Original Article

# Effect of Strengthening Exercises on Sleep Quality among Females Suffering from Polycystic Ovarian Syndrome: A Randomized Controlled Trial

*Shafiya Bashir, Kanu Goyal, Manu Goyal, Hina Vaish*[1]

Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Ambala, Haryana, [1]Department of Physiotherapy, School of Health Sciences, CSJM University, Kanpur, Uttar Pradesh, India

ABSTRACT

**Background:** Sleep problems also occur in women with polycystic ovarian syndrome (PCOS) of normal weight. Furthermore, PCOS and sleep disturbances are linked with worsening of cardiometabolic health in the long term. **Objective:** The study aimed to determine the effect of strengthening exercises on sleep quality among females suffering from PCOS. **Materials and Methods:** Twenty-four female participants aged 20–45 years suffering from PCOS from at least 1 year with body mass index of 18.5–29.9 kg/m$^2$ and Pittsburgh Sleep Quality Index (PSQI) score ≥5 were randomized into experimental ($n$ = 12) and control ($n$ = 12) groups; allocation (1:1). The participants were blinded. Experimental group received strengthening exercises thrice per week for 4 weeks, and no intervention was given in control group. Sleep quality was assessed using PSQI. **Results:** The Wilcoxon signed-rank test showed significant improvements ($P < 0.05$) in sleep quality, sleep latency, sleep efficiency, sleep disturbances, and global score with strengthening exercises. Mann–Whitney $U$-test revealed significant improvements ($P < 0.05$) in use of medication ($P = 0.016$) and global score ($P = 0.045$). **Conclusion:** Four weeks of strengthening exercises has significant benefits in improving the sleep quality among females with PCOS.

**Keywords:** *Pittsburgh sleep quality index, polycystic ovarian syndrome, sleep quality, strengthening exercises*

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## Introduction

Polycystic ovarian syndrome (PCOS) is an endocrine disorder affecting the reproductive, metabolic, and psychological health of females.[1] Three sets of diagnostic criteria namely the National Institutes of Health (NIH) Standards 1990, Rotterdam Criteria 2003, and Androgen Excess Society (AES) Guidelines 2006 define the PCOS.[2] PCOS is marked by irregular monthly periods, high androgen levels, and the presence of miniature cysts in the ovary on one or both sides. The global prevalence of PCOS is estimated between 4% and 20%.[2] The pooled prevalence of PCOS is close to 10% using Rotterdam's criteria and AES criteria, while it is 5.8% using NIH criteria among Indian women.[3]

The most common cause of female infertility worldwide is PCOS.[4] Sleep problems also occur in women with PCOS of normal weight; both PCOS and sleep disturbances are linked with worsening of cardiometabolic health in the long term and augmented risk of type 2 diabetes.[1] Obstructive sleep apnea (OSA) is common among women with PCOS, considerably higher than in other females of similar age and body mass index (BMI).[5] Sleep disturbances, especially difficulty falling asleep and difficulty maintaining sleep, are more common in women with PCOS compared to those without PCOS.[6] PCOS is associated with excessive daytime sleepiness often in the absence of OSA.[7] Sleep disruptions have ramifications for daytime mood, cognition, and psychomotor functioning, which

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*Address for correspondence:* Dr. Hina Vaish, Department of Physiotherapy, School of Health Sciences, CSJM University, Kanpur, Uttar Pradesh, India.
E-mail: hina22vaish@gmail.com



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has an immediate impact on well-being and daily activities and can affect performance in jobs.[8,9]

Sleep and exercise exert significant positive effects on one another.[10] Authors from a systematic review reported that self-reported sleep quality, daytime sleepiness and insomnia severity could be improved with exercise training.[11] Aerobic and resistance exercise training has shown to increase maximum oxygen consumption ($VO_{2\ max}$), reduce body weight, and waist circumference among females with PCOS.[12]

Strength training has shown to be effective in improving the sleep quality in various populations.[13,14] However, there is a dearth of literature to assess the effect of strengthening exercises on sleep quality among females with PCOS. Thus, we aimed to study the effect of strengthening exercises on sleep quality in females suffering from PCOS. We proposed the null hypothesis that strength training will have no significant difference between groups on sleep quality among females suffering from PCOS.

## Materials and Methods

This randomized controlled trial was approved by the Institutional Ethical Committee of the institute and was conducted in accordance with the guidelines of the Indian Council of Medical Research (2017), National Ethical Guidelines for biomedical and health research including human participants, and the ethical principles for medical research involving human participants listed in the Declaration of Helsinki (revised 2013).

The sample size was estimated by G*Power software, version 3.1.9.2, based on the effect size from a previous study.[15] The parameters included: assuming tests with *t* family distribution, means: difference between two independent means with effect size of 1.9,[16] a type I error of 0.05, a power equal to 0.80. The minimum sample size required was 24 (12 in each group).

A total of 24 females suffering from PCOS aged between 20 and 45 years with sleep disturbances score ≥5 on the Pittsburgh Sleep Quality Index (PSQI) were randomized by computer-generated randomization into experimental ($n$ = 12) and control ($n$ = 12) groups using sequentially numbered, opaque, sealed envelope allocation (1:1) method. The participants were blinded. PSQI was used to assess the participant's sleep quality. The randomization and allocation were performed by other members who were not part of the study.

The participants were recruited from the outpatient department (OPD) of a deemed university running medical college and physiotherapy OPD in Ambala, Haryana. The study was conducted in the duration from August 2021 to June 2022. The participants were enrolled by the primary researcher.

Females with BMI <18.5 kg/m$^2$ or >29.9 kg/m$^2$, with prescription of sleep medications, diabetes mellitus, history of COVID-19, pregnant females, and lactating mothers or involved in any leisure or athletic activities were excluded from the study.

The experimental group received strengthening exercises at a frequency of three times a week (1 set in 1$^{st}$ week, 2 sets in 2$^{nd}$ week, 3 sets in 3$^{rd}$ week, and 3 sets in 4$^{th}$ week) for 4 weeks. The exercises performed by participants were 10–15 repetitions of modified push-ups, squats, side lunges, bridging, calf raise, chair sit-ups, lateral raise, side bends, thoracic cat, and camel, with a rest period after every set. Spot marching was introduced as warm-up exercises and stretching exercises of large muscle groups as cool-down exercises.

The control group (CG) did not perform any strengthening exercises except for spot marching and stretching exercises.

Both the groups continued the use of medications for PCOS.

### Statistical analysis

Data were analyzed using Statistical Package for Social Science (SPSS, IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Shapiro–Wilk test of normality was used as the sample size was <50. $P < 0.05$ was considered statistically significant. All variables were analyzed at baseline and after 4 weeks of postintervention period. Demographic characteristics were represented in mean, mean of standard error, and range. Within-group analysis was performed using Wilcoxon Signed-rank test and Mann–Whitney *U*-test was used for between-group analysis.

## Results

All the exercise sessions were supervised, and there were no dropouts. The consort flow diagram for the trial is shown in Figure 1. The demographic characteristics of the participants are shown in Table 1. There was no significant difference between the groups at the baseline, indicating that the sample was homogeneous. Within-group analysis for sleep quality ($P$ = 0.002), sleep latency ($P$ = 0.034), sleep efficiency ($P$ = 0.041), sleep disturbance ($P$ = 0.014), and global score ($P$ = 0.003) showed statistically significant improvement with strengthening exercise [Table 2]. Between-group analysis also showed statistically significant result in improving the use of medications ($P$ = 0.016) and global score ($P$ = 0.045) with 4 weeks of strengthening exercise [Table 3].

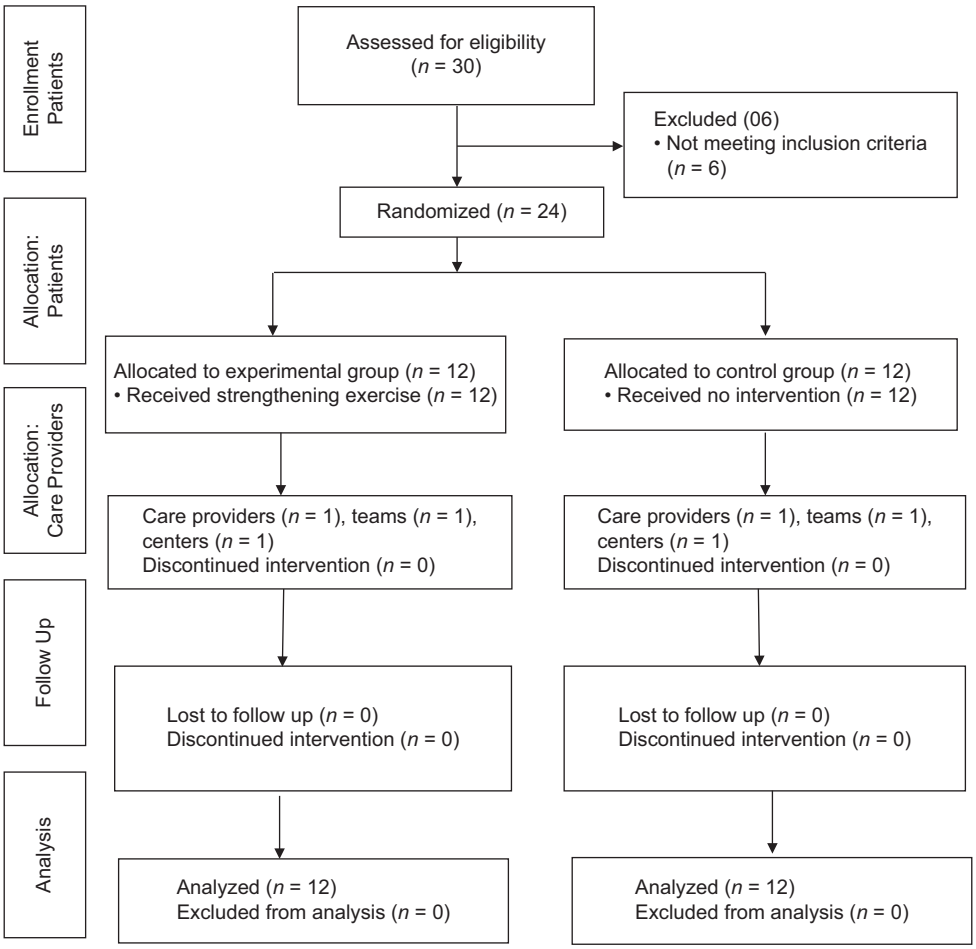


**Figure 1:** CONSORT flow diagram

**Table 1: Demographic characteristics of the participants**

| Demographic characteristics | Group 1 (experimental group) | | | Group 2 (control group) | | |
|---|---|---|---|---|---|---|
| | Mean±SD | Mean of SE | Range | Mean±SD | Mean of SE | Range |
| Age (years) | 23.64±3.171 | 23.64 (0.956) | 20–30 | 23.67±3.025 | 23.67 (0.873) | 20–29 |
| Weight (kg) | 56.81±7.45 | 56.81 (2.24) | 45–67 | 63.62±9.344 | 63.62 (2.69) | 49.5–82 |
| Height (m) | 1.56±0.058 | 1.56 (0.017) | 1.5–1.67 | 1.58±0.070 | 1.58 (0.020) | 1.49–1.7 |
| BMI (kg/m$^2$) | 23.66±2.95 | 23.66 (0.891) | 18.4–28.5 | 25.19±2.573 | 25.19 (0.742) | 21.7–29.2 |
| Waist circumference (cm) | 78.58±10.56 | 78.58 (3.186) | 58.8–91 | 86.36±9.324 | 86.36 (2.69) | 71.1–106.8 |
| Hip circumference (cm) | 93.9±10.31 | 93.93 (3.108) | 68–104.1 | 99.95±13.28 | 99.95 (3.83) | 86.3–137.1 |
| Waist-to-hip ratio | 0.834±0.066 | 0.834 (0.019) | 0.7–0.9 | 0.86±0.052 | 0.86 (0.015) | 0.77–0.94 |

SD: Standard deviation, SE: Standard error, BMI: Body mass index

## Discussion

The present study used the PSQI questionnaire to assess subjective sleep quality and showed a significant improvement after 4 weeks of strength training among females with PCOS. The average global index score of PSQI at baseline was around 12.92 in exercise group and 12.67 in CG with no significant difference between the groups indicating that all our participants had moderate-to-severe degree of poor sleep quality.[17]

Exercise training exerts a positive influence on sleep quality among women with PCOS. However, most of the previous trials are based on aerobic exercise interventions.[17] Tseng *et al*. reported that three 50-min aerobic exercise sessions per week over a 12-week period showed significant improvements in the global score ($P = 0.003$) on all subscales of PSQI ($P < 0.05$).[18]

The strength training intervention applied in the present study yielded several clinically important adaptations that may be associated with better management of the sleep disturbance in women with PCOS. Sleep quality, sleep latency, sleep efficiency, sleep disturbance, and global score significantly improved with strengthening

**Table 2: Within-group analysis of PQSI sleep subscores and global scores**

| Variable | Group 1 (experimental) | Group 2 (control) |
|---|---|---|
| Sleep quality baseline | 2.17 (1.64–2.70) | 2.08 (1.58–2.59) |
| Sleep quality postintervention | 1.25 (0.86–1.64) | 1.83 (1.38–2.29) |
| Mean difference 95% CI | 0.917 (0.58–1.24) | 0.25 (−0.145–0.645) |
| *P* | 0.002* | 0.180 |
| Sleep latency baseline | 2.17 (1.71–2.62) | 2.33 (1.92–2.75) |
| Sleep latency postintervention | 1.67 (1.25–2.08) | 2.17 (1.80–2.53) |
| Mean difference 95% CI | 0.50 (0.072–0.92) | 0.167 (−0.081–0.414) |
| *P* | 0.034* | 0.157 |
| Sleep duration baseline | 1.75 (1.27–2.23) | 1.42 (0.84–1.99) |
| Sleep duration postintervention | 1.505 (0.99–2.01) | 1.42 (0.84–1.99) |
| Mean difference 95% CI | 0.250 (−0.037–0.573) | |
| *P* | 0.083 | 1.000 |
| Sleep efficiency baseline | 1.92 (1.28–2.25) | 1.42 (0.73–2.11) |
| Sleep efficiency postintervention | 1.17 (1.16–0.51) | 1.42 (0.73–2.11) |
| Mean difference 95% CI | 0.750 (0.080–1.420) | |
| *P* | 0.041* | 1.000 |
| Sleep disturbances baseline | 1.83 (1.47–2.20) | 1.67 (1.17–2.16) |
| Sleep disturbances postintervention | 1.33 (0.92–1.75) | 1.67 (1.17–2.16) |
| Mean difference 95% CI | 0.50 (0.168–0.832) | |
| *P* | 0.014* | 1.000 |
| Use of medication baseline | 1.25 (0.77–1.73) | 2.0 (1.46–2.54) |
| Use of medications postintervention | 1.0 (0.46–1.54) | 2.0 (1.46–2.54) |
| Mean difference 95% CI | 0.250 (−0.037–0.537) | |
| *P* | 0.083 | 1.00 |
| Daytime dysfunction baseline | 1.83 (1.38–2.29) | 1.67 (1.10–2.23) |
| Daytime dysfunction postintervention | 1.58 (1.01–2.16) | 1.67 (1.10–2.23) |
| Mean difference 95% CI | 0.250 (−0.037–0.537) | |
| *P* | 0.083 | 1.000 |
| Global score baseline | 12.92 (10.64–15.19) | 12.67 (11.39–13.95) |
| Global score postintervention | 9.50 (7.16–11.84) | 12.25 (11.10–13.40) |
| Mean difference 95% CI | 3.41 (1.87–4.96) | 0.417 (−0.008–0.841) |
| *P* | 0.003* | 0.059 |

**P*<0.05 is statistically significant. CI: Confidence interval, PSQI: Pittsburgh sleep quality index

**Table 3: Between-group analysis of PQSI sleep subscores and global scores**

| Variable | Mean difference 95% CI | *P* |
|---|---|---|
| Sleep quality baseline | 0.083 (−0.606–0.773) | 0.78 |
| Sleep quality postintervention | −0.583 (−1.152–−0.015) | 0.058 |
| Sleep latency baseline | −0.167 (−0.747–0.414) | 0.567 |
| Sleep latency postintervention | −0.50 (−1.02–0.021) | 0.058 |
| Sleep duration baseline | 0.33 (−0.370–1.036) | 0.294 |
| Sleep duration postintervention | 0.083 (−0.637–0.803) | 0.853 |
| Sleep efficiency baseline | 0.50 (−0.381–1.381) | 0.255 |
| Sleep efficiency postintervention | −0.25 (−1.14–0.645) | 0.568 |
| Sleep disturbances baseline | 0.16 (−0.414–0.747) | 0.445 |
| Sleep disturbances postintervention | −0.33 (−0.941–0.274) | 0.227 |
| Use of medications baseline | −0.75 (−1.43–−0.06) | 0.050 |
| Use of medications postintervention | −1.00 (−1.72–−0.27) | 0.016* |
| Daytime dysfunction baseline | 0.16 (−0.51–0.85) | 0.664 |
| Daytime dysfunction postintervention | −0.08 (−0.84–0.67) | 0.783 |
| Global score baseline | 0.25 (−2.20–2.70) | 0.467 |
| Global score postintervention | −2.75 (−5.20–−0.29) | 0.045* |

**P*<0.05 is statistically significant. CI: Confidence interval, PSQI: Pittsburgh sleep quality index

exercise in within-group analysis. Between-group analysis also showed statistically significant result in improving use of medications and global score.

The probable reason for more improvements in within-group analysis could be the attendance at supervised training sessions in the present study was high. All the participants attended all exercise sessions. High attendance rates to supervised training have been reported in previous trials of aerobic training in PCOS.[19] Only two variables significantly improved between-group analysis indicating longer protocols are needed for more effects.

Even with aerobic training protocols, effects were significantly observed after 3 months of the intervention.[18]

The greater effect seen in our study in majority of subscores of PSQI in within-group analysis and global scores in both within and between-group analysis may be a result of the participants having moderate-to-severe degrees of poor sleep quality. In addition to the global PSQI score, both the sleep latency and sleep efficiency subscore of the PSQI significantly improved in our study. The PSQI sleep latency sub scores reflects sleep latency and the frequency of being unable to fall asleep in 30 min.[17] Hence, it is proposed that along with the reduction in the time taken to fall asleep, the frequency of experiencing sleep-related complaints declined in the present study.

Participants in the present study underwent strengthening exercise in the form of closed-chain exercises. The pineal gland secrets melatonin which plays the central role in coordination of circadian rhythm and system.[20] The circadian system consists of a central biological master clock and peripherally located biological clocks. The peripheral clock can work independently but is synchronized by the master clock. Master clock responds to external cues such as exercise, nutrient intake, and light-dark cycle.[21]

In recent years, it has been observed that a reduction in melatonin levels of follicular fluid exists in individuals with PCOS.[22] Thus, when participants perform strengthening exercises, the peripheral clock situated in skeletal muscles gets stimulated and secretes melatonin. Hence, sleep was affected in the present study with the strength training intervention.

Furthermore, authors from previous reports propose that resistance training could potentially improve sleep by improving symptoms of depression or anxiety, alterations in energy expenditure, effect on body temperature, or relief of musculoskeletal pain.[13]

The study had few limitations: The protocols were of 4 weeks with no follow-up. The PSQI questionnaire was self-reported; responses may vary depending on the participants' mood and attention and might not be true, such biases may affect the result.

### Clinical implications

In the last decade, there has been an increase in number of women suffering from PCOS globally. The inference from the present study is that exercise is associated with improved sleep quality, including increased total sleep time, decreased sleep start latency, and fewer awakenings. As a result, exercise has been advised as a useful method of avoiding and treating sleep disorders among women with PCOS. It can be speculated that such factors exist among women around the globe, and further longitudinal and larger multicenter experimental studies in women living with PCOS are needed to clarify these links and determine if these associations are amended by exercise modality or duration. Studies in future should also inspect a range of clinical cohorts using both objective and subjective measures to authorize the effectiveness of strengthening exercise on sleep disturbances and sleep quality and improve the currently narrow understanding of the physiological mechanism of this relationship.

## Conclusion

Four weeks of strengthening exercises has significant benefits in improving the sleep quality among females with PCOS, however, larger experimental trials are needed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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