SLEEP QUALITY AND OBESITY: A COMMUNITY BASED CROSS-SECTIONAL STUDY

Bishal Joshi,[1] Jay Prakash Jha,[2] Aishwarya Gupta,[3] Srijana Rayamajhi,[3] Sudeep Kumar Yadav,[4] Laxmi Shrestha,[5] Ajit Pahari,[1] Preetu Gurung[6]

ABSTRACT

INTRODUCTION

Obesity and poor sleep quality are challenging public health issues worldwide. Despite numerous research connecting obesity and sleep quality, there is limited study on it at specific community settings like Lumbini Province, Nepal. So, this comprehensive community-based cross-sectional study was conducted with the aim to assess the relationship between sleep quality, and obesity.

MATERIAL AND METHODS

This study was conducted from April to August 2023 in Ranigaon-2, Bhairahawa, Nepal. Total 76 participants were enrolled in the study and data were collected through door-to-door visits and included socio-demographic information, body-mass index (BMI), waist-hip ratio (WHR), and sleep quality assessed using the Pittsburgh Sleep Quality Index (PSQI). Descriptive statistics, Pearson's correlation, and logistic regressions were used for analysis.

RESULTS

The study included 35 males and 41 females with a mean age of 36.88±10.06 years. The mean BMI was 25.95 ± 3.78 kg/m² and average waist-hip ratio was 0.9 ± 0.06. The mean PSQI score was 6.82 ± 3.24, indicating poor sleep quality in about 60% of participants. No significant correlation was found between BMI, WHR, and sleep parameters. Age was directly correlated with sleep latency and PSQI score, and inversely with sleep efficiency.

CONCLUSION

Poor sleep quality was prevalent in the community, but no significant association was found between sleep indices and obesity parameters. The study found the impact of age on quality of sleep, highlighting the importance demographic factors in sleep research. In future, longitudinal studies are needed to explore the relationship between sleep, overweight, and obesity.

KEYWORDS

Body mass index, PSQI, Sleep, Waist-hip ratio.

1. Department of Physiology, Universal College of Medical Sciences, Bhairahawa, Nepal
2. Department of Clinical Physiology and Biophysics, Karnali Academy of Health Sciences, Jumla, Nepal
3. Intership, Universal College of Medical Sciences, Bhairahawa, Nepal
4. Rukum District Hospital, Karnali Province, Nepal
5. Department of Pharmacology, Universal College of Medical Sciences, Bhairahawa, Nepal
6. Department of Physiology, Devdaha Medical College, Devdaha, Nepal

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For Correspondence
Dr Bishal Joshi
Department of Physiology
Universal College of Medical Sciences,
Bhairahawa, Nepal
Email: drbishaljoshi76@gmail.com

INTRODUCTION

Obesity and poor sleep quality not only compromise individual well-being but also impose a considerable burden on healthcare systems worldwide.[1,2] A pooled estimates of the prevalence of obesity and overweight in the Middle East Asia were 21.17% and 33.14% respectively.[3] WHO estimates in 2022 that 43% of adults of 18 years and above have overweight (16% with obesity) globally, which includes 31% in South-East Asia region, (5% with obesity).[4] The World Obesity Federation projects that by 2030, one billion people will be obese, with South and Southeast Asia experiencing a doubling in obesity rates and 45 million children affected.[5] Studies in elderly population of different parts of Nepal have shown the prevalence of insomnia to be 46.2% in Hetauda, 52.3% in Nepalganj, 50% at Banepa, 29.1% at Kathmandu and 17.5% Nationwide.[6-10] The variation is largely due to different population and the tools to assess the condition. The National Sleep Foundation guidelines recommend 7-9 hours of sleep per night for adults, and inadequate sleep raises the risk of overweight/obesity by 1.4 times than normal sleepers.[11,12]

Furthermore, WHO data reflects that obesity and overweight can contribute to sleep-related issues such as insomnia, sleep apnea, and restless legs syndrome (RLS).[13] Several studies have also shown poor sleep patterns increase the risk of obesity and modifies endocrine function in a way that promotes weight gain.[14-16] A meta-analysis of 18 studies involving over 600,000 adults showed that sleeping less than 5 hours per night was associated with a 55% higher risk of obesity. Additionally, the analysis revealed that for each extra hour of sleep, the BMI decreased by 0.35 kg/m^2.[17] This highlights the significant impact of sleep on body weight.

Despite a large number of studies establishing the relationship between sleep and obesity, gaps remain in linking obesity with sleep in specific community settings and diverse demographic groups. There is hardly any study done in the community of Lumbini Province, Nepal. This study aimed to find the relationship between sleep quality and obesity in a community setting of Lumbini province, using standard metrics like body mass index (BMI), waist hip ratio (WHR), and Pittsburgh Sleep Quality Index (PSQI).

MATERIAL AND METHODS

This community-based cross-sectional study was conducted from April to August 2023 at Ranigaon-2, Bhairahawa Nepal after obtaining ethical approval from institutional review committee of Universal College of Medical Sciences, Bhairahawa, Nepal (Ref No. UCMS/IRC/230/22). The sample size was determined using the Elizabeth, Wanda and Apriyanti (2022) study,[18] which showed the odds ratio of having poor sleep with high BMI to be 8.57. Sample size was calculated using the sample size formula for comparing the two proportions, $n = [(Z\alpha/_2 + Z_1\_\beta)^2 \times [p_1.(1 - p_1) + p_2. (1 - p_2)] / (p_1 - p_2)^2$, where p1 and p2 are proportions of variable (sleep quality) in case (obese) and control (non-obese), and taking the prevalence of poor sleep in non-obese as 16.7% and in obese as 63.2% as per the literature, at 95% confidence and 80% power. Adding 10% non-response rate, required total sample size is 44. A total of 76 participants were enrolled in the study by convenient sampling technique.

Socio-demographic information was taken from all the participants. Body mass index (BMI) was calculated as ratio of weight in Kg and height in meter squared, was classified as per WHO Asian classification.[19] Waist and hip circumferences were measured using non-stretchable tape to ensure accuracy and consistency. The quality of sleep was assessed using Pittsburgh Sleep Quality Index (PSQI).[20] PSQI is a widely used tool to assess sleep quality over a month, comprising 19 self-assessment questions and five questions to be assessed by a bed partner or roommate (if available), forming seven component scores, each of which has a range of 0 to 3 points. The component scores are summed to produce a global score (range 0 to 21). Higher scores reflect worse sleep quality. The PSQI was translated into Nepali by two authors independently, and discrepancies were resolved to create a single version. Language and subject experts, including professors from Psychiatry and Physiology, reviewed the translation to ensure it retained the original meaning and relevance. Data were anonymized, coded, and analyzed using IBM SPSS 16. Descriptive statistics included frequency, proportion, mean, and standard deviation. Pearson's correlation and Logistic Regression analyzed the predictability of PSQI, with a significance level of $p < 0.05$.

RESULTS

Among the 76 participants, 35 (46%) were male and rest (54%) were female. Their mean age was 36.88±10.06 years, ranging from 25 to 64 years. Most of them were home-makers (19); other occupations include business, services, farming, teaching and labour (figure 1). Substance abuse of some type was taken by 21 participants, commonest being alcohol. About two-third people practiced regular exercise and 13 did not do any. Three-fourth of them (57) were apparently healthy as per history; remaining had diagnosed conditions such as thyroid disorders, asthma, and diabetes; but none of them were serious. Twenty citizens were taking medication of some type (including ayurvedic by one) at the time of data collection (figure 2). General physical examination of participants was grossly normal. Pulse rate on average was 82 ±11.26 (range 54 to 102) beats per minute. Majority of them had normal blood pressure, and 12 (15.79%) had hypertension as per JNC-7 classification (Figure 2). Mean body mass index was 25.95 ± 3.78 Kg/m^2; most of them fell in overweight category (35, 46.05%) and 25 participants (32.89%) were obese as per WHO Asian classification of BMI. The average waist-hip ratio was 0.9 ± 0.06, which was higher than 0.85 in 15 female (36.58% females) and higher than 0.9 in 33 male (94.28%) (Figure 2).

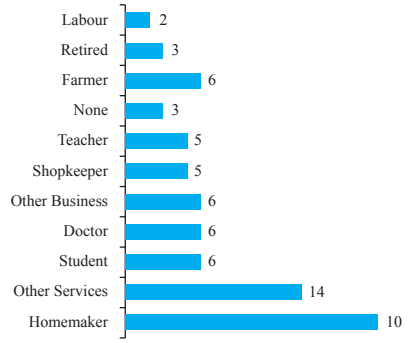

Figure 1. Occupation of participants.

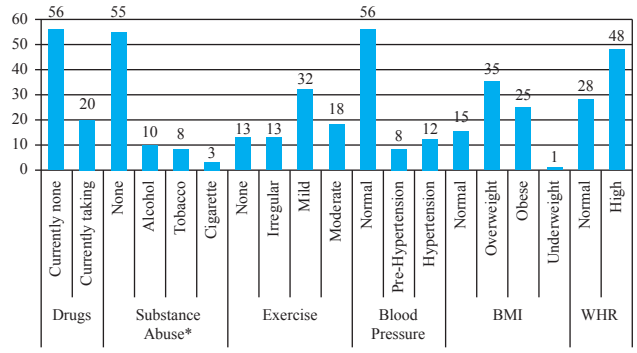

Figure 2. History and examination parameters of participants

Sleep parameters

Sleep quality and quantity was assessed by standard PSQI score. On average, participants sleep at 10:25 pm. Their sleep latency (time taken to fall asleep after going bed) was 28.36 ± 28.5 minutes; sleep latency exceeding 30 minutes was observed in 13 individuals. Overall sleep duration was 7.36 ± 0.9 hours, but the average sleep efficiency was 88%. The PSQI score was 6.82 ± 3.24 on average, ranging from 1 to 15. About 60% participants showed abnormal sleep duration (less than 7 hours) and PSQI score (5 or more) (figure 3).

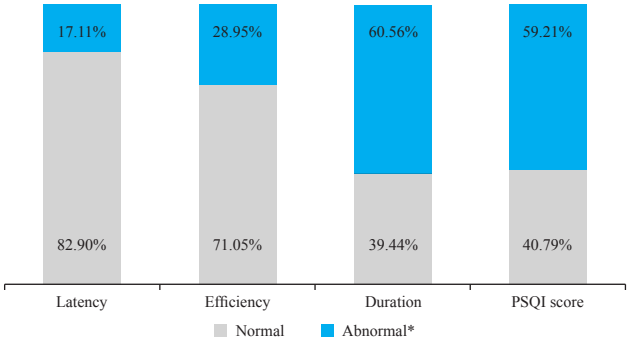

Figure 3. Sleep parameters of participants

*Abnormal parameter includes latency higher than 30 min, efficiency 85% or less, duration less than 7 hours and PSQI score 5 or higher.

Correlation

Sleep indices were correlated with various parameters by Pearson Correlation. It shows that higher age was directly correlated with sleep latency and PSQI score but inversely with sleep efficiency. Obesity indices such as BMI and WHR did not show any significant correlation with any sleep parameters (Table 1).

In order to assess the predictability of PSQI score, a logistic regression analysis was performed, using age, sex, presence of any comorbidity, substance abuse, exercise, BP classification, BMI, WHR, sleep latency, duration, actual duration and percent efficiency as predictor variables (Table 2). The logistic regression model assessed those factors dichotomizing the sleep quality with 5 or more PSQI score as poor and less than 5 as good quality of sleep. The odds ratios (OR) and corresponding 95% confidence intervals (CI) for each predictor were estimated. Among the predictors, sleep latency (OR = 1.08, 95% CI: 1.01–1.15, p = 0.018) was significantly associated with poor sleep quality, indicating that for every unit (minute) increase in sleep latency, the odds of experiencing poor sleep quality increased by 8%. Although not statistically significant, BMI and sleep efficiency approached statistical significance, suggesting that higher values of BMI and lower sleep efficiency might increase the odds of poor sleep quality. Other factors did not demonstrate statistically significant associations with poor sleep quality. The intercept suggested an extremely high baseline log odds for poor sleep, though its wide confidence interval indicates uncertainty in this estimate.

Table 1. Pearson correlation of sleep indices with other variables

Paramater 1	Sleep Index	Correlation	*p* value
Age	latency	0.416	<0.001*
	duration	0.197	0.089
	Efficiency percent	-0.346	0.002*
	PSQI score	0.378	0.001*
BMI	latency	0.024	0.84
	duration	-0.027	0.819
	Efficiency percent	0.025	0.828
	PSQI score	0.043	0.712
WHR	latency	0.157	0.175
	duration	0.171	0.139
	Efficiency percent	-0.168	0.146
	PSQI score	0.152	0.189

* Significant at 99% confidence level.

Table 2. Logistic regression analysis of predictors for poor sleep quality

Predictor	Z score	*p*-value	Odds ratio	95% Confidence Interval	
				Lower	Upper
Intercept	1.869	0.062	5.55E+35	0.018	1.67E+73
age	1.442	0.149	1.067	0.977	1.165
sex	0.223	0.824	1.213	0.222	6.613
Any Comorbidity	0.047	0.963	1.044	0.169	6.457
Substance Abuse	-0.409	0.682	0.647	0.080	5.210
exercise	-0.016	0.987	0.994	0.496	1.992
BP classification	-0.495	0.620	0.779	0.290	2.093
BMI	1.524	0.127	1.215	0.946	1.562
Waist-Hip Ratio	-0.612	0.541	0.019	0.000	5996.506
Sleep Latency	2.357	0.018*	1.079	1.013	1.150
Sleep Duration	-1.646	0.100	0.000	0.000	5.977
Actual Sleep Duration	1.567	0.117	13565.546	0.092	1.997E+9
Sleep Efficiency	-1.886	0.059	0.408	0.161	1.036

* Significant at 99% confidence level.

DISCUSSION

This community based cross sectional study was conducted in Ranigaon, Bhairahawa, Nepal to investigate the relationship between the sleep quality and obesity. According to the present research, on average, mean PSQI score was 6.82 ± 3.24, and almost 60% of them showed abnormal sleep quality. No significant correlation was found between the parameters of obesity (BMI and WHR) and of sleep, even though there was a high incidence of poor sleep quality in participants. A direct relation was found between sleep latency and PSQI score and an inverse relation was observed between age and sleep efficiency. PSQI score was significantly altered only by other sleep parameters and none of the obesity indices.

Previous studies have frequently demonstrated a bidirectional association between poor sleep quality and obesity, indicating that poor sleep may lead to weight gain,

and obesity may cause sleep disorders like sleep apnoea.[21-24] The result of the present study, however, is not consistent with the associations made by previous studies. This discrepancy could be due to the demographic and lifestyle differences of our study population from those in previous studies. It is also possible that the cross-sectional nature of the study and relatively small study population limited the significant associations. The current literature suggests that older individuals typically have lower sleep efficiency and longer sleep latency, which indicate poor sleep quality.[25-27] It is consistent with our study findings.

The findings of the present study are in alignment with some previous studies that also did not find a direct correlation between BMI and sleep quality in the certain study participants. According to a cohort study in large population by Patel et al, there is no significant association between sleep duration and BMI.[28] Also, the significant association between age and sleep parameters in the present study are consistent with the existing literature.[25-28] These age-related disturbances in regular sleep patterns may be due to several psychological and physiological factors including stress related to aging, disturbed circadian rhythm, less physical activity and impact of medications. Moreover, this finding along with similar finding of various studies highlights the need for making the strategies for improvement in sleep quality in elderly people, which may reduce the risks of poor sleep and obesity in them.

Our study has demonstrated that sleep latency is a significant predictor of poor sleep quality, highlighting the importance of addressing delays in falling asleep in interventions to improve sleep. Trends for BMI and sleep efficiency in the logistic regression analysis suggest potential areas for further exploration, but require larger sample sizes or additional data to confirm their associations.

Garfield (2019)[29] reviewed the epidemiological studies on sleep and obesity of more than twenty years and found that there is modest evidence of a bidirectional relationship between BMI and sleep duration both in children and adults. He also concludes that there is no solid evidence of causal relationship between BMI and sleep duration. Furthermore, lifestyle and age-related issues, coexisting conditions like hormonal disturbances and metabolic syndrome my further complicate the relationship between sleep and obesity.

In a meta-analysis, Patel and Hu concluded that there is a clear association between short sleep duration and obesity in different populations.[30] Similarly, research by Chaput et al. highlighted the reciprocal relationship between sleep and weight, and demonstrated that both short and extended sleep durations are linked to an increased risk of obesity in adults.[31] Likewise a robust association is seen between sleep and overweight or obesity in various studies.[32,33] In particular, studies repeatedly demonstrate that shorter sleep durations and lower sleep quality are associated with elevated BMIs and an elevated risk of obesity, emphasizing the vital role sleep plays in weight control.[34-37] These conflicting results emphasize the need for advanced research with well-structured methodology for understanding the underlining mechanism and rule out the confounding factors in sleep and obesity relationship, which suggest a complex relationship between sleep and obesity, and is influenced by various factors such as gender, age, and lifestyle as well as the research methodologies used.

A similar study done in young students showed that abnormal sleep latency was present in 20%, which is similar to our data; but inadequate sleep was present in 16% participants.[38] In current study, about 60% had abnormal sleep quality (duration as well as PSQI score) which is very concerning issue from public health perspective. Such type of problems exists in community but may go unrecognized. Poor living conditions, frequent mosquito bites and fragmented sleep, and cultural patterns regarding sleep may also be the reason behind poor sleep pattern. As sleep is directly related to the well-being, there is need for addressing this issue through community-based intervention, education and governmental policies.

One of the strengths of the present study is the assessment of obesity-related variables and sleep quality in a community context. Furthermore, Pittsburgh Sleep Quality Index (PSQI) is widely accepted valid tool for measuring multiple aspects of sleep quality.[39,40] However, as a cross-sectional study, it couldn't determine a causal relationship between different parameters. The PSQI is a validated instrument; but depending solely on the subjective response regarding sleep quality may introduce bias. Also, the convenient sampling limits its generalizability to broader population. Further studies on wider population with larger sample or random sampling, preferably with a longitudinal design would increase the quality of the results.

CONCLUSION

The present research found the poor sleep quality to be prevalent in the community but there was no significant association between sleep indices and obesity parameters. The age-related differences in quality of sleep were clearly observed highlighting the need to consider demographic factor while conducting sleep research. Further longitudinal research is required to explore the relationship between sleep, overweight and obesity.

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CONFLICT OF INTEREST

None

REFERENCES

1. Muscogiuri G, Barrea L, Aprano S, Framondi L, Di Matteo R, Laudisio D, et al. Sleep quality in obesity: does adherence to the mediterranean diet matter? Nutrients. 2020 May 10;12(5):1364.

2. Gupta NK, Mueller WH, Chan W, Meininger JC. Is obesity associated with poor sleep quality in adolescents? American Journal of Human Biology. 2002 Nov;14(6):762-8.

3. Okati-Aliabad H, Ansari-Moghaddam A, Kargar S, Jabbari N. Prevalence of obesity and overweight among adults in the Middle East countries from 2000 to 2020: a systematic review and meta-analysis. Journal of Obesity. 2022;2022(1):8074837.

4. World Health Organization. Obesity and overweight. Geneva : WHO ; 2021 [cited 2025 Mar 15]. Available from:https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

5. Tham KW, Abdul Ghani R, Cua SC, Deerochanawong C, Fojas M, Hocking S, et al. Obesity in South and Southeast Asia—A new consensus on care and management. Obesity Reviews. 2023 Feb;24(2):13520.

6. Bajracharya A, Adhikari I, Tamrakar N. Prevalence of Insomnia among Elderly in Selected Community of Makawanpur, Nepal. IOSR Journal of Nursing and Health Science (IOSR-JNHS). 2022;11(6):29-35.

7. Tharu RP, Mahatra RS. Prevalence and Associated Factors of Insomnia among Elderly People of Nepalgunj Sub-Metropolitan City, Nepal. AlQalam Journal of Medical and Applied Sciences. 2024 Jan 6:21-9.

8. Pradhan R, Shrestha S, Lakhe D, Kayastha B, Sainju S. Associated Risk Factors of Insomnia among Elderly People in Banepa Municipality. Janaki Medical College Journal of Medical Science. 2023 Jul 22;11(1):12-20.

9. Shrestha S, Roka T. Insomnia among Elderly People in a selected urban Community. Journal of Nepal Health Research Council. 2023 Dec 13;21(2):324-9.

10. Chandra A, Prakash P, Sharma N, Chandra A. Prevalence of sleep disturbances during COVID-19 pandemic in a Nepalese population: a cross-sectional study. Journal of Sleep Medicine. 2021 Dec 31;18(3):145-53.

11. Cerolini S, Lombardo C. Sleep and obesity. In: Bray GA, Bouchard C, editors. Handbook of obesity: two-volume set. 4th ed. Boca Raton, FL: CRC Press; 2024. Vol 1:378-90.

12. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's updated sleep duration recommendations: final report. Sleep Health. 2015 Dec;1(4):233–43. PMID: 29073398.

13. World Health Organization. Global Health Observatory (GHO) data: overweight and obesity; 2023.

14. Gildner TE, Liebert MA, Kowal P, Chatterji S, Josh Snodgrass J. Sleep duration, sleep quality, and obesity risk among older adults from six middle-income countries: Findings from the study on global ageing and adult health (SAGE). American Journal of Human Biology. 2014 Nov;26(6):803-12.

15. Knutson KL, Van Cauter E. Associations between sleep loss and increased risk of obesity and diabetes. Annals of the New York Academy of Sciences. 2008 May;1129(1):287-304.

16. Spiegel K, Tasali E, Penev P, Cauter EV. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. Annals of Internal Medicine. 2004 Dec 7;141(11):846-50.

17. Beccuti G, Pannain S. Sleep and obesity. Current Opinion in Clinical Nutrition & Metabolic Care. 2011 Jul 1;14(4):402-12.

18. Elizabeth B, Wanda D, Apriyanti E. The correlation between sleep quality and the prevalence of obesity in school-age children. Journal of Public Health Research. 2021 May;10(1_suppl):jphr-2021.

19. Weisell RC. Body mass index as an indicator of obesity. Asia Pacific J Clin Nutr. 2002;11:S681-4.

20. Buysse, DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index (PSQI): A new instrument for psychiatric research and practice. Psychiatry Research. 1989; 28:193-213.

21. Fatima Y, Doi SA, Mamun AA. Sleep quality and obesity in young subjects: a meta-analysis. Obesity Reviews. 2016 Nov;17(11):1154-66.

22. Nedeltcheva AV, Scheer FA. Metabolic effects of sleep disruption, links to obesity and diabetes. Current Opinion in Endocrinology, Diabetes and Obesity. 2014 Aug 1;21(4):293-8.

23. Grandner MA, Schopfer EA, Sands-Lincoln M, Jackson N, Malhotra A. Relationship between sleep duration and body mass index depends on age. Obesity. 2015 Dec;23(12):2491-8.

24. Itani O, Jike M, Watanabe N, Kaneita Y. Long sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression. Sleep Medicine. 2017 Apr 1;32:246-56.

25. Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. Sleep. 2004 Oct 1;27(7):1255-73.

26. Mander BA, Winer JR, Jagust WJ, Walker MP. Sleep: a novel mechanistic pathway, biomarker, and treatment target in the pathology of Alzheimer's disease?. Trends in Neurosciences. 2016 Aug 1;39(8):552-66.

27. Crowley K. Sleep and sleep disorders in older adults. Neuropsychology Review. 2011 Mar;21:41-53.

28. Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. Obesity. 2008 Mar;16(3):643-53.

29. Garfield V. The association between body mass index (BMI) and sleep duration: where are we after nearly two decades of epidemiological research?. International Journal of Environmental Research and Public Health. 2019 Nov;16(22):4327.

30. Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. Obesity. 2008 Mar;16(3):643-53.

31. Chaput JP, Després JP, Bouchard C, Tremblay A. The association between sleep duration and weight gain in adults: a 6-year prospective study from the Quebec Family Study. Sleep. 2008 Apr 1;31(4):517-23.

32. Liu, Y., Wheaton, A. G., Chapman, D. P., Cunningham, T. J., Lu, H., & Croft, J. B. Prevalence of healthy sleep duration among adults—United States, 2014. Morbidity and Mortality Weekly Report. 2016; 65(6):137-41.

33. 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 Medicine. 2004 Dec 7;1(3):e62.

34. Fatima Y, Doi SA, Mamun AA. Sleep quality and obesity in young subjects: a meta-analysis. Obesity Reviews. 2016 Nov;17(11):1154-66.

35. Wang H, Hu R, Du H, Fiona B, Zhong J, Yu M. The relationship between sleep duration and obesity risk among school students: a cross-sectional study in Zhejiang, China. Nutrition & Metabolism. 2018 Dec;15:1-9.

36. Jackson CL, Redline S, Emmons KM. Sleep as a potential fundamental contributor to disparities in cardiovascular health. Annual Review of Public Health. 2015 Mar 18;36:417-40.

37. Bjorvatn B, Sagen IM, Øyane N, Waage S, Fetveit A, Pallesen S, Ursin R. The association between sleep duration, body mass index and metabolic measures in the Hordaland Health Study. Journal of Sleep Research. 2007 Mar;16(1):66-76.

38. Jha JP, Pun DB, Thapa B, Chaudhary HP. Sleep habits and physical activity in health science students – a cross-sectional study. Europasian J. Med. Sci. 2024 Dec.31;6(9).

39. Backhaus J, Junghanns K, Broocks A, Riemann D, Hohagen F. Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. Journal of psychosomatic research. 2002 Sep 1;53(3):737-40.

40. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. 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. 2016 Feb 1;25:52-73.