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IMPACT OF SLEEP DEPRIVATION ON HORMONAL REGULATION AND INFLUENCE OF DIET ON SLEEP QUALITY

Introduction

Sleep regulates endocrine and metabolic homeostasis through circadian control of cortisol, melatonin, insulin, leptin, and ghrelin [1, 2]. Sleep deprivation disrupts hypothalamic-pituitary-adrenal (HPA) axis activity and metabolic regulation [1–7]. Emerging evidence suggests that dietary patterns may also influence sleep quality through biochemical mechanisms affecting neurotransmitter synthesis and metabolic stability [3, 4].

Goal

This study examined associations between sleep duration, dietary patterns, and self-reported hormonal symptoms, and to interpret these relationships from a biochemical perspective.

Material and methods of research

Data were collected using an online questionnaire (Google Forms) distributed through academic and social networks (n=350). The survey assessed sleep duration and quality, self-reported hormonal symptoms, dietary habits, physical activity, and stress levels. The majority of participants reported moderate stress levels and variable sleep durations, patterns typical of university student populations. The sample also included an older demographic consisting of family friends, relatives, lecturers and community members. The number of responses (n) varies slightly between analyses and is indicated in figure captions. Statistical analyses were conducted in Microsoft Excel using descriptive statistics and chi-square tests ($p<0.05$).

The results of the research and their discussion

A significant association was observed between sleep duration and hormonal symptom frequency ($\chi^2=25.82$, df=12, p=0.011), with shorter sleep duration associated with higher hormonal symptom frequency (Figure 1, 2).

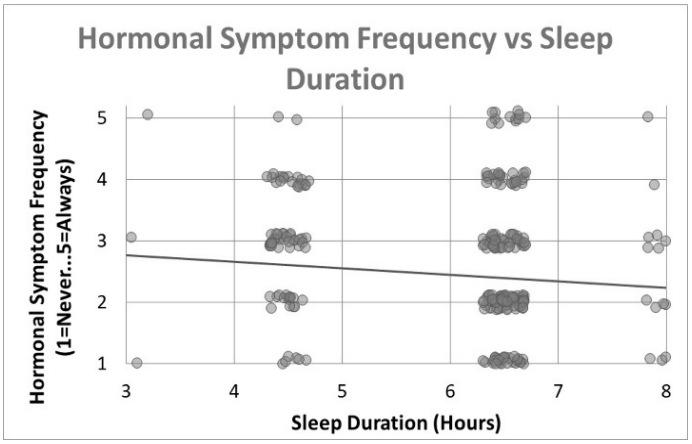


Figure 1 – Hormonal symptom frequency across sleep duration categories. Mean self-reported hormonal symptom frequency (1–5) across sleep duration groups: <4 h (n=8), 4–5 h (n=81), 6–7 h (n=227) and ≥8 h (n=34)

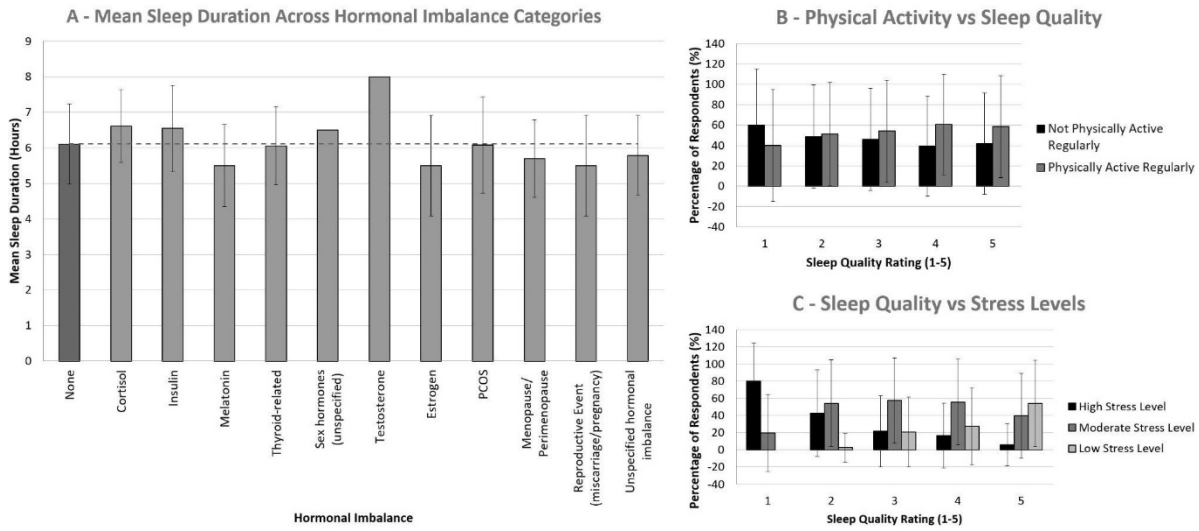


Figure 2 – Sleep metrics across physiological and lifestyle factors. A – Mean sleep duration across hormonal imbalance categories (melatonin n=4; thyroid n=9; cortisol/adrenal n=9; insulin n=11; PCOS n=6; menopause n=5; estrogen n=2; reproductive event-related n=2; testosterone n=1; unspecified n=19) vs no imbalance (n=281) shown by the dashed line. B – Sleep quality distribution for physically active (n=173) vs non-active participants (n=167). C – Sleep quality (1–5) across low (n=60), moderate (n=181), and high (n=91) stress levels

Better dietary quality was associated with higher sleep quality, with a highly significant association observed between diet quality score and sleep quality (χ^2=101.29, df = 16, p<0.001) (Figure 3). Higher sugar/processed-food intake showed inverse associations (Figure 4).

The findings support existing evidence linking sleep deprivation with hormonal and metabolic dysregulation. Sleep deprivation alters endocrine regulation through HPA-axis activation and cortisol dysregulation [1, 7]. Participants reporting hormonal imbalance also showed altered sleep duration, consistent with circadian-endocrine disruption [1, 5, 6].

Diet quality was strongly associated with sleep quality in this cohort, with a highly significant association demonstrated in Figure 3. Nutrient-dense diets rich in fiber, vitamins, polyphenols, and omega–3 fatty acids may improve sleep quality by reducing inflammation and stabilising metabolic regulation. Conversely, higher consumption of processed foods and refined carbohydrates may contribute to sleep fragmentation and metabolic instability [3, 4].

Psychological stress was negatively associated with sleep quality, consistent with evidence linking stress-induced HPA-axis activation and elevated cortisol to impaired sleep [1, 7]. Participants who engaged in regular physical activity reported higher sleep-quality scores, consistent with evidence that exercise improves sleep efficiency and modulates stress-related neuroendocrine pathways [7].

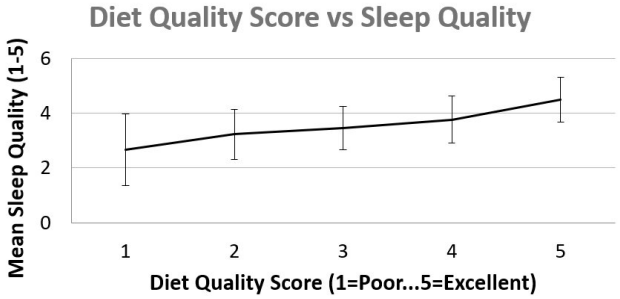


Figure 3 – Distribution of sleep quality across diet quality score categories. Mean sleep quality scores (1–5 scale) across diet quality groups: score 1 (n=12), score 2 (n=40), score 3 (n=170), score 4 (n=112), and score 5 (n=16). Error bars show standard deviation

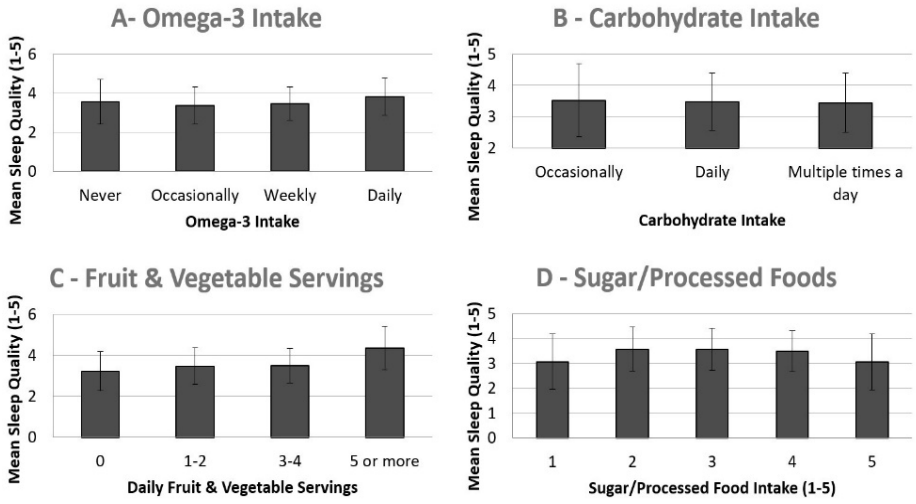


Figure 4 – Mean sleep quality scores across four dietary behaviour categories. A – Omega–3 intake: never (n=18), occasionally (n=113), weekly (n=57), daily (n=28); B – Carbohydrate intake: occasionally (n=21), daily (n=129), multiple times/day (n=66); C – Fruit and vegetable intake: 0 servings (n=20), 1–2 (n=233), 3–4 (n=87), ≥5 (n=10); D – Sugar/processed-food intake levels 1–5 (n=28, 106, 141, 112, 24). Error bars indicate standard deviation

This study has several strengths, including its examination of multiple interacting lifestyle and hormonal factors, and its focus on patterns relevant to biochemical and endocrine regulation. However, limitations include reliance on self-reported data and the cross-sectional design, which limits causal inference. Unequal sample sizes across hormonal categories may also affect interpretation. Future research should incorporate objective sleep measures and biochemical hormonal assessments.

Conclusions

This study demonstrates that shorter sleep duration is associated with a greater frequency of hormonal symptoms, consistent with known effects of sleep loss on cortisol regulation, appetite-related hormones, and metabolic signalling. Higher dietary quality, characterised by greater intake of nutrient-dense foods and lower consumption of sugar/processed foods, was strongly linked with better sleep quality and longer sleep duration. Healthier dietary patterns were associated with better sleep-related behaviours and improved sleep quality. These findings highlight the interconnected roles of sleep, diet, and endocrine function and suggest potential benefits of lifestyle-based interventions.

LITERATURE

1. Kim, T. W. The impact of sleep and circadian disturbance on hormones and metabolism / T. W. Kim, J. H. Jeong, S. C. Hong // Sleep Medicine Clinics. – 2015. – Vol. 10, № 2. – P. 123–139.

2. Sleep deprivation and central appetite regulation / S. Liu, L. Yu, X. Zhang [et al.]. // Nutrients. – 2022. – Vol. 14, № 18. – P. 3842.

3. St-Onge, M. P. Effects of diet on sleep quality / M. P. St-Onge, A. Mikic, C. E. Pietrolungo // Advances in Nutrition. – 2016. – Vol. 7, № 5. – P. 938–949.

4. Association between diet and sleep quality: a systematic review / J. Godos, R. Ferri, F. Caraci [et al.]. // Nutrients. – 2021. – Vol. 13, № 3. – P. 868.

5. Impact of sleep patterns upon female neuroendocrinology and reproductive outcomes / G. Beroukhim, R. M. Alderson, K. D. Acharya [et al.]. // Frontiers in Endocrinology. – 2022. – Vol. 12. – P. 829–921.

6. Circadian rhythm disruption and polycystic ovary syndrome: molecular links and clinical implications / T. Heydari, R. Rezaei, S. Ghafouri-Fard, M. Taheri // Biomedicine & Pharmacotherapy. – 2025. – Vol. 181. – P. 116–610.

7. Grandner, M. A. Sleep, health, and society/ M. A. Grandner // Sleep Medicine Clinics. – 2017. – Vol. 12, № 1. – P. 1–22.