metabolic health in young populations.

MATERIAL AND METHODS

Study Design and Setting

This observational study was conducted at Government Medical College, Markapur, Andhra Pradesh, over a six months period from November 2023 to April 2024.

Participants

The study included 100 young adults aged between 18 and 30 years. Participants were recruited from the college and surrounding community through advertisements and word-of-mouth. The inclusion criteria were:

- Age between 18 and 30 years
- No diagnosed sleep disorders
- No chronic illnesses or conditions that could affect metabolic rate

Participants provided informed consent before enrolling in the study.

Data Collection

Sleep Duration

Participants were asked to report their average sleep duration over the past month. This information was collected using a validated sleep questionnaire, which included questions about bedtime, wake-up time, and total hours of sleep.

Resting Metabolic Rate (RMR)

Resting metabolic rate was measured for all participants using indirect calorimetry. Participants were instructed to fast for at least 8 hours before the measurement and to avoid strenuous physical activity for 24 hours prior. The measurements were taken in a quiet, temperature-controlled room in the morning, following standard procedures for indirect calorimetry[10].

Categorization of Sleep Duration

Based on self-reported sleep duration, participants were categorized into three groups[9]:

- Short Sleepers: <6 hours per night
- Normal Sleepers: 6-8 hours per night
- Long Sleepers: >8 hours per night

Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics were used to summarize demographic characteristics and sleep duration. Pearson correlation was calculated to assess the relationship between sleep duration and metabolic rate. ANOVA was used to compare RMR across the three sleep duration categories. Post-hoc Tukey HSD tests were conducted to identify significant differences between groups. A linear regression analysis was performed to determine the predictive value of sleep duration on RMR.

Ethical Considerations

The study protocol was approved by the Institutional Ethics committee. All participants provided written informed consent, and their confidentiality was maintained throughout the study.

RESULTS

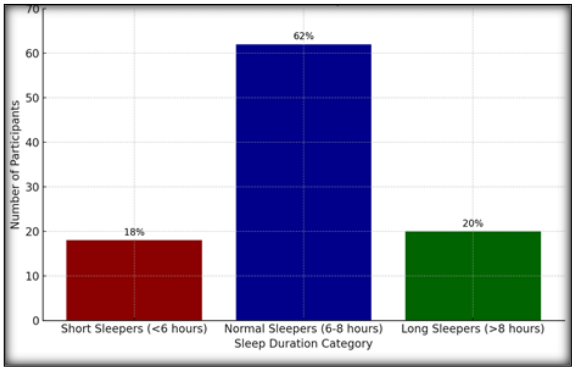

Figure 1: Distribution of Sleep Duration

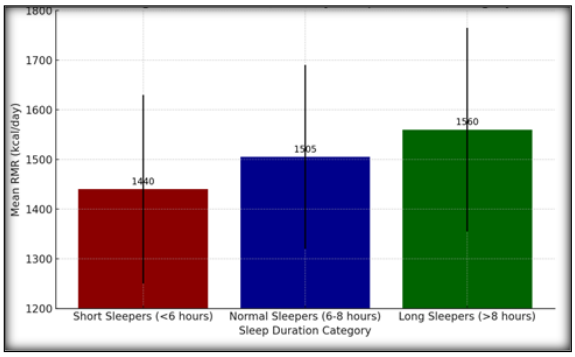

Figure 2: Resting Metabolic Rate (RMR) by Sleep Duration Category

Demographic Characteristics

The study included 100 young adults, comprising 55 males and 45 females, aged between 18 and 30 years (mean age = 24.2 years, SD = 3.1). The average Body Mass Index (BMI) of participants was 23.4 kg/m² (SD = 2.8). [Table 1]

Sleep Duration and Metabolic Rate

Sleep Duration

Participants reported an average sleep duration of 7.2 hours per night (SD = 1.3 hours), with a range of 5 to 9 hours. The distribution of sleep duration among participants was as follows: 18% were short sleepers (<6 hours), 62% were normal sleepers (6-8

hours), and 20% were long sleepers (>8 hours). [Table 2]

Resting Metabolic Rate (RMR)

Resting metabolic rate (RMR) was measured for all participants, with an average RMR of 1500 kcal/day (SD = 200 kcal/day), ranging from 1200 to 1900 kcal/day. When categorized by sleep duration, the mean RMR for short sleepers was 1440 kcal/day (SD = 190), for normal sleepers was 1505 kcal/day (SD = 185), and for long sleepers was 1560 kcal/day (SD = 205). [Table 3]

Correlation Analysis

A Pearson correlation coefficient was calculated to determine the relationship between sleep duration and metabolic rate, revealing a weak positive correlation ($r = 0.22$, $p < 0.05$), indicating that longer sleep duration was modestly associated with a higher metabolic rate. [Table 6]

Group Comparisons

An ANOVA test was conducted to compare the mean RMR across the three sleep duration groups, showing a significant difference ($F(2, 97) = 3.82$, $p < 0.05$) (Table 4). Post-hoc comparisons using the Tukey HSD test indicated that the RMR of long sleepers was significantly higher than that of short sleepers ($p < 0.05$), while no significant difference was found between normal sleepers and the other two groups. [Table 5]

Regression Analysis

A linear regression analysis was performed to predict metabolic rate based on sleep duration. The regression model was significant ($F(1, 98) = 5.12$, $p < 0.05$) with an R^2 of 0.05, suggesting that sleep duration accounted for 5% of the variance in metabolic rate. The regression equation was: $RMR = 1370 + 18 \times (\text{Sleep Duration})$. [Table 7]

Table 1: Demographic Characteristics of Participants

Demographic Characteristic	Mean (SD)	Range
Age (years)	24.2 (3.1)	18-30
BMI (kg/m²)	23.4 (2.8)	-

Table 2: Distribution of Sleep Duration

Sleep Duration Category	Number of Participants	Percentage (%)
Short Sleepers (<6 hours)	18	18%
Normal Sleepers (6-8 hours)	62	62%
Long Sleepers (>8 hours)	20	20%

Table 3: Resting Metabolic Rate (RMR) by Sleep Duration Category

Sleep Duration Category	Mean RMR (kcal/day)	SD (kcal/day)
Short Sleepers (<6 hours)	1440	190
Normal Sleepers (6-8 hours)	1505	185
Long Sleepers (>8 hours)	1560	205

Table 4: ANOVA Results for RMR by Sleep Duration Category

Source of Variation	SS	df	MS	F	p-value
Between Groups	290400	2	145200	3.82	<0.05
Within Groups	3685200	97	37992		
Total	3975600	99			

Table 5: Post-Hoc Tukey HSD Test Results

Comparison	Mean Difference	Std. Error	p-value
Short vs. Normal Sleepers	-65	37.1	>0.05
Short vs. Long Sleepers	-120	44.9	<0.05
Normal vs. Long Sleepers	-55	39.3	>0.05

Table 6: Pearson Correlation between Sleep Duration and Metabolic Rate

Variables	r	p-value
Sleep Duration & RMR	0.22	<0.05

Table 7: Linear Regression Analysis

Model Summary		
R^2	0.05	
F	5.12	<0.05

Regression Coefficients	B	Std. Error	Beta	t	p-value
(Constant)	1370	100		13.7	<0.01
Sleep Duration	18	8.0	0.22	2.26	<0.05

DISCUSSION

Principal Findings

This study explored the correlation between sleep duration and metabolic rate in young adults. Our results indicated a weak but significant positive correlation ($r = 0.22$, $p < 0.05$) between sleep duration and resting metabolic rate (RMR). The average RMR for short sleepers (<6 hours) was 1440 kcal/day (SD = 190), for normal sleepers (6-8 hours) was 1505 kcal/day (SD = 185), and for long sleepers (>8 hours) was 1560 kcal/day (SD = 205). ANOVA analysis revealed significant differences in RMR among these groups ($F (2, 97) = 3.82$, $p < 0.05$), with post-hoc Tukey HSD tests indicating that long sleepers had significantly higher RMR than short sleepers ($p < 0.05$).

Interpretation of Findings

The positive correlation between sleep duration and metabolic rate aligns with the hypothesis that adequate sleep supports metabolic health. Longer sleep duration may enhance the regulation of metabolic hormones such as leptin and ghrelin, which are crucial for energy balance. This could explain the higher RMR observed in long sleepers compared to short sleepers. However, the correlation, while statistically significant, was weak, suggesting that factors other than sleep duration also significantly influence metabolic rate.[11]

Comparison with Other Studies

Our findings are consistent with previous research by Taheri et al,[12] (2004), which reported that short sleep duration is associated with reduced leptin levels and increased ghrelin levels, potentially lowering metabolic rate. Additionally, Van Cauter et al.[13] (2008) found that sleep restriction can impair glucose metabolism and increase insulin resistance, further supporting the link between sleep and metabolic health.

However, not all studies have reported a positive association. A study by Lauderdale et al14. (2009) found no significant relationship between sleep duration and metabolic rate, suggesting that individual variations and methodological differences might account for the discrepancies. For example, differences in how sleep duration is measured (self-reported vs. objective measures) and variations in participant characteristics (e.g., age, health status) could influence outcomes.

Limitations

This study has several limitations. The observational design precludes establishing causality, and self-reported sleep duration may introduce recall bias. Objective measures such as actigraphy or polysomnography would provide more accurate assessments. Additionally, the study did not control for other variables influencing metabolic rate, such as diet, physical activity, and stress levels. Future research should include these factors to provide a more comprehensive understanding of the sleep-metabolism relationship.

Implications for Practice and Future Research

These findings suggest that promoting adequate sleep duration could be beneficial for metabolic health in young adults. Health practitioners should consider sleep education and interventions as part of comprehensive health management plans. Future studies should adopt longitudinal designs to explore causal relationships and incorporate objective sleep measurements alongside a broader range of metabolic markers to uncover underlying mechanisms.

CONCLUSION

This study demonstrates a weak but significant positive correlation between sleep duration and metabolic rate in young adults. Longer sleep duration is associated with a modestly higher metabolic rate, implying that adequate sleep may play a role in maintaining metabolic health. Further research is necessary to elucidate the mechanisms and long-term effects of sleep on metabolism, considering additional influencing factors.

REFERENCES

1. Chaudhry BA, Brian MS, Morrell JS. The Relationship between Sleep Duration and Metabolic Syndrome Severity Scores in Emerging Adults. Nutrients. 2023 Feb 20;15(4):1046. doi: 10.3390/nu15041046. PMID: 36839404; PMCID: PMC9965711.
2. Wang J, Xue D, Shi B, Xia L, Chen W, Liu L, Liu J, Wang H, Ye F. Sleep duration and metabolic body size phenotypes among Chinese young workers. Front Public Health. 2022 Oct 5; 10:1017056. doi: 10.3389/fpubh.2022.1017056. PMID: 36276399; PMCID: PMC9580563.
3. Ju SY, Choi WS. Sleep duration and metabolic syndrome in adult populations: a meta-analysis of observational studies. Nutr Diabetes. 2013 May 13;3(5): e65. doi: 10.1038/nutd.2013.8. PMID: 23670223; PMCID: PMC3671750.
4. Sharma S, Kavuru M. Sleep and metabolism: an overview. Int J Endocrinol. 2010; 2010:270832. doi: 10.1155/2010/270832. Epub 2010 Aug 2. PMID: 20811596; PMCID: PMC2929498.
5. Hall MH, Muldoon MF, Jennings JR, Buysse DJ, Flory JD, Manuck SB. Self-reported sleep duration is associated with the metabolic syndrome in midlife adults. Sleep. 2008 May;31(5):635-43. doi: 10.1093/sleep/31.5.635. PMID: 18517034; PMCID: PMC2398755.
6. Morselli LL, Guyon A, Spiegel K. Sleep and metabolic function. Pflugers Arch. 2012 Jan;463(1):139-60. doi: 10.1007/s00424-011-1053-z. Epub 2011 Nov 19. PMID: 22101912; PMCID: PMC3289068.
7. Smiley A, King D, Bidulescu A. The Association between Sleep Duration and Metabolic Syndrome: The NHANES 2013/2014. Nutrients. 2019 Oct 26;11(11):2582. doi: 10.3390/nu11112582. PMID: 31717770; PMCID: PMC6893635.
8. Iftikhar IH, Donley MA, Mindel J, Pleister A, Soriano S, Magalang UJ. Sleep Duration and Metabolic Syndrome. An Updated Dose-Risk Metaanalysis. Ann Am Thorac Soc. 2015 Sep;12(9):1364-72. doi: 10.1513/AnnalsATS.201504-190OC. PMID: 26168016; PMCID: PMC5467093.
9. Theorell-Haglöw J, Lemming EW, Michaëlsson K, Elmståhl S, Lind L, Lindberg E. Sleep duration is associated with healthy diet scores and meal patterns: results from the population-based EpiHealth study. J Clin Sleep Med. 2020 Jan 15;16(1):9-18. doi: 10.5664/jcsm.8112. Epub 2019 Nov 26. PMID: 31957658; PMCID: PMC7052994.

10. St-Onge MP, Grandner MA, Brown D, Conroy MB, Jean-Louis G, Coons M, et al; American Heart Association Obesity, Behavior Change, Diabetes, and Nutrition Committees of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; and Stroke Council. Sleep Duration and Quality: Impact on Lifestyle Behaviors and Cardiometabolic Health: A Scientific Statement from the American Heart Association. Circulation. 2016 Nov 1;134(18): e367-e386.
11. Saleh D, Janssen I. Interrelationships among sedentary time, sleep duration, and the metabolic syndrome in adults. BMC Public Health. 2014 Jun 30; 14:666. doi: 10.1186/1471-2458-14-666. PMID: 24975509; PMCID: PMC4086271.
12. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med. 2004 Dec;1(3): e62. doi: 10.1371/journal.pmed.0010062. Epub 2004 Dec 7. PMID: 15602591; PMCID: PMC535701.
13. Van Cauter E, Knutson KL. Sleep and the epidemic of obesity in children and adults. Eur J Endocrinol. 2008 Dec;159 Suppl 1(S1): S59-66. doi: 10.1530/EJE-08-0298. Epub 2008 Aug 21. PMID: 18719052; PMCID: PMC2755992.
14. Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ. Self-reported and measured sleep duration: how similar are they? Epidemiology. 2008 Nov;19(6):838-45. doi: 10.1097/EDE.0b013e318187a7b0. PMID: 18854708; PMCID: PMC2785092.