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The Impact of Sleep Onset and Efficiency on Body Mass Index among College Students: A Factor Analysis Approach

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Abstract

Sleep is crucial for overall health and well-being, and college students often face sleep issues due to various factors. Inadequate sleep, which affects metabolism and behavior, increases the risk of obesity. Prior studies typically examine individual sleep factors or compare them, neglecting potential interactions and the multidimensional role of sleep in health outcomes. Hence, this study surveyed the seven sleep components using the Pittsburgh Sleep Quality Index (PSQI) to identify factors affecting sleep quality and evaluate its effect on the body mass index of GE-Science, Technology, and Society (GE-STS) students in a private university in Cebu. Three factors were determined through factor analysis: Sleep Health, Sleep Onset and Maintenance Efficiency, and Sleep Disruption Intervention. Moreover, regression analysis supported the significant relationship ($p = 0.023$) between the sleep onset and maintenance efficiency factor and Body Mass Index (BMI), emphasizing its importance in designing sleep interventions for college students.

Keywords

Pittsburgh Sleep Quality Index (PSQI), Body Mass Index (BMI), college students, factor analysis, obesity, health

INTRODUCTION

Sleep is crucial to overall health and well-being as it regulates complex physiological processes required to maintain metabolic homeostasis (Kohansieh & Makaryus, 2015; Sharma & Kavuru, 2010). Insufficient sleep may disrupt normal body functioning, manifested in various health disorders such as diabetes and obesity (Suni, 2023). The 2016 AIA Healthy Living Index survey showed that Filipinos had one of the highest rates of sleep deprivation in all of Asia (AIA Group Limited, 2016). Poor sleep is associated with unhealthy habits such as elevated stress levels, lower physical activity, and unhealthy food options (Centers for Disease Control and Prevention, 2024).

As adolescents develop, they undergo significant changes in sleep patterns influenced by psychosocial factors, lifestyle shifts, and the maturation of biological processes regulating sleep/wake systems (Carskadon et al., 2004). Recent epidemiological and laboratory studies have shed light on potential behavioral and physiological mechanisms that explain the link between sleep loss and a higher likelihood of developing weight-related issues (Beccuti & Pannain, 2011). Poor sleep can contribute to weight gain, as individuals who sleep less may consume more calorie-dense snacks and foods, leading to overeating (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2022). Sleep deprivation can also decrease physical activity (Fry, 2022). It is also known to disrupt circadian rhythms, leading to impaired glucose metabolism, insulin resistance, and an increased risk of obesity (Wong et al., 2022).

Morrissey et al. (2020) defined and categorized four sleep dimensions associated with obesity based on preexisting literature: sleep duration, sleep quality, sleep efficiency, and sleep timing. Studies that examined the association of different sleep components and health emphasize the multidimensional nature of sleep. However, these were mainly focused on assessing individual components, often sleep duration, or comparing the association among various components and a given health outcome using linear regression models. Matricciani et al. (2018) argued that this approach overlooks the possible interactions between components, or the inherently multidimensional nature of sleep, in explaining differences in health outcomes.

Hence, this study utilized the standardized Pittsburgh Sleep Quality Index (PSQI), which measures sleep quality and patterns across seven components: subjective sleep quality (an individual's self-assessment of satisfaction with their sleep), sleep latency (the time it takes to fall asleep), sleep duration (total sleep obtained in a night or 24 hours), habitual sleep efficiency (daily sleep efficiency), sleep disturbances (frequent awakenings due to various factors), use of sleeping medications, and daytime dysfunction (inability to maintain wakefulness and alertness during the day). Evaluation of the psychometric properties and factor structure of the PSQI among young adults, particularly in the local context, has been limited. Therefore, this study aims to characterize the factors affecting the sleep quality index and assess its effect on the body mass index (BMI) of GE-Science, Technology, and Society (GE-STS) students at a private university in Cebu.

METHODS

Research Design

The study utilized an analytical cross-sectional design, which gathers data at one point in time from a defined population of GE-STS students to investigate correlations between sleep components (predictors) and BMI (outcome). It was consistent with the research objectives, which were to identify factors influencing sleep quality and assess their impact on BMI using the standardized PSQI questionnaire and appropriate statistical analyses.

Sample and data collection

The study was conducted in a private university in Cebu City, Philippines. It involved randomly selected students enrolled in the GE-STS course, a part of the university's undergraduate curriculum. GE-STS requires an understanding of the impacts of technology, including how it affects sleep patterns, thus making the respondents an essential part of the research. Stratified random sampling was used to select the students within the course. The sample size was calculated using Cochran's formula (Pourhoseingholi et al., 2013),

$$n_0 = z^2 p(1-p)/d^2$$

where "Z" is the standard normal variant at 95% C.I. (1.96), "p" is the expected proportion in the population based on the prevalence of overweight and obese Filipino adolescents (11.6%) (UNICEF, 2022), and "d" is the absolute error or precision (5%). The required sample size "n_0" was 158 students. The sample size was stratified according to the relative weight of each course offering (stratum) in the total population. A sampling frame was obtained from which respondents were randomly selected using a computer program. The data were collected at a single time in April 2023. The survey was conducted face-to-face and involved (1) a thorough orientation on the Informed Consent Form (ICF); (2) the survey proper, which consisted of answering a 19-item standardized questionnaire on sleep quality and patterns of sleep; and (3) data collection for BMI. The examination period was avoided so as not to influence the results.

Research Instruments

The study employed the Pittsburgh Sleep Quality Index (PSQI), a 19-item self-report questionnaire (Buysse et al., 1989), to examine sleep quality and patterns across seven sleep components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Each component corresponds to one or more items in the questionnaire and is scored on a 0-3 Likert scale, with 0 representing no difficulty and 3 reflecting severe difficulty. Mollayeva et al. (2016) revealed PSQI to have internal consistency, test-retest reliability, and scope validity in healthy and patient populations. On the other hand, respondents' height and weight were measured using a stadiometer and weighing scale to obtain their BMI.

Data Analysis

The data in this study were analyzed using Minitab and multiple statistical techniques, including factor analysis, principal component analysis (PCA), and regression analysis. Factor analysis was performed to identify factors influencing the sleep quality index from the seven sleep components. PCA was conducted to quantify the influence of sleep components on these factors. Regression analysis was carried out to determine if there is a significant relationship between these factors and the BMI of GE-STS students. These statistical methods were adapted to develop targeted interventions to improve sleep and promote overall health.

Ethical Consideration

To ensure that participants were fully informed of the necessary information about the study, the researchers explained the study's objectives, methods, and potential benefits before participants answered the questionnaire. The researchers also informed the participants of their right to decline or withdraw from the study at any time and assured them of the confidentiality of their data. No student was enrolled in the study unless they willingly consented and received the necessary information. Furthermore, before beginning the study, the researchers obtained ethical clearance (Protocol No. SAS-BIO- 2023 – 001) from the appropriate ethics committee. The ethics committee reviewed the study's design, methodology, and procedures to ensure they met ethical standards. The researchers also kept detailed records of their ethical practices throughout the study, which would be made available for review by the ethics committee or any other relevant authorities.

RESULTS AND DISCUSSION

Factor Analysis of the Sleep Components of the Pittsburgh Sleep Quality Index (PSQI)

Factor analysis was applied to the scores of the seven sleep components from the PSQI survey conducted among GE-STS students to identify factors that affect sleep quality. The varimax rotated loadings for each variable are presented in Table 1, showing a cumulative variance of 65.2%. The analysis identified three factors accounting for the variance in the seven sleep components: Sleep Health (Factor 1), Sleep Onset and Maintenance Efficiency (Factor 2), and Sleep Disruption Intervention (Factor 3).

Factor 1, termed Sleep Health, includes subjective sleep quality (C1), sleep duration (C3), and daytime dysfunction (C7). These variables exhibited positive loadings on Factor 1, signifying that higher scores on C1, C3, and C7 are associated with higher scores on overall sleep health. Factor 2, named Sleep Onset and Maintenance Efficiency, encompasses sleep latency (C2) and habitual sleep efficiency (C4). These variables have strong negative loadings, indicating that a longer time to fall asleep and lower efficiency in maintaining sleep are negatively associated with this factor. Factor 3, labeled Sleep Disruption Intervention, consists of sleep disturbances (C5) and the use of sleeping medication (C6). Positive loadings on this factor suggest that the higher levels of sleep disturbances and more frequent use of sleeping medication are strongly related to sleep disruption.

Table 1. *Varimax Rotated Factor Matrix of the Sleep Components Displaying a Three-Factor Model*

Variables	**Factor 1** *Sleep Health*	**Factor 2** *Sleep Onset and Maintenance Efficiency*	**Factor 3** *Sleep Disruption Intervention*
C1 - Subjective Sleep Quality	0.782	-0.239	0.142
C2 - Sleep Latency	0.153	-0.784	0.227
C3 - Sleep Duration	0.825	-0.158	-0.122
C4 - Habitual Sleep Efficiency	0.066	-0.861	-0.069
C5 - Sleep Disturbances	0.157	-0.061	0.676
C6 - Use of Sleeping Medication	-0.004	-0.053	0.785
C7 - Daytime Dysfunction	0.740	0.088	0.253
Variance	1.8919	1.4520	1.2279
% Var	0.270	0.207	0.175

Principal Component Analysis of the Three Factors (Sleep Health, Sleep Onset and Maintenance Efficiency, and Sleep Disruption Intervention)

Principal component analysis (PCA) was performed on the variables corresponding to the three identified factors to determine the impact of each variable. Table 2 displays each variable's weights (eigenvectors) on the principal components (PC1, PC2, PC3) and the eigenvalues, representing the variance explained by each principal component.

In Factor 1, subjective sleep quality (C1), sleep duration (C3), and daytime dysfunction (C7) have different weights on PC1, indicating varying contributions to overall sleep health. For Factors 2 and 3, the variables (C2, C4 for Factor 2 and C5, C6 for Factor 3) have similar weights on PC1, suggesting equal importance to their respective principal components. Each factor's first principal component (PC1) explains the highest variance, with 63.5% for Factor 1, 70.8% for Factor 2, and 57.9% for Factor 3.

Regression Analysis of the Three Factors and BMI

Before conducting the regression analysis to investigate the relationship between three sleep-related factors and BMI, a Box-Cox transformation was applied to satisfy the normality requirement of the values of the dependent variable, BMI. The results in this section include the regression model that predicts the value of BMI (dependent variable) based on the values of the factors (independent variables); the coefficients table (Table 3), which is used to determine the strength and direction of the relationship between the factors and BMI, as well as the statistical significance of the relationship; the model summary table (Table 4) which provides information about how well the regression model fits the data; the analysis of variance (ANOVA) table (Table 5) which summarizes the statistical significance of the regression model and its coefficients.

A regression analysis was conducted to explore the relationship between the three sleep factors and BMI. The regression model used to predict BMI based on the following factors is:

BMI = 0.04999 - 0.000453 Sleep Health - 0.001052 Sleep Onset and Maintenance Efficiency - 0.001432 Sleep Disruption Intervention

The regression equation predicts BMI based on the constant term, the regression coefficients associated with each factor, and the values of the factors. The constant term represents the expected BMI when all factors are zero. The regression coefficients indicate the change in BMI for a one-unit increase in each factor.

Table 3 shows the estimated regression coefficients, with the P value of Factor 2 (<0.05) indicating a statistically significant relationship between Sleep Onset and Maintenance Efficiency and BMI. A negative coefficient suggests that later sleep onset and lower maintenance efficiency are associated with an increase in BMI.

Table 2. *Varying and Equal Weights of the Variables on the Principal Components of the Three Factors*

	PC1	PC2	PC3
Factor 1			
C1 - Subjective Sleep Quality	0.605	-0.288	-0.742
C3 - Sleep Duration	0.591	-0.463	0.661
C7 - Daytime Dysfunction	0.534	0.838	0.109
Eigenvalue	1.9051*	0.6421	0.4528
Proportion	0.635	0.214	0.151
Cumulative	0.635	0.849	1.000
Factor 2			
C2 - Sleep Latency	0.707	0.707	
C4 - Habitual Sleep Efficiency	0.707	-0.707	
Eigenvalue	1.4161*	0.580	
Proportion	0.708	0.292	
Cumulative	0.708	1.000	
Factor 3			
C5 - Sleep Disturbance	0.707	-0.707	
C6 - Use of Sleep Medication	0.707	0.707	
Eigenvalue	1.1573*	0.8427	
Proportion	0.579	0.421	
Cumulative	0.579	1.000	

Legend: Eigenvalues > 1 - significant (*)

Table 3. *Regression Coefficients Revealing the Significant Correlation of Factor 2 to BMI*

Term	Coef	SE Coef	T value	P value	VIF
Constant	0.04999	0.00177	28.25	0.000	
Factor 1	-0.000453	0.000534	-0.85	0.397ns	1.10
Factor 2	-0.001052	0.000459	-2.29	0.023*	1.09
Factor 3	-0.001432	0.000898	-1.60	0.113ns	1.05

Legend:
Coef - estimated coefficient; SE Coef - standard error; VIF - variance inflation factor
P value < 0.05 - significant (*); P value > 0.05 - not significant (ns)

The coefficient of determination (R-sq) value, which indicates the proportion of the variance in BMI that can be explained by Factors 1, 2, and 3, is given in Table 4. The results reveal that the three factors explain 7.22% of the variance in BMI.

Table 5 presents the ANOVA results, indicating that the overall regression model is statistically significant ($F(3,154) = 4$, $p = 0.009$), with at least one sleep-related factor significantly affecting BMI.

Table 4. *R-sq Value of the Regression Model Representing a Moderate Fit*

S	R-sq	R-sq(adj)	R-sq(pred)
0.0072422	7.22%	5.41%	2.18%

Legend:
S - standard error of the estimate;R-sq - coefficient of determination; R-sq(adj) - adjusted coefficient of determination; R-sq(pred) - predicted coefficient of determination

Table 5. *Analysis of Variance (ANOVA) Supporting the Statistical Significance of the Regression Model*

Source	DF	Adj SS	Adj MS	F value	P value
Regression	3	0.000629	0.000210	4.00	0.009*
Factor 1	1	0.000038	0.000038	0.72	0.397
Factor 2	1	0.000275	0.000275	5.25	0.023
Factor 3	1	0.000133	0.000133	2.55	0.113
Error	154	0.008077	0.000052		
Lack-of-Fit	115	0.006402	0.000056	1.30	0.178
Pure Error	39	0.001675	0.000043		
Total	157	0.008706			

Legend:
DF - degrees of freedom; Adj SS - adjusted sum of squares; Adj MS - adjusted mean square
P value < 0.05 - significant (*)

The primary objective of the present research was to identify the factors affecting the sleep quality index and to assess their effect on BMI among college students. Limited research has been conducted in the Philippines on this topic, and to the researchers' knowledge, this study is the first to explore this phenomenon in Cebu, Philippines.

This study identified three distinct factors from the seven PSQI sleep components (see Table 1), highlighting the multidimensionality of the PSQI scale in a young adult population. This finding aligns with Gelaye et al. (2014), who established a three-factor model among college students in Peru, although the specific components grouped into each factor were different. In contrast, the same study also reported a two-factor structure in Chile, Ethiopia, and Thailand. Manzar et al. (2016) discovered a unidimensional structure in their study of Indian college students. These variations in factor structure across studies, particularly in college populations, may be attributed to cultural differences, significantly influencing sleep behavior (Gelaye et al. 2014; Guo et al., 2016; Liu et al., 2021).

Among the three factors identified, the Sleep Onset and Maintenance Efficiency factor was noted to have the most significant influence on the BMI of college students. This finding is consistent with previous research, which identified sleep latency and habitual sleep efficiency as crucial contributors to poor sleep quality, with sleep latency being the second most vital component associated with obesity among the PSQI components (Al-Rashed et al., 2021; Mirdha et al., 2019; Vargas et al., 2014). The result suggests that students' ability to initiate and maintain sleep effectively is more crucial for weight regulation than overall sleep health or medical interventions (Kahlhöfer et al., 2016; Mirdha et al., 2019).

Meeting the need for adequate sleep involves volitional behaviors influenced by genetic and physiological factors, with psychological, behavioral, social, cultural, and environmental factors also playing significant roles (Watson et al., 2015). As previously highlighted, physiological changes during adolescence significantly affect sleep patterns, disrupting neuroendocrine function and glucose metabolism (Beccuti & Pannain, 2011; Carskadon et al., 2004). The association between sleep patterns and BMI demonstrates that insufficient sleep leads to irregular appetite by increasing levels of ghrelin (an appetite-stimulating hormone), reducing levels of leptin (an appetite-suppressing hormone), and decreasing orexin activity (a hypothalamic neuropeptide regulating appetite), thereby promoting increased food intake (Gozal & Kheirandish-Gozal, 2012; Markwald et al., 2013). However, recent research suggests that hormonal changes are not the primary mechanism linking insufficient sleep to increased food intake (Chaput & St-Onge, 2014). Instead, insufficient sleep primarily affects body weight through increased food consumption driven by greater eating opportunities and the heightened appeal of high-calorie foods (Chaput, 2014). Additionally, while sleep restriction can slightly increase energy expenditure due to prolonged wakefulness, it often leads to reduced physical activity and increased sedentary behavior due to fatigue (Klingenberg et al., 2012).

A study by Olds et al. (2011) found that adolescents with later bedtimes, regardless of total sleep duration, exhibited reduced physical activity and an increased likelihood of being overweight. Similarly, Baron et al. (2011) reported a correlation between later bedtimes and obesity, suggesting that delayed bedtimes might lead to increased calorie consumption during dinner and after 8:00 p.m., potentially increasing BMI. This connection highlights a complex interaction between sleep patterns and metabolic processes, which may contribute to metabolic syndrome and further influence weight management (Bowman et al., 2019).

In addition, sleep efficiency is known to play a role in the relationship between physical activity level and cognitive performance. Individuals with higher sleep efficiency—meaning they spend more time sleeping—tend to exhibit better inhibitory control when engaging in physical activity (Li et al., 2021). Substantial inhibitory control is essential for managing eating behaviors and maintaining a healthy BMI, as it helps individuals resist unhealthy food temptations and regulate portion sizes, thus preventing weight gain (Mayer et al., 2022). Conversely, lower sleep efficiency has been linked to higher weight status and reduced physical activity, potentially due to increased sleep latency and extended time before waking (Kahlhöfer et al., 2016; Shrivastava et al., 2014).

Although the present study found no significant relationship between Sleep Health and Sleep Disruption Intervention factors and BMI, contrary to previous research noting their effects on weight status (Maharjan et al., 2020; Papatriantafyllou et al., 2022; Rahe et al., 2015; Vargas et al., 2014), the potential health risks of both factors should still be emphasized. Further research may be needed to identify other variables explaining the relationship between Factors 1 and 3 and BMI.

Limitations

Several limitations should be noted in this current study. The research was conducted within a single university setting, so the findings could not be applied to a larger population. In addition, the study does not allow for making causal statements, as variables were measured at one point. The study did not assess other characteristics that could act as confounders in the relationship between sleep quality index and BMI. These include sociodemographic factors (age, gender, race, marital status, and regular or irregular student status), lifestyle habits (smoking, use of substances), academic pressure, and other sleep-related characteristics.

CONCLUSION

The results of this study provide insight into the complex relationship between sleep and BMI. Identifying Sleep Onset and Maintenance Efficiency as the factors that have the most tremendous significance for BMI highlights their critical role in the overall health of college students. This finding is a valuable foundation for implementing measures that can enhance students' health. The institution can utilize this research to establish programs designed to support these particular aspects of sleep for its students. Therapies that target the efficiency and onset of sleep could have a direct favorable effect on BMI and general health. Furthermore, public health policies must prioritize college students' sleep enhancement measures. It would be beneficial to implement regulations that encourage improved sleep hygiene and provide tools to support restful sleeping practices in college settings to help create a healthier campus community.

REFERENCES

AIA Group Limited. (2016). *Media release Filipinos score low on the 2016 healthy living index due to unhealthy habits.* https://www.aia.com.ph/content/dam/ph/en/docs/press-releases/2016/aia-philam-life-filipinos-low-on-the-2016-healthy-living-index.pdf

Al-Rashed, F., Sindhu, S., Al Madhoun, A., Alghaith, A., Azim, R., Al-Mulla, F., & Ahmad, R. (2021). Short Sleep Duration and Its Association with Obesity and Other Metabolic Risk Factors in Kuwaiti Urban Adults. *Nature and Science of Sleep, 13,* 1225–1241. https://doi.org/10.2147/nss.s311415

Baron, K. G., Reid, K. J., Kern, A. S., & Zee, P. C. (2011). Role of sleep timing in caloric intake and BMI. *Obesity, 19*(7), 1374–1381. https://doi.org/10.1038/oby.2011.100

Beccuti, G., & Pannain, S. (2011). Sleep and obesity. *Current Opinion in Clinical Nutrition and Metabolic Care, 14*(4), 402–412. https://doi.org/10.1097/MCO.0b013e3283479109

Bowman, M. A., Duggan, K. A., Brindle, R. C., Kline, C. E., Krafty, R. T., Thayer, J. F., & Hall, M. H. (2019). Prospective associations among objectively and subjectively assessed sleep and the metabolic syndrome. *Sleep Medicine,* 58, 1–6. https://doi.org/10.1016/j.sleep.2019.02.005

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Carskadon, M. A., Acebo, C., & Jenni, O. G. (2004). Regulation of adolescent sleep: Implications for behavior. A*nnals of the New York Academy of Sciences, 1021*(1), 276–291. https://doi.org/10.1196/annals.1308.032

Centers for Disease Control and Prevention. (2024, May 15). About Sleep and Your Heart Health. Retrieved February 17, 2023, from https://www.cdc.gov/heart-disease/about/sleep-and-heart-health.html?CDC_AAref_Val=https://www.cdc.gov/bloodpressure/sleep.htm.%20Accessed%2017%20Feb.%202023

Chaput, J. P. (2014). Sleep patterns, diet quality and energy balance. *Physiology & Behavior, 134*, 86–91. https://doi.org/10.1016/j.physbeh.2013.09.006

Chaput, J. P., & St-Onge, M.-P. (2014). Increased food intake by insufficient sleep in humans: Are we jumping the gun on the hormonal explanation? *Frontiers in Endocrinology*, 5. https://doi.org/10.3389/fendo.2014.00116

Fry, A. (2023, December 22). *The link between obesity and sleep deprivation*. Sleep Foundation. Retrieved March 20, 2023 from https://www.sleepfoundation.org/physical-health/obesity-and-sleep

Gelaye, B., Lohsoonthorn, V., Lertmeharit, S., Pensuksan, W. C., Sanchez, S. E., Lemma, S., Berhane, Y., Zhu, X., Vélez, J. C., Barbosa, C., Anderade, A., Tadesse, M. G., & Williams, M. A. (2014). Construct validity and factor structure of the pittsburgh sleep quality index and epworth sleepiness scale in a multi-national study of African, South East Asian and south American college students. *PLoS ONE, 9*(12), e116383. https://doi.org/10.1371/journal.pone.0116383

Gozal, D., & Kheirandish-Gozal, L. (2012). Childhood obesity and sleep: Relatives, partners, or both?-a critical perspective on the evidence. *Annals of the New York Academy of Sciences, 1264*(1), 135–141. https://doi.org/10.1111/j.1749-6632.2012.06723.x

Guo, S., Sun, W., Liu, C., & Wu, S. (2016). Structural validity of the pittsburgh sleep quality index in Chinese undergraduate students. *Frontiers in Psychology*, 07. https://doi.org/10.3389/fpsyg.2016.01126

Kahlhöfer, J., Karschin, J., Breusing, N., & Bosy-Westphal, A. (2015). Relationship between actigraphy-assessed sleep quality and fat mass in college students. *Obesity, 24*(2), 335–341. https://doi.org/10.1002/oby.21326

Klingenberg, L., Sjödin, A., Holmbäck, U., Astrup, A., & Chaput, J.-P. . (2012). Short sleep duration and its association with energy metabolism. *Obesity Reviews, 13*(7), 565–577. https://doi.org/10.1111/j.1467-789x.2012.00991.x

Kohansieh, M., & Makaryus, A. N. (2015). Sleep deficiency and deprivation leading to cardiovascular disease. *International Journal of Hypertension*, 2015, 1–5. https://doi.org/10.1155/2015/615681

Li, L., Yu, Q., Zhao, W., Herold, F., Cheval, B., Kong, Z., Li, J., Mueller, N., Kramer, A. F., Cui, J., Pan, H., Zhan, Z., Hui, M., & Zou, L. (2021). Physical activity and inhibitory control: The mediating role of sleep quality and sleep efficiency. *Brain Sciences, 11*(5), 664. https://doi.org/10.3390/brainsci11050664

Liu, D., Kahathuduwa, C., & Vazsonyi, A. T. (2021). The Pittsburgh Sleep Quality Index (PSQI): Psychometric and clinical risk score applications among college students. *Psychological Assessment, 33*(9). https://doi.org/10.1037/pas0001027

Maharjan, N., Karki, P. K., Adhikari, B., Bhaila, A., & Shrestha, H. (2020). Association between sleep duration, sleep quality and body mass index in medical students. *Journal of Chitwan Medical College, 10*(4), 34–38. https://doi.org/10.54530/jcmc.248

Manzar, M. D., Zannat, W., Hussain, M. E., Pandi-Perumal, S. R., Bahammam, A. S., Barakat, D., Ojike, N. I., Olaish, A., & Spence, D. W. (2016). Dimensionality of the pittsburgh sleep quality index in the young collegiate adults. *SpringerPlus, 5*(1). https://doi.org/10.1186/s40064-016-3234-x

Markwald, R. R., Melanson, E. L., Smith, M. R., Higgins, J., Perreault, L., Eckel, R. H., & Wright, K. P. (2013). Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. *Proceedings of the National Academy of Sciences, 110*(14), 5695–5700. https://doi.org/10.1073/pnas.1216951110

Matricciani, L., Bin, Y. S., Lallukka, T., Kronholm, E., Wake, M., Paquet, C., Dumuid, D., & Olds, T. (2018). Rethinking the sleep-health link. *Sleep Health, 4*(4), 339–348. https://doi.org/10.1016/j.sleh.2018.05.004

Mayer, M. A., Catalani, F., Fraire, J., Deltetto, N., Lucía Martín, Beneitez, A., Fischman, D., & Orden, A. B. (2022). Inhibitory control and obesity in adolescents: A prospective cohort study. *Appetite, 171*, 105910–105910. https://doi.org/10.1016/j.appet.2022.105910

Mirdha, M., Sharma, H. B., & Mallick, H. N. (2019). Study of association between body mass index and sleep quality among Indian students. *Sleep Medicine, 64*(1), S259. https://doi.org/10.1016/j.sleep.2019.11.724

Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C. M., & Colantonio, A. (2016). The pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Medicine Reviews, 25*, 52–73. https://doi.org/10.1016/j.smrv.2015.01.009

Morrissey, B., Taveras, E., Allender, S., & Strugnell, C. (2020). Sleep and obesity among children: A systematic review of multiple sleep dimensions. *Pediatric Obesity, 15*(4). https://doi.org/10.1111/ijpo.12619

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2023). F*actors affecting weight & health*. Retrieved July 14, 2024 from https://www.niddk.nih.gov/health-information/weight-management/adult-overweight-obesity/factors-affecting-weight-health

Olds, T. S., Maher, C. A., & Matricciani, L. (2011). Sleep duration or bedtime? Exploring the relationship between sleep habits and weight status and activity patterns. *Sleep, 34*(10), 1299–1307. https://doi.org/10.5665/sleep.1266

Papatriantafyllou, E., Efthymiou, D., Zoumbaneas, E., Popescu, C. A., & Vassilopoulou, E. (2022). Sleep deprivation: Effects on weight loss and weight loss maintenance. *Nutrients, 14*(8), 1549. https://doi.org/10.3390/nu14081549

Pourhoseingholi, M. A., Vahedi, M., & Rahimzadeh, M. (2013). Sample size calculation in medical studies. *Gastroenterology and Hepatology from Bed to Bench, 6*(1), 14–17.

Rahe, C., Czira, M. E., Teismann, H., & Berger, K. (2015). Associations between poor sleep quality and different measures of obesity. *Sleep Medicine, 16*(10), 1225–1228. https://doi.org/10.1016/j.sleep.2015.05.023

Sharma, S., & Kavuru, M. (2010). Sleep and metabolism: An overview. I*nternational Journal of Endocrinology, 2010*(270832), 1–12. https://doi.org/10.1155/2010/270832

Shrivastava, D., Jung, S., Saadat, M., Sirohi, R., & Crewson, K. (2014). How to interpret the results of a sleep study. *Journal of Community Hospital Internal Medicine Perspectives, 4*(5), 24983. https://doi.org/10.3402/jchimp.v4.24983

Suni, E. (2024, April 25). *How sleep deprivation affects your heart*. Sleep Foundation. Retrieved July 14, 2024 from https://www.sleepfoundation.org/sleep-deprivation/how-sleep-deprivation-affects-your-heart

UNICEF. (2022, March 4). *Everybody needs to act to curb obesity*. UNICEF Philippines. https://www.unicef.org/philippines/press-releases/everybody-needs-act-curb-obesity

Vargas, P. A., Flores, M., & Robles, E. (2014). Sleep quality and body mass index in college students: The role of sleep disturbances. *Journal of American College Health, 62*(8), 534–541. https://doi.org/10.1080/07448481.2014.933344

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F., & Tasali, E. (2015). Joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society on the recommended amount of sleep for a healthy adult: Methodology and discussion. *Journal of Clinical Sleep Medicine, 11*(8), 931–952. https://doi.org/10.5664/jcsm.4950

Wong, P. M., Barker, D., Roane, B. M., Van Reen, E., & Carskadon, M. A. (2022). Sleep regularity and body mass index: Findings from a prospective study of first-year college students. *Sleep Advances, 3*(1). https://doi.org/10.1093/sleepadvances/zpac004

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