RESEARCH PAPER

Association of Sleep Duration and Sleep Disturbances with Cardiometabolic Parameters and PCOS Risk in Young Women

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ABSTRACT

Background:
Sleep duration and sleep quality are linked to blood pressure, body weight and other cardiometabolic outcomes. Sleep disturbances are also common in women with polycystic ovary syndrome (PCOS). Little is known about how sleep relates to blood pressure, BMI, physical activity and reproductive features together in apparently healthy young women.

Objective:
To assess the association of sleep duration and sleep disturbances with blood pressure, BMI and other lifestyle-related factors in young women. We also examined whether sleep is associated with an integrated PCOS risk profile.

Methods:
This cross-sectional study included 150 female students aged 18–25 years from Dasmesh Institute of Research & Dental Sciences and Dasmesh College of Physiotherapy, Faridkot. They were recruited by convenience sampling. Women with diagnosed PCOS, hypertension or cardiovascular disease, endocrine disorders, diagnosed sleep disorders or current hormonal therapy were excluded. Participants completed a structured questionnaire on sleep, physical activity, and menstrual and hormonal history. We measured height, weight, waist and hip circumference, and blood pressure. PCOS-related risk was estimated with an unvalidated eight-item composite score (BMI, menstrual irregularity, acne, hirsutism, sleep disturbance or short sleep, physical inactivity, waist–hip ratio and raised blood pressure). The score was classed as low, moderate or high risk and is meant for screening, not diagnosis. Data were analysed with descriptive statistics and the chi-square test, with significance set at $p \leq 0.05$.

Results:
Altered sleep duration or sleep disturbance was reported by 38% of participants. In the sample as a whole, 25% had a BMI ≥25, 55% had a waist–hip ratio >0.85, 19% had menstrual irregularity, 31% had moderate-to-severe acne and 24% had low physical activity. Only 6% had elevated blood pressure. Sleep status was significantly associated with low physical activity ($\chi^2 = 8.312$, $p = 0.004$), waist–hip ratio >0.85 ($\chi^2 = 3.894$, $p = 0.048$) and accommodation type (day scholar vs hosteller; $p = 0.001$). It was not significantly associated with BMI ≥25 ($p = 0.054$), menstrual irregularity, acne, hirsutism or elevated blood pressure. Sleep status was also significantly associated with the PCOS risk category ($\chi^2 = 41.198$, $p < 0.001$). Among women with altered sleep or sleep disturbance, 6 of 57 were in the low-risk category, compared with 59 of 93 among those without.

Conclusion:
Altered sleep duration or sleep disturbance was associated with low physical activity, higher waist–hip ratio and a higher PCOS risk score in young women. It was not significantly associated with BMI or blood pressure. Because of the cross-sectional design, these findings show associations rather than causation. They suggest that sleep assessment may help identify PCOS-related risk early in young women.

Keywords: sleep duration, sleep disturbance, blood pressure, body mass index, waist–hip ratio, PCOS risk, young women

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INTRODUCTION

Sleep is an essential biological process involved in the regulation of metabolic, endocrine, cardiovascular and behavioural functions. Alterations in sleep duration and sleep quality have increasingly been recognized as important lifestyle-related factors associated with adverse cardiometabolic outcomes. Epidemiological studies have reported associations between short sleep duration and increased body mass index (BMI), altered appetite-regulating hormones, hypertension and cardiovascular risk. Taheri et al. reported that short sleep duration was associated with reduced leptin, elevated ghrelin and increased BMI, suggesting a potential relationship between sleep and energy regulation.[1]

Sleep disturbances may also influence cardiovascular regulation through autonomic and metabolic pathways. Gangwisch et al. reported an association between short sleep duration and hypertension, with potential mechanisms involving increased sympathetic activity, prolonged elevation of blood pressure and altered neuroendocrine regulation.[2] Similarly, a study conducted among healthy young adults reported that short sleep duration was associated with elevated 24-hour blood pressure after adjustment for other factors.[3]

Sleep is also closely related to physical activity and other lifestyle behaviours. Young adults with poor sleep quality may demonstrate lower levels of physical activity, while sedentary behaviour and physical inactivity may also influence sleep patterns. In a large cross-sectional study of young adults, poor sleep quality and several sleep-related domains were associated with insufficient physical activity.[4] Another study among young adults found relationships between sleep quality, physical activity and anthropometric characteristics.[5]

Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting women of reproductive age and is characterized by a heterogeneous combination of reproductive, hyperandrogenic and metabolic abnormalities. The phenotype may include menstrual irregularity, clinical or biochemical hyperandrogenism and metabolic abnormalities. A population-based study by Azziz et al. demonstrated the presence of PCOS and its heterogeneous clinical features in an unselected population of reproductive-aged women.[6]

PCOS is also associated with metabolic abnormalities, including obesity, central adiposity and insulin resistance, which may contribute to increased long-term cardiometabolic risk. The relationship between PCOS and sleep has received increasing attention because sleep disturbances and sleep-disordered breathing have been reported in women with the syndrome. Vgontzas et al. reported a substantially higher frequency of sleep-disordered breathing and daytime sleepiness in women with PCOS compared with controls, with insulin resistance identified as an important factor associated with sleep-disordered breathing.[7]

Similarly, Fogel et al. reported a higher prevalence of obstructive sleep apnea in obese women with PCOS compared with age- and weight-matched controls, with apnea severity associated with waist–hip ratio and androgen concentrations.[8] These findings suggest that sleep-related abnormalities in women with PCOS may be related not only to body weight but also to the metabolic and endocrine characteristics of the syndrome.

Evidence from community-based populations has further demonstrated an association between PCOS and sleep disturbances. Moran et al. reported that sleep disturbances were almost twice as common in women with PCOS compared with women without PCOS,

although the association was influenced by BMI and depressive symptoms.[9] In an Australian national cohort, Mo et al. similarly reported that women with PCOS were more likely to experience difficulty sleeping and sleep-related symptoms even after adjustment for BMI, depressive symptoms and other factors.[10] Franik et al. also reported clinically significant insomnia and excessive daytime sleepiness among women with PCOS, supporting the importance of assessing sleep disturbances in this population.[11]

The relationship between sleep and PCOS-related characteristics has also been investigated in women without established PCOS. Lim et al. studied healthy women and found that those reporting less than 6 hours of sleep were more likely to report abnormal menstrual cycle length and had higher fasting insulin and greater odds of insulin resistance. Importantly, short sleep was not associated with the androgenic and ovarian morphological features used to define PCOS.[12] This finding is relevant to early risk assessment because sleep-related characteristics may be associated with selected metabolic or reproductive features without necessarily indicating established PCOS.

The relationship between sleep and body composition in women with PCOS has also been demonstrated in studies using objective sleep assessment. Oberg et al. reported shorter sleep time, poorer sleep efficiency and greater wakefulness after sleep onset in overweight or obese women with PCOS compared with controls.[13] Hachul et al. similarly reported poorer subjective sleep quality and alterations in sleep architecture among women with PCOS, with obesity influencing several sleep-related parameters.[14]

Sleep may therefore represent an important component of a broader lifestyle profile associated with PCOS-related metabolic and reproductive risk. However, most previous research has focused either on women with established PCOS or on individual relationships between sleep and isolated cardiometabolic outcomes. There is comparatively less information regarding the combined assessment of sleep status with anthropometric, blood pressure, physical activity and reproductive characteristics in apparently healthy young women.

Therefore, the present study was undertaken to assess the association of sleep duration and sleep-related disturbances with blood pressure, BMI and other lifestyle-related factors in young women and to examine whether sleep-related characteristics are associated with an integrated PCOS risk profile. The study may provide preliminary information regarding the role of sleep assessment in the early identification of PCOS-related risk among young women.

MATERIALS & METHODS

Study design and subjects

A cross-sectional observational study was carried out among female students of Dasmesh Institute of Research & Dental Sciences and Dasmesh College of Physiotherapy, Faridkot, between. Both day scholars and hostellers aged 18-25 years were approached. Subjects were recruited by convenience sampling. The sample size of 150 was calculated in G*Power, using values from earlier studies.

Students were eligible if they were female, aged 18-25 years, self-reported as healthy, and willing to take part. Subjects with a diagnosis of PCOS, known hypertension or cardiovascular disease, an endocrine disorder (such as thyroid dysfunction or diabetes), a diagnosed sleep disorder, or current hormonal therapy were excluded. Written informed consent was obtained from every subject.

Data collection

Each subject filled in a printed, structured questionnaire that covered demographic details, sleep and circadian preference, physical activity, and menstrual and hormonal history. Anthropometric measurements and blood pressure were recorded at the same visit.

Measures

For sleep, subjects were asked about usual bedtime, wake time, average sleep duration per night, and how often they woke during the night. Short sleep was defined as [<7 h]. Circadian preference was scored from five items rated on a 5-point scale, giving a total of 5-25, where a higher score meant a stronger morning preference.

Physical activity was self-reported by subjects as walking, moderate, and vigorous activity and converted to MET-min/week using 3.3, 4.0, and 8.0 METs respectively.

Height, weight, waist circumference, and hip circumference were measured, and BMI and waist-to-hip ratio were calculated. Systolic and diastolic blood pressure were taken with a digital monitor after five minutes of seated rest.

PCOS-related risk was estimated using a composite score built from eight items: BMI, menstrual irregularity, acne, hirsutism, sleep disturbance or short sleep, physical inactivity, waist-to-hip ratio, and raised blood pressure. Each item was scored [0/1] using cut-offs, giving a total of 0-8. Scores of 0-2, 3-5, and 6-8 were classed as low, moderate, and high risk. This score has not been validated and is meant to flag risk, not to diagnose PCOS.

Statistical Analysis

Analysis and interpretation of data was done according to the objectives using descriptive and inferential statistics. The level of significance chosen was at $p \leq 0.05$.

Distribution of Risk Factors for PCOS The distribution of each risk factor showed that:

- While 25% of participants were overweight or obese, the majority (75%) had a BMI below 25.
- Only 19% of subjects reported having irregular periods, indicating a low prevalence.
- Thirty-one percent of the sample had moderate to severe acne.
- A significant percentage (93%) showed a Ferriman-Gallwey score higher than 8, indicating a high hirsutism prevalence.
- 38% of subjects experienced sleep difficulties or altered sleep duration (>6 hours of disturbed sleep).
- Twenty-four percent of participants had little physical activity (MET <600).
- A waist-hip ratio >0.85, which indicates central obesity risk, was present in more than half (55%).
- Only 6% of subjects had elevated blood pressure.

Table No.1:- Exactly half of the participants were day scholars and the other half were hostellers, with each group making up 50% of the sample.

Variables	Opts	Percentage(%)	Frequency(f)
Day Scholar/hosteller	YES	50%	75
	NO	50%	75

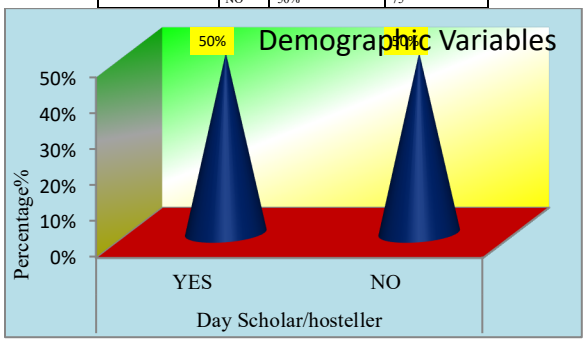


Fig.No. 1:- showing half of the participants were day scholars and the other half were hostellers, with each group making up 50% of the sample.

Table No.2:- Most participants (81%) did not have menstrual irregularity, while 19% reported irregular periods. This indicates that menstrual irregularity was uncommon in the group

Variables	Opts	Percentage(%)	Frequency(f)
Menstrual Irregularity	NO	81%	121
	YES	19%	29

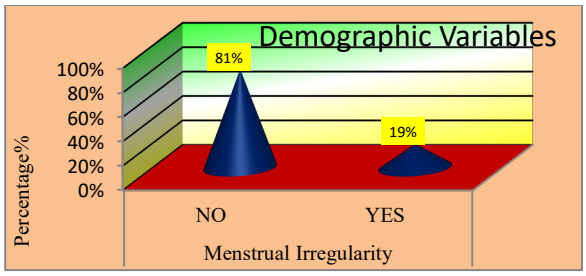


Fig.No. 2:- showing 81% participants did not have menstrual irregularity, while 19% reported irregular periods. This indicates that menstrual irregularity was uncommon in the group.

Table No.3 :- Most participants (93%) had a hirsutism score greater than 8, indicating a high prevalence of hirsutism in the group, while only 7% had a score of 8 or less.

Variables	Opts	Percentage(%)	Frequency(f)
Hirsutism score (FG>8)	NO	7%	11
	YES	93%	139

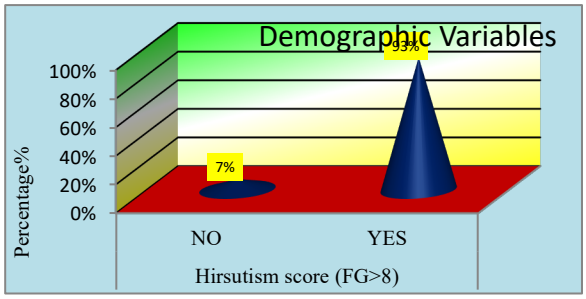


Fig.No. 3:- showing 93%participants had a hirsutism score greater than 8, indicating a high prevalence of hirsutism in the group, while only 7% had a score of 8 or less.

Table No.4:- Most participants (62%) did not report sleeping more than 6 hours or having disturbed sleep, while 38% did. This shows that sleep issues or extended sleep were present in over one-third of the group.

Variables	Opts	Percentage(%)	Frequency(f)
Sleep >6 Hrs or Disturbed	NO	62%	93
	YES	38%	57

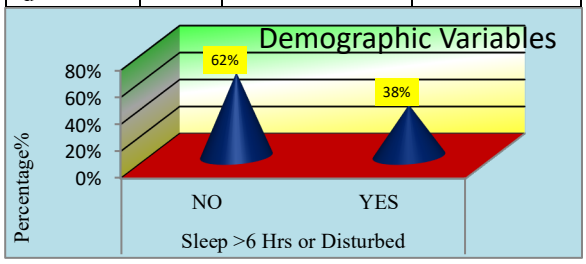


Fig.No. 4:- showing 62% participants did not report sleeping more than 6 hours or having disturbed sleep, while 38% did. This shows that sleep issues or extended sleep were present in over one-third of the group.

Table. No.5:-More than half of the participants (55%) had a waist-hip ratio greater than 0.85, while 45% did not. This indicates that a high waist-hip ratio was common in the group.

Variables	Opts	Percentage(%)	Frequency(f)
Waist-hip ratio >0.85	NO	45%	68
	YES	55%	82

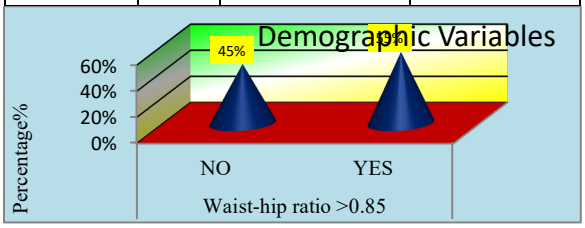


Fig.No. 5:-Showing more than half of the participants (55%) had a waist-hip ratio greater than 0.85, while 45% did not. This indicates that a high waist-hip ratio was common in the group.

Table No. 6:- Most participants (75%) had a BMI less than 25, while 25% had a BMI of 25 or above. This shows that the majority of respondents were in the normal or underweight BMI range.

Variables	Opts	Percentage(%)	Frequency(f)
BMI>=25	NO	75%	113
	YES	25%	37

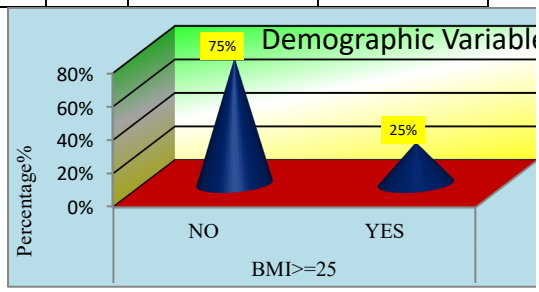


Fig.No. 6:- Showing 75% participants had a BMI less than 25, while 25% had a BMI of 25 or above. This shows that the majority of respondents were in the normal or underweight BMI range.

Variables	Opts	Percentage(%)	Frequency(f)
Acne (moderate-severe)	NO	69%	103
	YES	31%	47

Table No.7:- The majority of participants (69%) did not have moderate to severe acne, while 31% did. This means moderate to severe acne was present in about one-third of the group.

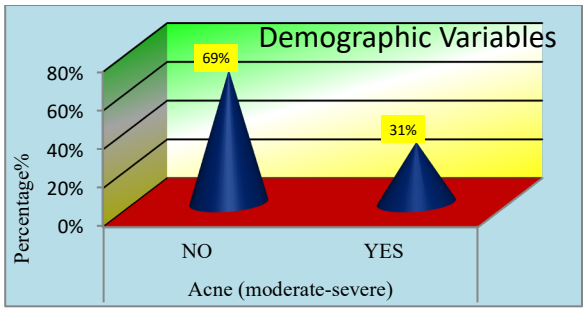


Fig.No. 7:- showing 69% participants did not have moderate to severe acne, while 31% did. This means moderate to severe acne was present in about one-third of the group

Table No.8:- Most participants (76%) did not have low physical activity levels, while 24% had a MET score below 600, indicating low physical activity. This suggests that low physical activity was found in about one-fourth of the group.

Variables	Opts	Percentage(%)	Frequency(f)
Low Physical Activity (MET<600)	NO	76%	114
	YES	24%	36

Fig. No.8:- showing 76% participants did not have low physical activity levels, while 24% had a MET score below 600, indicating low physical activity. This suggests that low physical activity was found in about one-fourth of the group.

Table No.9:- The vast majority of participants (94%) did not have elevated blood pressure, while only 6% did. This shows that elevated BP was rare in the group.

Variables	Opts	Percentage (%)	Frequency(f)
Elevated BP (SBP>130,DBP>85)	NO	94%	141
	YES	6%	9

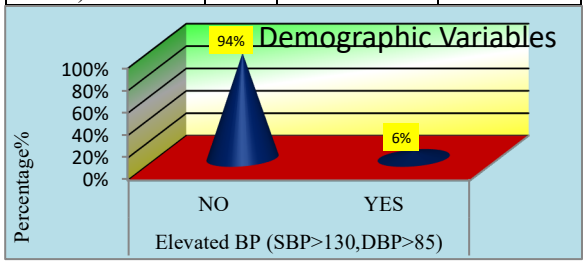


Fig.No. 9:- showing 94% participants did not have elevated blood pressure, while only 6% did. This shows that elevated BP was rare in the group.

Association Table

Table No.10:- Showing association of sleep duration and sleep disturbances with cardiometabolic and PCOS related parameters in young women

PCOS RISK		LEVELS		ASSOCIATION WITH SLEEP >6 HRS OR DISTURBED SCORES				
Variables	Opts	NO	YES	Chi Test	P Value	df	Table Value	Result
BMI>=25	NO	75	38	3.7116	0.0544	1	3.8411	Not Significant
	YES	18	19					
Menstrual Irregularity	NO	73	48	0.7400	0.3900	1	3.8411	Not Significant
	YES	20	9					
Acne (moderate-severe)	NO	66	37	0.6022	0.4368	1	3.8411	Not Significant
	YES	27	20					
Hirsutism score (FG>8)	NO	7	4	0.0113	0.9008	1	3.8411	Not Significant
	YES	86	53					
Sleep >6 Hrs or Disturbed	NO	93	0		N.A		N.A	
	YES	0	57					
Low Physical Activity (MET <600)	NO	78	36	8.3112	0.0044	1	3.8411	Significant
	YES	15	21					
Waist-hip ratio >0.85	NO	48	20	3.8944	0.0488	1	3.8411	Significant
	YES	45	37					
Elevated BP (SBP>130,DBP>85)	NO	89	52	1.2522	0.2633	1	3.8411	Not Significant
	YES	4	5					
Day Scholar/hosteller	YES	56	19	10.01	0.0015	1	3.841	Significant
	NO	37	38					
PCOS RISK SCORE CATEGORY	HIGH RISK	1	4	41.1198	<0.0001	2.0000	5.9991	Significant
	MODERATE RISK	33	47					
	LOW RISK	59	6					

Table No.11:- Showing association of cardiometabolic and PCOS related parameters with overall PCOS Risk categories in Young women

PCOS RISK		LEVELS			ASSOCIATION WITH PCOS RISK SCORES				
Variables	Opts	HIGH RISK	MODERATE RISK	LOW RISK	Chi Test	P Value	df	Table Value	Result
BMI >=25	NO	2	52	59	16.291	<0.001	2	5.991	Significant
	YES	3	28	6					
Menstrual Irregularity	NO	1	59	61	21.493	<0.001	2	5.991	Significant
	YES	4	21	4					
Acne (moderate-severe)	NO	0	47	56	23.852	<0.001	2	5.991	Significant
	YES	5	33	9					
Hirsutism score	NO	0	3	8	4.2	0.118	2	5.9	Not Sign
	YES	5	77	57					

(FG>8)					74			91	ificant
Sleep >6 Hrs or Disturbed	NO	1	33	59	41.198	<0.001	2	5.991	Significant
	YES	4	47	6					
Low Physical Activity (MET<600)	NO	0	54	60	28.479	<0.001	2	5.991	Significant
	YES	5	26	5					
Waist-hip ratio >0.85	NO	0	22	46	31.382	<0.001	2	5.991	Significant
	YES	5	58	19					
Elevated BP (SBP >130 ,DBP >85)	NO	5	74	62	0.859	0.651	2	5.991	Not Significant
	YES	0	6	3					
Day Scholar/hosteller	YES	3	29	43	13.035	0.001	2	5.991	Significant
	NO	2	51	22					
PCOS RISK SCORE CATEGORY	HIGH RISK	5	0	0					
	MODERATE RISK	0	80	0		N.A		N.A	
	LOW RISK	0	0	65					

Discussion :-

The aim of the study was to assess the association of sleep duration and sleep-related disturbances with blood pressure, BMI and other lifestyle-related factors among young women and to examine their relationship with an integrated PCOS risk profile. A total of 150 female participants aged 18–25 years were included. The study assessed BMI, waist–hip ratio, blood pressure, menstrual irregularity, acne, hirsutism, physical activity and sleep-related status as components of the lifestyle-based risk assessment.

In the present study, 38% of participants experienced sleep difficulties or altered sleep duration, while 62% did not. In addition, 25% of participants had BMI ≥25, 55% had waist–hip ratio >0.85, 19% reported menstrual irregularity, 31% had moderate-to-severe acne and 24% had low physical activity. Only 6% of participants had elevated blood pressure. These findings indicate that several anthropometric, behavioural and reproductive risk characteristics were present even within this apparently healthy young population.

The association between sleep status and low physical activity was statistically significant (χ^2=8.312, p=0.004). This finding is consistent with previous research among young adults. Štefan et al., in a large cross-sectional study of university students aged 18–24 years, reported that poor sleep quality and several sleep-related problems were associated with insufficient physical activity.[4] Their findings support the relationship between sleep and physical activity in young adults, although the direction of the association remains uncertain.

The present association may reflect the interaction between sleep and daily lifestyle behaviour. Young women experiencing disturbed sleep may have reduced daytime activity, fatigue or altered daily routines, while insufficient physical activity may also be associated with poorer sleep. Kakinami et al. reported associations between sedentary behaviour and poor sleep quality in young adults, although the relationship with physical activity itself was less consistent.[5] Therefore, the significant association identified in the present study should be considered as part of an interconnected lifestyle pattern rather than evidence of a direct causal relationship.

A statistically significant association was also observed between sleep status and waist–hip ratio >0.85 (χ^2=3.894, p=0.048). More than half of the participants had a waist–hip ratio above 0.85, whereas only 25% had BMI ≥25. This difference is important because BMI provides an overall measure of body size, whereas waist–hip ratio provides information regarding body-fat distribution. The present findings therefore suggest that central adiposity-related characteristics may be evident even when BMI does not meet the study-defined threshold.

Previous research also supports a relationship between sleep and anthropometric characteristics. Taheri et al. reported an association between short sleep duration,

altered appetite-regulating hormones and increased BMI.[1] In a large U.S. population study, short sleepers had higher BMI and greater waist circumference, with the relationship also observed among women and younger adults.[15] Kim et al. also reported a relationship between sleep-quality disturbance and BMI in young adults.[5] These findings provide support for the observed relationship between sleep status and central anthropometric characteristics in the present study.

However, the association between sleep status and BMI ≥25 did not reach statistical significance (χ^2=3.716, p=0.054). Although the p-value was close to 0.05, it did not meet the predefined significance criterion of p≤0.05. Therefore, the present study does not demonstrate a statistically significant association between the sleep variable and BMI category. This finding differs from some previous studies reporting associations between short sleep and increased BMI. Such differences may be related to differences in age, sample characteristics, sleep classification, BMI categorization and study design. It is also possible that waist–hip ratio captured an aspect of adiposity that was not detected by the categorical BMI analysis in the present sample.

Limitations

The study had several limitations. First, the cross-sectional design prevents determination of temporal or causal relationships between sleep and PCOS-related risk factors. Second, participants were recruited using convenience sampling from a single institutional setting, which may limit generalizability. Third, sleep duration and sleep disturbance were combined into a single categorical variable, limiting separate interpretation of sleep duration and sleep quality. Fourth, PCOS was not clinically or biochemically diagnosed in the study, and the integrated score should therefore be considered a risk-screening model rather than a diagnostic instrument. Finally, only a small proportion of participants had elevated blood pressure, which may have limited the statistical power for detecting an association with BP.

Future studies should include larger and multicentre populations and use longitudinal designs to establish temporal relationships between sleep characteristics and PCOS-related outcomes. Separate assessment of sleep duration and sleep quality using validated instruments, together with objective sleep measures, metabolic biomarkers, androgen profiles and established PCOS diagnostic criteria, would provide a more comprehensive understanding of the relationship.

CONCLUSION

The present study concluded that sleep-related status was significantly associated with low physical activity, increased waist–hip ratio and overall PCOS risk category among young women aged 18–25 years. However, no statistically significant association was observed between sleep status and BMI ≥25 or elevated blood pressure.

The findings suggest that assessment of sleep, together with physical activity, anthropometric and reproductive characteristics, may contribute to an integrated approach for the early identification of PCOS-related risk in young women. Further longitudinal studies are required to determine whether sleep-related changes precede the development of cardiometabolic and reproductive abnormalities.

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