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SLEEP, NUTRITION, AND PHYSICAL ACTIVITY AS PREDICTORS OF HEALTH OUTCOMES IN PCOS: A LIFESTYLE MEDICINE PERSPECTIVE

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is an endocrine-metabolic disorder with reproductive, metabolic, and psychological morbidity. Sleep quality, physical activity, and dietary adherence are each implicated in PCOS pathophysiology, but their joint predictive contributions remain poorly characterised, particularly in South Asian populations.

Objective: To determine the independent and joint predictive contributions of sleep quality, physical activity, and dietary adherence to PCOS health outcomes in Bangladeshi women.

Methods: A cross-sectional survey was conducted among 450 women (aged 18–45 years) with confirmed or Rotterdam-criteria-consistent PCOS, recruited from tertiary gynaecology/endocrinology clinics and PCOS patient communities in Dhaka, Bangladesh. Sleep quality, physical activity, and dietary adherence were assessed using the Pittsburgh Sleep Quality Index (PSQI), International Physical Activity Questionnaire Short Form (IPAQ-SF), and PREDIMED-14 Screener; psychological outcomes were assessed with the PHQ-9 and GAD-7. Data were analysed by hierarchical linear and binary logistic regression in IBM SPSS Version 27.0.

Results: Poor sleep quality (PSQI > 5) was present in 45.1% of participants; 64.7% showed low Mediterranean dietary adherence. All three lifestyle domains were significantly associated with every outcome in bivariate analysis (all $p < .01$), including quality of life ($\rho = -.59$ for PSQI). In adjusted models, global PSQI score was the dominant independent predictor of fatigue ($B = 0.47, p < .001$), depressive symptoms ($B = 0.74, p < .001$), anxiety symptoms ($B = 0.57, p < .001$), BMI ($B = 0.99, p < .001$), menstrual irregularity ($OR = 1.48, p < .001$), and composite symptom severity ($OR = 1.63, p < .001$). Physical activity and dietary adherence were substantially attenuated after adjustment; PREDIMED-14 adherence retained independent significance for fatigue ($B = -0.09, p = .023$), BMI ($B = -0.20, p = .005$), and menstrual irregularity ($OR = 0.89, p = .043$), while physical activity retained significance only for menstrual irregularity ($OR = 0.78, p = .041$).

Conclusion: Sleep quality is the dominant independent predictor of metabolic, reproductive, and psychological outcomes in Bangladeshi women with PCOS, supporting explicit prioritisation of sleep assessment and intervention within multicomponent lifestyle medicine approaches.

Keywords: Polycystic Ovary Syndrome; Sleep Quality; Physical Activity; Mediterranean Diet; Lifestyle Medicine; Bangladesh

1 INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder in women of reproductive age, affecting 8–13% of this population worldwide (Teede et al., 2023; Bozdag et al., 2016), and is defined by the revised Rotterdam criteria as at least two of oligo- or anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology (The Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group, 2004). Beyond anovulatory infertility, PCOS carries substantial cardiometabolic risk: insulin resistance affects 50–70% of affected women regardless of BMI (Steputo et al., 2013), and the syndrome is associated with markedly elevated odds of depression and anxiety, each exceeding 30% prevalence in clinical samples (Cooney et al., 2017; Barry et al., 2011). This convergent burden makes PCOS a priority target for non-pharmacological, lifestyle-based intervention.

Sleep, physical activity, and diet are each independently implicated in PCOS pathophysiology. Women with PCOS show markedly elevated rates of obstructive sleep apnoea independent of obesity (Tasali et al., 2006), and poor sleep quality has been linked mechanistically to HPA-axis dysregulation and worsened insulin resistance (Fernandez et al., 2018). Reduced physical activity independently contributes to insulin resistance and cardiometabolic risk, while structured exercise improves insulin sensitivity and menstrual frequency even without weight change (Harrison et al., 2011; Patten et al., 2020). Hypercaloric, pro-inflammatory dietary patterns worsen androgen excess and menstrual dysregulation, whereas Mediterranean dietary adherence improves insulin sensitivity and reduces systemic inflammation (Barrea et al., 2019; Szczuko et al., 2019). Despite this evidence base, the three domains are rarely examined jointly, precluding assessment of their relative and independent contributions within a single predictive model (Teede et al., 2023).

This gap is pronounced in Bangladesh, where the South Asian metabolic phenotype manifests adverse cardiometabolic risk at lower BMI thresholds than in Western populations (Wijeyaratne et al., 2002), and where rapid urbanisation, a dietary transition toward energy-dense processed foods, and high rates of sleep insufficiency converge to create a distinct lifestyle risk profile (Hasan & Winsor, 2023; Khan et al., 2024; Islam et al., 2021). Population-based lifestyle research applying validated instruments in Bangladeshi women with PCOS remains limited. This study therefore characterised sleep quality (PSQI), physical activity (IPAQ-SF), and dietary adherence (PREDIMED-14) as predictors of menstrual irregularity, symptom severity, fatigue, depressive and anxiety symptoms, and quality of life in a cross-sectional sample of Bangladeshi women with PCOS, and determined their independent and joint predictive contributions in a multivariable regression framework adjusting for sociodemographic and clinical covariates.

2 METHODS

2.1 Design, Setting, and Participants

A cross-sectional, self-administered questionnaire survey was conducted at tertiary-level gynaecology and endocrinology outpatient departments in Dhaka, Bangladesh, supplemented by recruitment through PCOS patient support communities on social media, to enhance socioeconomic and geographic diversity. No biological specimens or clinical measurements were accessed; all data were self-reported. Reporting follows the STROBE guideline for cross-sectional studies (von Elm et al., 2007). Eligible participants were women aged 18–45 years, resident in Bangladesh, with a physician-confirmed PCOS diagnosis or self-reported diagnosis consistent with at least two Rotterdam (2003) criteria, capable of providing informed consent and completing the questionnaire in Bengali or English. Exclusion criteria were current pregnancy or <6 months postpartum, peri- or post-menopausal status, systemic hormone replacement therapy for non-PCOS indications, and >20% missing items on any validated instrument.

The minimum sample size, calculated using Cochran's (1977) formula ($Z = 1.96$, $p = 0.50$, $E = 0.05$), was 385; this was inflated to 450 to accommodate an anticipated 15% non-response rate, and independently verified against the minimum events-per-variable criterion of ten for logistic regression (Peduzzi et al., 1996). Participants were recruited by purposive consecutive sampling at facility sites and purposive identification of online PCOS communities, with eligibility confirmed via embedded screening items; participation was voluntary and uncompensated. After written or electronic informed consent, the questionnaire was self-administered in Bengali or English, in person at facility sites or via a secure digital platform online; data collection ran from January to July 2026. Completed questionnaires were reviewed against the missingness threshold, entered into a password-protected SPSS database with 10% double-entry verification.

2.2 Instruments and Variables

The questionnaire comprised five internationally validated instruments and two purpose-designed sections, forward-backward translated into Bengali following established cross-cultural adaptation guidelines (Beaton et al., 2000) and pilot tested on 30 eligible participants before full-scale deployment. Sociodemographic and anthropometric items captured age, education, occupation, income, and self-reported height and weight (BMI); clinical history items captured diagnosis method, comorbidities, and menstrual pattern. Sleep quality was assessed using the 19-item Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), yielding a global score of 0–21 (>5 indicates clinically significant poor sleep). Physical activity was assessed using the seven-item IPAQ-SF (Craig et al., 2003), expressed as MET-minutes/week and classified as low (<600), moderate (600–2,999), or high ($\geq 3,000$) activity. Dietary adherence was assessed using the 14-item PREDIMED Screener (Martínez-González et al., 2012; score 0–14, with 0–6, 7–9, and 10–14 denoting low, moderate, and high Mediterranean adherence). PCOS-specific outcomes (ten items) captured menstrual regularity, hirsutism/acne/alopecia severity, fatigue (0–10 NRS), and quality of life. Depressive and anxiety symptoms were assessed using the PHQ-9 (Kroenke et al., 2001; 0–27, ≥ 10 clinically significant) and GAD-7 (Spitzer et al., 2006; 0–21, ≥ 10 clinically significant).

The three primary predictors were global PSQI score, total weekly MET-minutes, and PREDIMED-14 score (all continuous). Primary outcomes were menstrual irregularity, composite symptom severity, fatigue, PHQ-9, GAD-7, and BMI; quality of life was examined only in bivariate analysis owing to its ordinal structure. Covariates were age, education, occupation, residence, income, comorbidities, and current PCOS pharmacological treatment.

2.3 Statistical Analysis

Data were analysed in IBM SPSS Statistics Version 27.0. Continuous variables were screened for normality (Shapiro-Wilk) and summarised as mean (SD) or median (IQR); categorical variables as frequencies and percentages. Bivariate associations used Pearson or Spearman correlations, t-tests or Mann-Whitney U tests, and chi-square tests as appropriate. Hierarchical linear regression was applied to continuous outcomes, with sociodemographic and clinical covariates entered in Block 1 and the three lifestyle predictors entered jointly in Block 2; incremental variance (ΔR^2) indexed the lifestyle contribution. Binary logistic regression was applied to categorical outcomes, yielding odds ratios (OR) with 95% confidence intervals. Multicollinearity was assessed by variance inflation factor (threshold <5.0); significance was set at $p < .05$ (two-tailed). Missing data below 5% were handled by listwise deletion; multiple imputation by chained equations was pre-specified above this threshold (Sterne et al., 2009).

2.4 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Bookman Research & Training Institute (BRTI). Written informed consent was obtained from all participants; anonymity was maintained using alphanumeric codes, with no personally identifiable information retained. A pre-specified safeguarding protocol referred participants endorsing suicidal ideation on PHQ-9 item 9 to a designated clinical officer. Data were stored in password-protected encrypted files accessible only to named research team members.

3 RESULTS

3.1 Sample Characteristics

A total of 450 women with PCOS completed the survey (Figure 1). Household income was missing or undisclosed for 35 participants (7.8%); because income was a regression covariate, these were excluded by listwise deletion, yielding a complete-case analytic sample of $n = 415$ (92.2%) for the multivariable models (Table 2A, 2B, Figure 3); no other variable contributed further missingness. All other results, including the bivariate associations in §3.3 and Figure 2, are based on the full sample ($n = 450$). Mean age was 27.2 years (SD = 5.1); the largest educational categories were Bachelor's degree (22.9%) and higher secondary qualification (22.0%). Most participants resided in urban (50.7%) or suburban (27.1%) settings. Mean BMI was 24.7 kg/m² (SD = 4.7); applying Asian-specific cut-points, 35.6% were overweight, 26.4% obese, 28.0% normal weight, and 10.0% underweight, consistent with the lower adiposity-risk threshold reported in South Asian PCOS cohorts (Wijeyaratne et al., 2002). Full sociodemographic, clinical, and lifestyle distributions are presented in Table 1.

Table 1: Sociodemographic, Clinical, and Lifestyle Characteristics of the Study Sample (n = 450)

Characteristic	n	%
Age, years, mean (SD)	27.2 (5.1)	—
BMI (Asian cut-points), n (%)		
Underweight (<18.5)	45	(10.0)
Normal (18.5–22.9)	126	(28.0)
Overweight (23.0–27.4)	160	(35.6)
Obese (≥27.5)	119	(26.4)
Education, n (%)		
No formal education	14	(3.1)
Primary school	22	(4.9)
Secondary school	90	(20.0)
Higher secondary/Intermediate	99	(22.0)
Diploma/Vocational	54	(12.0)
Bachelor's degree	103	(22.9)
Postgraduate degree	45	(10.0)
Medical/professional degree	23	(5.1)
Occupation, n (%)		
Employed full-time	130	(28.9)
Homemaker	117	(26.0)
Student	79	(17.6)
Employed part-time	53	(11.8)
Self-employed/freelance	39	(8.7)
Unemployed	24	(5.3)
On medical/maternity leave	7	(1.6)
Retired	1	(0.2)
Marital status, n (%)		
Married/long-term relationship	238	(52.9)
Single/never married	189	(42.0)
Separated/divorced	20	(4.4)
Widowed	3	(0.7)
Residence, n (%)		
Urban	228	(50.7)
Suburban	122	(27.1)
Rural	100	(22.2)
Household income (BDT/month), n (%)		
Below 20,000	62	(13.8)
20,000–40,000	127	(28.2)
40,001–70,000	112	(24.9)

70,001–100,000	75	(16.7)
Above 100,000	39	(8.7)
Prefer not to disclose	24	(5.3)
Missing	11	(2.4)
Diagnosis source, n (%)		
Gynaecologist	215	(47.8)
Endocrinologist	73	(16.2)
GP/family doctor	64	(14.2)
Suspected/self-diagnosed	98	(21.8)
Age at diagnosis, years, mean (SD)	23.4 (5.6)	—
Family history of PCOS, n (%)		
Yes	157	(34.9)
No	207	(46.0)
Not certain	86	(19.1)
Comorbidities, n (%) ^a		
None	185	(41.1)
Insulin resistance	101	(22.4)
Depression (diagnosed)	57	(12.7)
Hypothyroidism	53	(11.8)
Anxiety (diagnosed)	50	(11.1)
Type 2 diabetes mellitus	31	(6.9)
Obstructive sleep apnoea	26	(5.8)
Lifestyle predictors		
PSQI global score, mean (SD)	5.9 (3.3)	—
PSQI >5 (poor sleep quality), n (%)	203	(45.1)
PSQI category: Good	169	(37.6)
PSQI category: Moderate disturbance	236	(52.4)
PSQI category: Severe disturbance	45	(10.0)
IPAQ-SF: Low/inactive, n (%)	131	(29.1)
IPAQ-SF: Moderate, n (%)	244	(54.2)
IPAQ-SF: High/active, n (%)	75	(16.7)
PREDIMED-14: Low adherence, n (%)	291	(64.7)
PREDIMED-14: Moderate adherence, n (%)	139	(30.9)
PREDIMED-14: High adherence, n (%)	20	(4.4)
Health outcomes		
Fatigue (NRS 0–10), mean (SD)	4.4 (2.5)	—
BMI, kg/m ² , mean (SD)	24.7 (4.7)	—
PHQ-9 total score, mean (SD)	5.7 (4.2)	—
PHQ-9 ≥10 (clinically significant), n (%)	81	(18.0)
GAD-7 total score, mean (SD)	5.0 (3.8)	—

GAD-7 ≥ 10 (clinically significant), n (%)	56	(12.4)
Menstrual regularity, n (%)		
Regular (26–35 days)	171	(38.0)
Slightly irregular	121	(26.9)
Moderately irregular	90	(20.0)
Severely irregular/absent	68	(15.1)

A Comorbidity percentages are not mutually exclusive (participants could report more than one condition); "None" reflects participants reporting no listed comorbidity. Asian-specific BMI cut-points applied throughout (Wijeyaratne et al., 2002). PSQI = Pittsburgh Sleep Quality Index; IPAQ-SF = International Physical Activity Questionnaire Short Form; PREDIMED-14 = Mediterranean Diet Adherence Screener; NRS = Numerical Rating Scale; PHQ-9 = Patient Health Questionnaire-9; GAD-7 = Generalized Anxiety Disorder Scale-7.

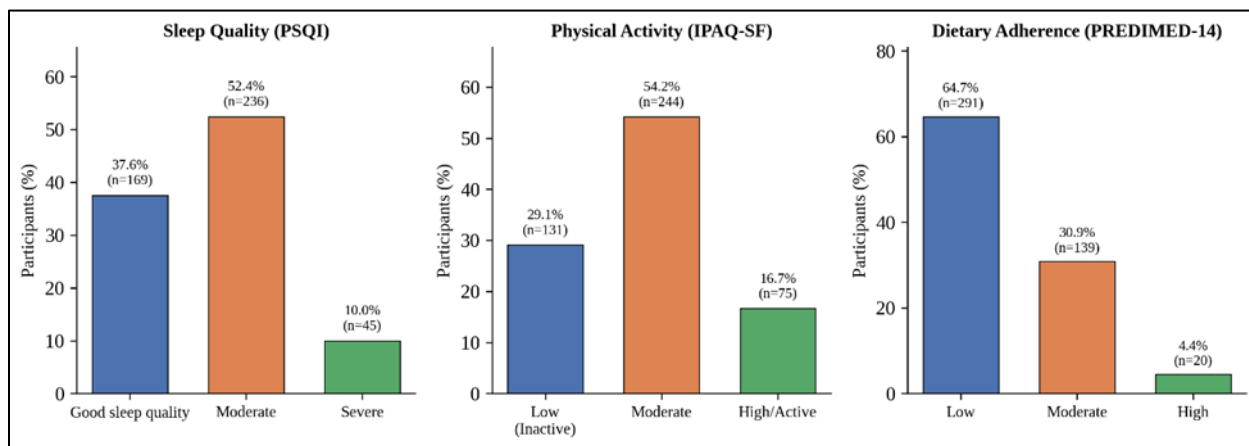


Figure 1: Participant Flow Diagram. Recruitment, Screening, and Inclusion of Participants (n = 450).

3.2 Distribution of Lifestyle Predictors

Mean global PSQI score was 5.9 (SD = 3.3); 45.1% of participants (n = 203) exceeded the clinical poor-sleep threshold of 5 (Buysse et al., 1989). Using the three-band ordinal classification applied in §3.3–3.4, 37.6% fell in the good-quality band, 52.4% in moderate disturbance, and 10.0% in severe disturbance (Table 1); the two schemes are not perfectly nested, as the 78 participants (17.3%) scoring exactly 5 are classed as moderate disturbance but not as poor sleepers under the strict >5 threshold. Median physical activity was 1,089.5 MET-min/week (M = 1,426.2, SD = 1,278.5): 29.1% were low active, 54.2% moderately active, and 16.7% highly active. Mean PREDIMED-14 score was 5.6 (SD = 2.3), indicating low overall dietary adherence; 64.7% scored in the low-adherence band, 30.9% moderate, and 4.4% high.

3.3 Bivariate Associations between Lifestyle Domains and Health Outcomes

All three lifestyle predictors were significantly associated with every outcome in unadjusted analysis (all $p < .01$). Sleep quality showed the strongest and most consistent associations: poorer global PSQI score correlated with fatigue ($r = .69$), composite symptom severity ($r = .68$), BMI ($r = .75$), PHQ-9 ($r = .60$), and GAD-7 ($r = .51$), and with menstrual irregularity ($\rho = .62$) and quality of life ($\rho = -.59$). Physical activity showed weaker inverse correlations (fatigue $r = -.27$, BMI $r = -.29$, symptom severity $r = -.24$, PHQ-9 $r = -.18$, GAD-7 $r = -.14$, menstrual irregularity $\rho = -.23$), as did PREDIMED-14 score (BMI $r = -.33$, symptom severity $r = -.32$, fatigue $r = -.29$, PHQ-9 $r = -.23$, GAD-7 $r = -.21$, menstrual irregularity $\rho = -.26$).

3.4 Multivariable Predictors of PCOS Health Outcomes

Hierarchical linear regression models entered sociodemographic and clinical covariates in Block 1 and the three lifestyle predictors jointly in Block 2 (VIF range 1.01–2.33, below the threshold of 5.0). Results are presented in Table 2.

Table 2A: Hierarchical Linear Regression — Continuous Outcomes

Predictor	Fatigue (NRS)	PHQ-9	GAD-7	BMI
Block 1 (covariates) R^2 , unadjusted	0.028	0.018	0.009	0.008
Block 1 (covariates) adj. R^2	0.013	0.004	−0.006	−0.007
Block 2 (+ lifestyle) R^2 , unadjusted	0.490	0.366	0.258	0.562
Block 2 (+ lifestyle) adj. R^2	0.479	0.352	0.241	0.552
ΔR^2 (lifestyle contribution)	0.462	0.348	0.249	0.554
Global PSQI score, B (p)	0.469 (<.001)	0.743 (<.001)	0.572 (<.001)	0.985 (<.001)
IPAQ-SF MET-min/wk ($\times 1000$), B (p)	−0.126 (.083)	0.035 (.802)	0.046 (.740)	−0.237 (.067)
PREDIMED-14 score, B (p)	−0.091 (.023)	−0.122 (.116)	−0.102 (.184)	−0.199 (.005)

Block 1 covariates: age, education level, urban residence, household income, presence of any comorbidity, current PCOS pharmacological treatment. Block 2 adds the three lifestyle predictors. ΔR^2 is calculated as the difference in unadjusted R^2 between Block 2 and Block 1 (the standard hierarchical-regression convention); it will not equal the difference between the adjusted R^2 rows, which are reported separately for reference. B = unstandardised regression coefficient. n = 415 (complete cases across all model variables; see §3.1).

Table 2B: Binary Logistic Regression — Categorical Outcomes

Predictor	Menstrual irregularity (mod.–severe), OR (p)	Top-tertile symptom severity, OR (p)
Global PSQI score	1.48 (<.001)	1.63 (<.001)
IPAQ-SF MET-min/wk ($\times 1000$)	0.78 (.041)	0.90 (.360)
PREDIMED-14 score	0.89 (.043)	0.95 (.322)

OR = odds ratio, adjusted for the same Block 1 covariates as Table 2A. Outcome 1: moderate-to-severe menstrual irregularity (binary). Outcome 2: top-tertile composite PCOS symptom severity. n = 415.

For fatigue, Block 1 covariates explained negligible variance (adjusted $R^2 = .013$); adding lifestyle predictors raised explained variance to 47.9% ($\Delta R^2 = .462$, $F(3, 405) = 122.44$, $p < .001$), with global PSQI score the dominant predictor ($B = 0.469$, 95% CI [0.411, 0.527], $p < .001$) and PREDIMED-14 score retaining a small independent association ($B = -0.091$, $p = .023$); physical activity did not reach significance. A parallel pattern held for PHQ-9 ($\Delta R^2 = .348$, $F(3, 405) = 74.09$, $p < .001$; PSQI $B = 0.743$, 95% CI [0.630, 0.856], $p < .001$) and GAD-7 ($\Delta R^2 = .249$, $F(3, 405) = 45.27$, $p < .001$; PSQI $B = 0.572$, 95% CI [0.460, 0.683], $p < .001$), with PSQI score the sole significant independent predictor for both.

The largest incremental contribution was for BMI, where Block 1 explained no meaningful variance but Block 2 raised adjusted R^2 to .552 ($\Delta R^2 = .554$, $F(3, 405) = 170.69$, $p < .001$); both PSQI score ($B = 0.985$, 95% CI [0.882, 1.088], $p < .001$) and PREDIMED-14 score ($B = -0.199$, $p = .005$) were independent predictors, while physical activity approached but did not reach significance.

Logistic models corroborated sleep centrality while showing a more consistent contribution from activity and diet: for moderate-to-severe menstrual irregularity, PSQI score independently predicted increased odds (OR = 1.48, $p < .001$), with physical activity (OR = 0.78, $p = .041$) and PREDIMED-14 score (OR = 0.89, $p = .043$) also independently associated with reduced odds. For top-tertile symptom severity, PSQI score again dominated (OR = 1.63, $p < .001$), while activity and diet did not retain independent significance.

4 DISCUSSION

4.1 Principal Findings

This study examined sleep quality, physical activity, and dietary adherence as joint predictors of metabolic, reproductive, and psychological outcomes in a large sample of Bangladeshi women with PCOS. All three domains were significantly associated with every outcome in unadjusted analysis, but after adjustment for covariates and for the other two domains, sleep quality (global PSQI score) emerged as the dominant independent predictor across all six outcomes and the sole significant predictor of depressive and anxiety symptoms specifically (Figure 3). Physical activity and dietary adherence, despite comparable bivariate associations (Figure 2), were substantially attenuated: activity retained significance only for menstrual irregularity, while dietary adherence retained it for fatigue, BMI, and menstrual irregularity. Sleep quality therefore appears to function not as one of three co-equal lifestyle determinants but as a central, possibly upstream, node through which the broader lifestyle risk profile operates, while dietary adherence retains a smaller, non-redundant contribution.

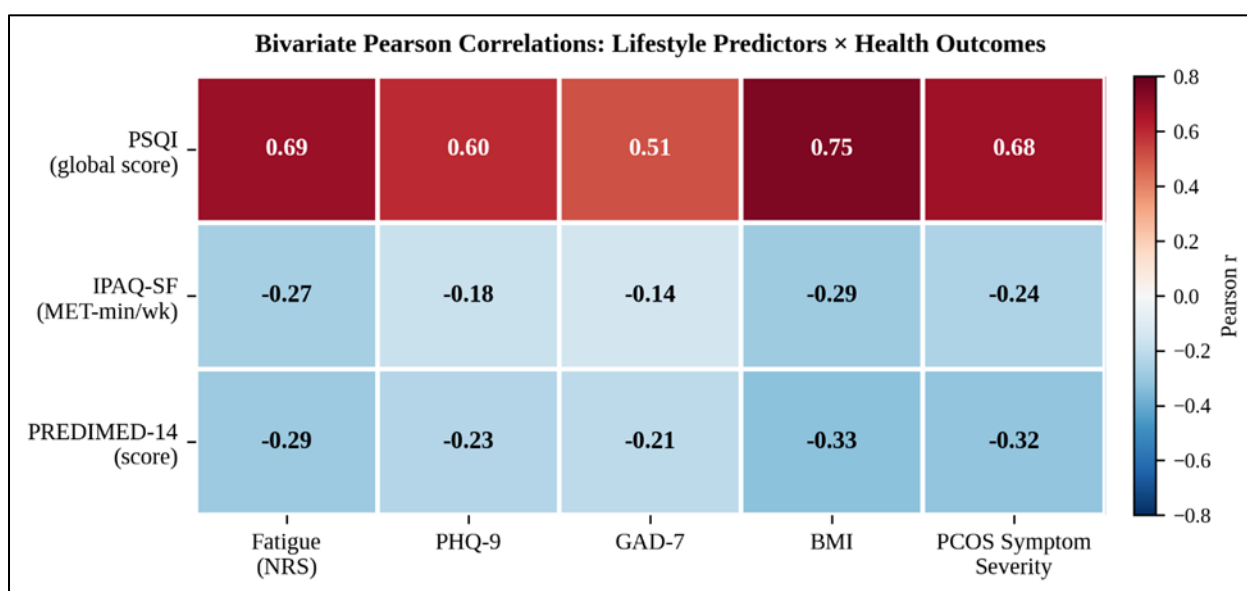


Figure 2: Bivariate Associations between Lifestyle Predictors and PCOS Health Outcomes

Heatmap of unadjusted Pearson r or Spearman ρ between PSQI, IPAQ-SF, and PREDIMED-14 scores and seven health outcomes; all associations significant at $p < .01$.

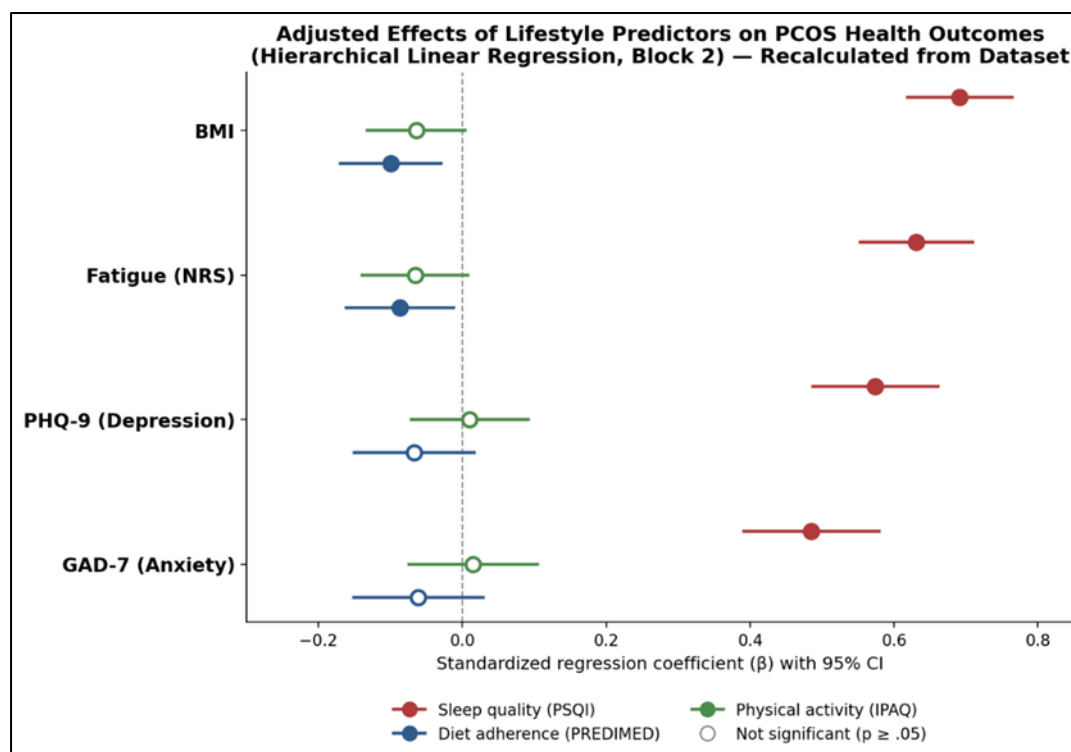


Figure 3: Independent Predictors of PCOS Health Outcomes in Multivariable Regression Models

Forest plot of standardised regression coefficients (β) with 95% CIs for PSQI, IPAQ-SF, and PREDIMED-14 scores as predictors of BMI, fatigue, PHQ-9, and GAD-7 (Block 2), adjusted for sociodemographic and clinical covariates. Filled markers denote significant associations ($p < .05$); $n = 415$.

4.2 Mechanistic Considerations

The magnitude of the PSQI–BMI association ($r = .75$) is the study's most striking finding. Three converging pathways plausibly explain it. Obstructive sleep apnoea, markedly elevated in PCOS independent of adiposity, independently drives insulin resistance and weight gain through intermittent hypoxia, sympathetic activation, and HPA-axis stimulation, in a bidirectional relationship with metabolic dysfunction (Helvaci et al., 2017; Kahal et al., 2018). Experimental sleep-restriction studies show that even short-term curtailment alters leptin and ghrelin, increasing hunger independent of baseline adiposity (Spiegel et al., 2004). The elevated depressive and anxiety burden linked to poor sleep here is consistent with a self-reinforcing cycle in which sleep disruption, mood disturbance, and HPA-axis dysregulation sustain one another in PCOS (Fernandez et al., 2018). These mechanisms support a model in which sleep disturbance functions as a physiological amplifier that intersects with, and potentially mediates, the downstream metabolic and psychological consequences of the syndrome.

The attenuation of physical activity and dietary effects after adjustment is more nuanced than uniform loss of relevance. IPAQ-SF-measured activity lost independent significance for all continuous outcomes despite robust unadjusted associations, retaining significance only for menstrual irregularity. PREDIMED-14 adherence remained independent for fatigue, BMI, and menstrual irregularity, but not for the psychological outcomes. This pattern may reflect genuine mediation, with activity and diet acting on outcomes largely through improvements in sleep and adiposity rather than independent pathways, consistent with reported gains in sleep architecture following exercise and Mediterranean-pattern interventions (Patten et al., 2020; Szczuko et al., 2019); statistical suppression from intercorrelation among the three domains and BMI, despite acceptable VIFs (maximum 2.33); or greater recall and social-desirability bias in self-reported activity than in the more straightforward PSQI items. The retained independent associations between dietary adherence and both fatigue and BMI nonetheless indicate a measurable, non-redundant metabolic contribution, consistent with proposed gut-microbiota-mediated and pro-inflammatory pathways linking diet to PCOS pathophysiology (Tremellen & Pearce, 2012).

4.3 Bangladeshi Context and Practice Implications

The prevalence of poor sleep quality (45.1%) and low dietary adherence (64.7%) here exceeds comparable Western PCOS estimates, plausibly reflecting rapid urbanisation, sedentary occupational structures, and a dietary transition toward energy-dense foods in urban Bangladesh. The psychological burden (18.0% depression, 12.4% anxiety) is broadly consistent with, though somewhat lower than, other nationwide Bangladeshi PCOS samples (Hasan et al., 2022),

possibly reflecting this study's dual facility- and community-based recruitment. Combined with the lower BMI threshold for adverse metabolic phenotypes in South Asian women (Wijeyaratne et al., 2002), these findings show lifestyle-based risk to be highly prevalent and metabolically consequential at a comparatively early stage of adiposity accrual. Current guidance recommends concurrent attention to diet, activity, and sleep in PCOS management (Teede et al., 2023); our results suggest sleep assessment and intervention deserve a co-primary rather than adjunctive role in multicomponent lifestyle medicine programmes, without diminishing the established value of activity and dietary modification supported by extensive interventional evidence (Moran et al., 2020).

4.4 Strengths and Limitations

Strengths include dual facility- and community-based recruitment, five internationally validated and culturally adapted instruments, an a priori sample size verified against the events-per-variable criterion (Peduzzi et al., 1996), and joint modelling of all three lifestyle domains. Limitations include the cross-sectional design, which precludes causal inference for relationships most plausibly bidirectional; reliance on self-reported exposures and outcomes, raising recall, social-desirability, and common-method-variance concerns (Podsakoff et al., 2003); PCOS diagnosis without biochemical or ultrasonographic verification for a subset of participants; a purposive, non-probability sampling strategy limiting generalisability beyond tertiary care and online PCOS communities; and the substantial PSQI–BMI correlation, which limits how cleanly independent contributions can be separated despite acceptable VIFs. Residual confounding by unmeasured factors, including objectively measured adiposity and polysomnographically confirmed OSA status, cannot be excluded. Longitudinal cohorts and mediation analyses using objective sleep and activity measures are needed to clarify causal ordering; given the magnitude of the sleep–metabolic association identified here, randomised trials of sleep-focused intervention, alone and combined with standard diet and exercise components, represent a logical next step, particularly in South Asian populations where early-onset metabolic risk and high background sleep disturbance converge.

5 CONCLUSION

In this sample of Bangladeshi women with PCOS, sleep quality was the dominant independent predictor of metabolic, reproductive, and psychological outcomes, exceeding the adjusted contribution of physical activity and dietary adherence despite similar unadjusted associations across all three domains. Sleep quality therefore deserves explicit priority, not adjunctive treatment, in multicomponent PCOS lifestyle medicine, and stands out as a high-yield, underused target for future interventional research.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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