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Effect of Obesity on Subjective and Objective Sleep Parameters in Non- Diabetic Adults: PSQI–Fitbit Study

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ABSTRACT

Background: Obesity is a growing public health challenge globally and is strongly associated with metabolic and cardiovascular disorders. Emerging evidence suggests that obesity adversely affects sleep quality and architecture, which may further aggravate metabolic dysfunction. However, comprehensive evaluation combining both subjective and objective sleep assessments in non-diabetic obese adults remains limited, particularly in the Indian Population.
Methods: This cross-sectional observational study was conducted among adult participants categorized into obese and non-obese groups according to the WHO Asia-Pacific BMI criteria. Subjective sleep quality was assessed using the PSQI questionnaire. Objective sleep parameters, including total sleep duration, deep sleep duration, REM sleep duration, sleep efficiency, sleep latency, and sleep quality score, were recorded using a Fitbit Inspire 3 wearable device over seven consecutive nights. Statistical analysis was performed using appropriate parametric and non-parametric tests. A p-value <0.05 was considered statistically significant.
Results: Obese participants demonstrated significantly poorer subjective sleep quality, higher global Pittsburgh Sleep Quality Index (PSQI) scores, longer sleep latency, shorter sleep duration, and lower sleep efficiency than non-obese individuals (p<0.05). Objective analysis using Fitbit revealed significantly reduced total sleep time, decreased deep and REM sleep duration, and impaired sleep efficiency among obese subjects. The combined subjective and objective findings strongly indicate compromised sleep architecture and quality in obese non-diabetic adults.
Conclusion: Obesity significantly impairs both subjective perception and objective measures of sleep quality in non-diabetic adults. Early identification of sleep disturbances in obese individuals may allow timely interventions to prevent future metabolic and cardiovascular complications.

Key-words: Obesity, Sleep Quality, PSQI, Fitbit, Wearable Devices, Sleep Architecture, Non-Diabetic Adults

INTRODUCTION

Obesity has emerged as a global epidemic with rapidly increasing prevalence in both developed and developing nations. In India, adult obesity rates have shown a steep upward trend, contributing substantially to the burden of non-communicable diseases.

Beyond its well-established association with metabolic and cardiovascular disorders, obesity is increasingly recognized as a significant disruptor of sleep physiology [1-3].

Sleep is a fundamental biological process essential for physical restoration, cognitive function, metabolic regulation, and emotional well-being. Sleep quality is a multidimensional construct encompassing sleep duration, latency, continuity, efficiency, and subjective satisfaction. Disturbances in sleep architecture, particularly reduced slow-wave sleep and fragmented REM sleep, are known to adversely affect metabolic

homeostasis, appetite regulation, and insulin sensitivity [4-6].

Several studies have demonstrated a bidirectional relationship between obesity and sleep disturbances. Obesity predisposes individuals to poor sleep through mechanisms such as obstructive sleep apnoea, altered circadian rhythm, autonomic imbalance, and hormonal dysregulation involving leptin and ghrelin. Conversely, poor sleep promotes weight gain through appetite stimulation, reduced energy expenditure, and insulin resistance, forming a vicious cycle [7-9].

Traditional assessment of sleep quality has largely relied on subjective questionnaires such as PSQI. While valuable, subjective tools may not fully capture sleep architecture. Recent advancements in wearable technology allow objective, non-invasive monitoring of sleep parameters, providing valuable insights into real-world sleep behaviour [10-12].

Despite growing interest, studies simultaneously evaluating subjective and objective sleep parameters in obese non-diabetic adults remain scarce, particularly in the Indian population. The present study aims to bridge this gap by comprehensively assessing sleep quality using the PSQI and objective monitoring via Fitbit [13-15].

MATERIALS AND METHODS

Study Design- This cross-sectional observational study was conducted in the Department of Physiology at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India, after obtaining institutional ethical clearance.

Sample Size- The sample size was calculated based on previous studies assessing differences in global PSQI scores between obese and non-obese adults, assuming a moderate effect size, 80% power, and a 5% alpha level. Based on these parameters, the minimum required sample size was 60 participants. A total of 66 subjects were recruited to compensate for potential dropouts, incomplete questionnaire responses, non-compliance with wearable device use, and potential data loss during monitoring.

Study Population- A total of 66 participants were enrolled, with equal distribution between the obese and non-obese groups. Adult participants aged 18–45 years were recruited and divided into two groups:

Obese group: BMI ≥25 kg/m² (WHO Asia-Pacific criteria)
Non-obese group: BMI 18.5–22.9 kg/m²

Inclusion Criteria
❖ Apparently healthy adults
❖ Non-diabetic participants
❖ Willingness to provide informed consent

Exclusion Criteria
❖ Diagnosed diabetes mellitus
❖ Known sleep disorders
❖ Chronic systemic illness
❖ Shift workers
❖ Current use of sedatives or psychotropic medications

Subjective Sleep Assessment- Sleep quality was evaluated using the PSQI[10] questionnaire, which assesses seven components:
1. Subjective sleep quality
2. Sleep latency
3. Sleep duration
4. Sleep efficiency
5. Sleep disturbances
6. Use of sleeping medication
7. Daytime dysfunction

A global PSQI score >5 indicates poor sleep quality.

Objective Sleep Assessment- Objective sleep parameters [11,12] were recorded using a Fitbit Inspire 3 wearable device worn continuously for consecutive 7 nights. Fitbit Inspire 3 has demonstrated acceptable agreement with polysomnography for sleep duration and efficiency. The following parameters were analysed:
• Total sleep duration (hours)
• Deep sleep duration (hours)
• REM sleep duration (hours)
• Sleep efficiency (%)
• Sleep latency (minutes)
• Sleep quality score

Statistical Analysis- Data were analysed using SPSS version 20. Continuous variables were expressed as mean±standard deviation. Group comparisons were performed using an independent t-test or a Mann–Whitney U test, as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1 summarizes the baseline demographic and anthropometric characteristics of study participants. Both groups were comparable in age. Body mass index

(BMI) was significantly higher in the obese group compared to the non-obese group (p<0.001), confirming appropriate group classification.

Table 1: Baseline characteristics of study participants

Parameter	Non-obese (Mean±SD)	Obese (Mean±SD)	p-value
Age (years)	27.21±5.30	28.39±5.77	0.38 (NS)
BMI (kg/m²)	21.37±1.33	28.32±1.74	< 0.001*

Table 2 presents component-wise and global PSQI scores in both groups. Obese participants demonstrated significantly higher global PSQI scores, indicating poorer sleep quality. Sleep latency, sleep disturbances, reduced

sleep duration, impaired sleep efficiency, and increased daytime dysfunction were significantly worse in obese participants compared to non-obese controls (p<0.05 for all).

Table 2: Comparison of PSQI components between obese and non-obese groups

PSQI Component	Non-obese (Mean±SD)	Obese (Mean±SD)	p-value
Subjective sleep quality	1.12±0.55	1.88±0.60	<0.05
Sleep latency	0.67±0.69	1.55±0.83	<0.01
Sleep duration	1.03±0.64	1.61±0.70	<0.05
Sleep efficiency	1.00±0.43	1.45±0.75	<0.05
Sleep disturbances	1.06±0.56	1.76±0.75	<0.01
Daytime dysfunction	0.88±0.60	1.64±0.74	<0.01
Global PSQI score	5.76±2.01	9.89±2.43	<0.001

Objective sleep assessment using Fitbit revealed significant deterioration of sleep architecture among obese participants. Total sleep duration, deep sleep duration, REM sleep duration, and sleep efficiency were

significantly reduced, while sleep latency was significantly prolonged in obese individuals compared to non-obese participants (Table 3).

Table 3: Comparison of objective sleep parameters using Fitbit

Parameter	Non-obese (Mean±SD)	Obese (Mean±SD)	p-value
Total sleep duration (hours)	7.08±0.43	5.98±0.48	<0.01
Deep sleep duration (hours)	1.38±0.13	1.06±0.11	<0.01
REM sleep duration (hours)	2.26±0.24	1.92±0.24	<0.05
Time in bed (hours)	7.82±0.46	6.93±0.55	<0.05
Sleep efficiency (%)	89.45±1.70	81.85±2.25	<0.001
Sleep latency (minutes)	13.48±5.27	27.42±9.54	<0.001
Sleep quality score (1–100)	74.99±2.69	59.06±3.12	<0.001

DISCUSSION

The present study demonstrated that obese individuals had significantly impaired sleep quality compared to non-obese participants. Obese participants showed significantly higher global PSQI scores along with increased sleep latency, reduced sleep duration, and lower sleep efficiency. Objective sleep assessment using Fitbit further revealed reduced total sleep duration, decreased deep and REM sleep, and prolonged sleep latency among obese participants compared to non-obese controls. These findings collectively indicate that obesity adversely affects both subjective perception and objective measures of sleep architecture and overall sleep quality.

The findings of the present study are consistent with previous research reporting a strong association between obesity and sleep disturbances. Several studies have documented that obese individuals are more likely to experience reduced slow-wave sleep, fragmented REM sleep, and poor sleep efficiency, which may negatively influence metabolic homeostasis and overall health status [5,7,14]. Disturbances in sleep architecture can impair glucose metabolism, alter appetite regulation, and increase the risk of cardiometabolic disorders.

Multiple physiological mechanisms may explain the relationship between obesity and impaired sleep quality. Adiposity-related mechanical effects on the upper airway can contribute to breathing irregularities during sleep, leading to fragmented sleep and increased sleep latency. Additionally, hormonal dysregulation involving leptin and ghrelin may influence appetite control, energy balance, and sleep–wake cycles. Autonomic nervous system imbalance and low-grade systemic inflammation, commonly observed in obese individuals, may further disrupt normal sleep architecture and restorative sleep processes [8,9,16].

Another important aspect highlighted by this study is the value of combining subjective and objective sleep assessment tools. While questionnaire-based instruments such as the PSQI provide important information on perceived sleep quality, wearable devices enable continuous monitoring of objective sleep parameters in real-world conditions. The concordance between PSQI scores and Fitbit-derived sleep parameters observed in the present study strengthens the reliability of the findings. It demonstrates the usefulness of wearable technology in sleep research [11,12,17].

From a clinical and public health perspective, early identification of sleep disturbances among obese individuals is essential. Poor sleep quality may further exacerbate obesity-related metabolic disturbances, creating a vicious cycle that increases the risk of metabolic syndrome, insulin resistance, hypertension, and cardiovascular disease. Therefore, routine screening of sleep quality in obese individuals may help clinicians identify high-risk patients and implement timely lifestyle, behavioural, and therapeutic interventions [18].

Overall, this study's findings highlight the significant impact of obesity on both subjective and objective sleep parameters. Addressing sleep disturbances in obese individuals may play a crucial role in improving metabolic health, enhancing quality of life, and preventing long-term cardiometabolic complications.

SUMMARY

Obese individuals demonstrated significantly impaired sleep quality on both subjective and objective assessments. The consistency between PSQI and Fitbit findings strengthens the reliability of these results and highlights the profound impact of obesity on sleep architecture and restorative sleep.

LIMITATIONS

Despite the strengths of the present study, certain limitations should be acknowledged while interpreting the findings. These limitations may affect the generalizability and causal interpretation of the results.

CONCLUSIONS

Obesity is significantly associated with marked deterioration in both subjective perception and objective measures of sleep quality in non-diabetic adults. Obese individuals exhibit prolonged sleep latency, reduced total sleep duration, impaired sleep efficiency, and altered sleep architecture, including decreased deep and REM sleep. These disturbances may contribute to the development and progression of metabolic and cardiovascular dysfunction. Routine screening for sleep disturbances in obese individuals should be incorporated into standard clinical practice to facilitate early identification and timely lifestyle, behavioural, and therapeutic interventions. Early management of sleep abnormalities may play a crucial role in improving overall health outcomes, enhancing quality of life, and preventing future cardiometabolic complications.

Further longitudinal studies are warranted to explore causal relationships and evaluate the impact of targeted sleep interventions in this population.

CONTRIBUTION OF AUTHORS

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