Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 18 May 2026
Revised 22 June 2026
Accepted 10 July 2026

Natural Resources for Human Health 2026, Vol. 6 (6s): 708–720

KEYWORDS:
Polycystic ovary syndrome; electrical muscle stimulation; quality of life; SF-36; PCOSQ; psychosocial health; randomised controlled trial

Effect of Electrical Muscle Stimulation on Psychosocial Well-being and Quality of Life in Women with Polycystic Ovary Syndrome: A Randomized Controlled Trial

Divya Goyal[1], Vishwajeet Trivedi[1], Tabish Fahim[1]*

[1]Department of Physiotherapy, School of Health and Allied Sciences, GD Goenka University, Gurugram, Haryana, India.
*Corresponding Author: Dr. Tabish Fahim, Department of Physiotherapy, School of Health and Allied Sciences, GD Goenka University, Sohna Road, Gurugram, Haryana 122103, India.

ABSTRACT:

Background: Polycystic ovary syndrome (PCOS) carries a well-documented psychosocial toll that includes heightened rates of depression, anxiety, poor body image, and diminished quality of life (QoL). While lifestyle interventions are first-line recommendations, exercise adherence in this population remains critically low owing to fatigue, pain, and motivational barriers. Electrical muscle stimulation (EMS) offers an exercise-mimetic alternative, yet its influence on the psychosocial dimensions of PCOS has not previously been examined in a controlled trial.

Objective: To evaluate whether a 12-week supervised whole-body EMS programme improves health-related QoL (HRQoL), assessed by both generic (SF-36) and disease-specific (PCOSQ) instruments, relative to standard medical care alone.

Methods: Forty-two overweight/obese women (BMI > 24 kg/m²) aged 18–35 years with Rotterdam-confirmed PCOS were randomly allocated (1:1) to EMS (n = 21; 36 sessions, 3×/week, 12 weeks) or a control arm receiving standard care plus patient education (n = 21). The SF-36 and PCOSQ were administered at baseline, post-intervention, and 3-month follow-up. Between-group differences were analysed using the Mann–Whitney U test for change scores, analysis of covariance (ANCOVA) adjusted for baseline values, and linear mixed models. Effect sizes were reported as Cohen's d.

Results: All 42 participants completed the trial. The EMS group demonstrated statistically significant and clinically meaningful improvements across every SF-36 domain and both summary components (all $p < 0.001$). PCS increased from 40.30 ± 3.26 to 51.39 ± 3.13 at follow-up; MCS rose from 36.55 ± 4.96 to 51.12 ± 4.81. PCOSQ Total scores climbed from 3.34 ± 0.37 to 5.39 ± 0.51 at follow-up ($p < 0.001$). Between-group Cohen's d values ranged from 1.41 to 5.75, all exceeding the large-effect threshold. Gains persisted or continued at the 3-month follow-up. The control group remained essentially unchanged on all measures.

Conclusion: Structured EMS training yields substantial, durable enhancements in both generic and PCOS-specific QoL among overweight and obese women with PCOS. These findings position EMS as a viable adjunctive intervention capable of addressing the psychosocial burden of the syndrome within a biopsychosocial management framework.

Natural Resources for Human Health
eISSN: 2583-1194

1. INTRODUCTION

Polycystic ovary syndrome (PCOS) stands as the most frequently encountered endocrine disorder among women in their reproductive years, with global prevalence estimates spanning 8–13% under the National Institutes of Health criteria and climbing to 15–20% when the broader Rotterdam classification is applied (Bozdag et al., 2016; WHO, 2023). Characterised by a triad of hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology, the syndrome extends well beyond its reproductive manifestations to encompass metabolic, cardiovascular, and—crucially—psychological dimensions (Azziz et al., 2016; Teede et al., 2023).

Growing evidence positions the psychosocial burden of PCOS among the most incapacitating aspects of the condition. Pooled analyses have revealed that women with PCOS carry approximately 3.8-fold higher odds of depressive disorders and 5.6-fold higher odds of clinically significant anxiety compared with age-matched controls (Barry et al., 2011). Body image dissatisfaction—driven by weight gain, acne, and hirsutism—compounds this psychological distress and independently erodes self-esteem, social participation, and intimate relationships (Bazarganipour et al., 2013; Amiri et al., 2019). Together, these interconnected burdens substantially diminish both generic and disease-specific health-related quality of life (Barnard et al., 2007; Dokras et al., 2018).

Current international clinical practice guidelines (Teede et al., 2023) place lifestyle modification—particularly structured physical activity—at the foundation of PCOS management. Exercise has been shown to ameliorate insulin resistance, reduce adiposity, improve hormonal profiles, and confer psychological benefits in affected women (Patten et al., 2021; Benham et al., 2018). However, adherence to conventional exercise programmes remains disappointingly low in this population. Systematic barriers including chronic fatigue, musculoskeletal pain, negative body image in gym settings, low self-efficacy, and time constraints collectively impede engagement with recommended activity levels (Lim et al., 2019; Thomson et al., 2016; Umamaheswar & Bhatbolan, 2025).

Electrical muscle stimulation (EMS) has attracted growing research attention as an exercise-mimetic modality capable of sidestepping many of these adherence barriers. By delivering controlled electrical impulses to superficial electrodes placed over major muscle groups, EMS elicits involuntary muscle contractions that activate both type I and type II motor fibres (Filipovic et al., 2011). Systematic reviews and meta-analyses have confirmed that whole-body EMS produces measurable improvements in lean mass, body composition, and markers of metabolic health in sedentary and clinically complex populations (Kemmler et al., 2021). Preliminary evidence further suggests that EMS-induced muscle contractions stimulate myokine secretion—including irisin and interleukin-6—which may promote central neurotrophic factor production and autonomic rebalancing, thereby exerting mood-modulating effects (Pedersen & Febbraio, 2012; Severinsen & Pedersen, 2020; Wrann et al., 2013).

Despite this convergence of mechanistic plausibility and clinical need, no randomised controlled trial has yet examined whether EMS can improve the psychosocial and quality-of-life outcomes specifically associated with PCOS. This gap is particularly notable given that the 2023 international PCOS guidelines emphasise the importance of routine psychosocial screening and call for interventions targeting psychological well-being alongside metabolic health (Teede et al., 2023). The present trial was therefore designed to evaluate whether a structured 12-week whole-body EMS programme produces measurable, durable improvements in both generic (SF-36) and disease-specific (PCOSQ) quality of life in overweight and obese women with PCOS, compared with standard medical care alone.

2. MATERIALS AND METHODS

2.1 Study Design and Ethical Approvals

This investigation followed a two-arm, parallel-group, randomised controlled design and was carried out at the Exercise Tolerance Laboratory within the Department of Physiotherapy, GD Goenka University, Gurugram, Haryana, India. The protocol received prior approval from the Institutional Ethics Committee and was prospectively registered with the Clinical Trials Registry of India (CTRI). All procedures adhered to the ethical standards set forth in the Declaration of Helsinki (World Medical Association, 2013) and the Indian Council of Medical Research guidelines (ICMR, 2017). Each participant provided written informed consent before enrolment.

2.2 Participants

The study recruited women between 18 and 35 years of age who held a confirmed PCOS diagnosis based on the Rotterdam criteria (Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group, 2004) and had a body mass index exceeding 24 kg/m², consistent with the Asian-specific overweight threshold recommended by the WHO Expert Consultation (2004). Recruitment was conducted through collaborating gynaecology clinics in the Gurugram district. Key exclusion criteria encompassed secondary causes of hyperandrogenism, pregnancy or lactation, uncontrolled thyroid or adrenal disease, neuromuscular pathology, cardiac pacemaker implantation, active skin lesions at intended electrode sites, and concurrent participation in other structured exercise or investigational programmes.

2.3 Sample Size Determination

An a priori power analysis was performed using G*Power 3.1.9.7 (Faul et al., 2009). Drawing on a large anticipated effect size (f = 1.0) derived from prior exercise intervention studies in PCOS (Kirthika et al., 2019), with a two-tailed α of 0.05 and statistical power set at 0.80, the calculation yielded a minimum requirement of 17 participants per group. To account for potential attrition, 21 women were enrolled in each arm, yielding a total sample of 42.

2.4 Randomisation and Allocation Concealment

Participants were allocated in a 1:1 ratio to either the EMS intervention arm (Group A) or the standard-care control arm (Group B). Allocation sequences were generated and sealed in sequentially numbered, opaque envelopes by a researcher who had no involvement in recruitment or outcome assessment. Given the nature of the intervention, participant blinding was not feasible; however, the outcome assessor remained blinded to group assignment throughout the study.

2.5 Intervention Protocol

EMS Group (Group A): Participants attended 36 supervised sessions over 12 weeks (three per week), each administered by a qualified physiotherapist. An 8-channel electrical stimulator delivered Russian current (carrier frequency 2500 Hz, modulated at 50 Hz, 10-second on/off duty cycle) through surface electrodes positioned bilaterally over the quadriceps, hamstrings, gluteal muscles, and abdominal wall. Stimulation intensity was titrated to each participant's maximum tolerable level, targeting visible involuntary muscle contractions without pain. Session duration was 30 minutes of active stimulation, and each treatment included a structured warm-up and cool-down period.

Control Group (Group B): Participants continued to receive their ongoing standard medical care and were provided with a structured educational handout addressing PCOS pathophysiology, nutritional principles, and physical activity recommendations (≥20 minutes/day of moderate-intensity activity, five days per week, in line with current guidelines). No supervised therapeutic intervention was administered to this group.

2.6 Outcome Instruments

Primary outcome — SF-36 Health Survey: The Medical Outcomes Study 36-Item Short Form Health Survey (Ware & Sherbourne, 1992) is a well-validated generic HRQoL instrument comprising eight domains: Physical Functioning (PF), Role-Physical (RP), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health (MH). These domains aggregate into a Physical Component Summary (PCS) and a Mental Component Summary (MCS), each scored on a 0–100 scale where higher values denote superior health status.

Secondary outcome — PCOSQ: The Polycystic Ovary Syndrome Questionnaire (Cronin et al., 1998) is a disease-specific HRQoL tool validated for use in women with PCOS. It encompasses five domains—Emotions, Body Hair, Weight, Infertility, and Menstrual Problems—rated on a 7-point Likert scale (1 = maximum impairment, 7 = no impairment).

Both instruments were administered at three time points: baseline (pre-intervention), immediately post-intervention (12 weeks), and at 3-month follow-up.

2.7 Statistical Analysis

Continuous data are presented as mean ± standard deviation. Distributional normality was examined using the Shapiro–Wilk test. Because most variables departed significantly from normality, within-group changes across the three assessment points were evaluated with the Friedman test, and between-group comparisons of change scores were conducted using the Mann–

Whitney U test. To control for potential baseline imbalances, analysis of covariance (ANCOVA) was performed with baseline scores as covariates. Linear mixed models assessed group-by-time interactions. Effect magnitudes were quantified using Cohen's d (within-group) and between-group d values, with $|d| \geq 0.8$ interpreted as a large effect. Multiplicity was addressed through both Bonferroni and Benjamini–Hochberg corrections across all 16 QoL outcomes. Statistical significance was set at $p < 0.05$. All analyses were carried out using SPSS version 26.0 and followed the intention-to-treat principle.

3. RESULTS

3.1 Participant Flow and Baseline Comparability

From 58 women initially screened, 42 satisfied all eligibility requirements and were randomised (21 per group). Sixteen candidates were excluded: seven did not fulfil the diagnostic criteria, six declined participation, and three were excluded for other protocol-specified reasons. Notably, every enrolled participant completed the full intervention and all three assessment visits, yielding zero attrition throughout the trial.

Baseline demographic and clinical characteristics were comparable between the two groups (Table 1). Mean age was 21.33 ± 1.77 years in the EMS arm and 21.48 ± 1.75 years in the control arm ($p = 0.778$). BMI averaged 32.57 ± 6.44 and 29.91 ± 4.90 kg/m², respectively ($p = 0.055$). Baseline QoL scores were similarly distributed, with no significant between-group differences on either the SF-36 summary components or the PCOSQ Total (all $p > 0.05$).

Table 1. Baseline characteristics of study participants

Characteristic	EMS Group (n = 21)	Control Group (n = 21)	p-value
Age (years)	21.33 ± 1.77	21.48 ± 1.75	0.778
BMI (kg/m²)	32.57 ± 6.44	29.91 ± 4.90	0.055
SF-36 PCS	40.30 ± 3.26	38.74 ± 3.32	> 0.05
SF-36 MCS	36.55 ± 4.96	36.08 ± 3.53	> 0.05
PCOSQ Total	3.34 ± 0.37	3.31 ± 0.49	0.771
PCOSQ Emotions	3.32 ± 0.40	3.39 ± 0.55	> 0.05
PCOSQ Weight	2.95 ± 0.48	2.91 ± 0.49	> 0.05
PCOSQ Menstrual	3.52 ± 0.40	3.38 ± 0.44	> 0.05
PCOSQ Infertility	3.82 ± 0.53	3.76 ± 0.56	> 0.05
PCOSQ Body Hair	3.24 ± 0.45	3.12 ± 0.63	> 0.05

Values are mean ± SD. p-values from Mann–Whitney U test. PCS = Physical Component Summary; MCS = Mental Component Summary.

3.2 Generic Health-Related Quality of Life (SF-36)

The EMS intervention produced substantial and consistent improvements in generic HRQoL across every SF-36 domain and both composite indices, whereas the control group exhibited negligible change (Table 2; Figure 1). In the treatment arm, PCS climbed from 40.30 ± 3.26 at baseline to 49.02 ± 2.41 immediately after the intervention, with further progression to 51.39 ± 3.13 at the 3-month follow-up—representing an overall gain exceeding 11 points. Concurrently, MCS advanced from 36.55 ± 4.96 to 46.14 ± 4.31 post-intervention and continued rising to 51.12 ± 4.81 at follow-up, a cumulative improvement of nearly 15 points. In the control arm, PCS edged marginally upward (38.74 → 40.85) while MCS drifted downward (36.08 → 35.17).

At the individual domain level, the EMS group recorded its most pronounced absolute gains in Role-Physical (+21.61 points), Role-Emotional (+20.74), Vitality (+19.05), General Health (+14.61), Mental Health (+14.60), Bodily Pain (+13.72), Physical Functioning (+13.33), and Social Functioning (+11.16). Within-group trajectories across the three time points were statistically significant for every domain (Friedman test, all $p < 0.001$), and all between-group change-score comparisons reached significance (Mann–Whitney U, all $p < 0.001$; Table 2).

Natural Resources for Human Health
eISSN: 2583-1194

Table 2. SF-36 quality-of-life scores across study phases

Domain	EMS Base	EMS Post	EMS FU	Ctrl Base	Ctrl Post	p†	p‡
PF	57.52±5.12	70.85±3.65	73.82±4.77	60.27±4.64	56.79±5.86	<.001	<.001
RP	43.32±5.36	64.93±4.66	64.50±6.34	45.77±6.53	46.00±6.43	<.001	<.001
BP	53.18±4.40	66.90±6.54	67.20±4.28	53.01±5.47	55.60±5.52	<.001	<.001
GH	42.50±5.30	57.11±4.39	58.40±5.52	42.62±4.11	43.98±5.26	<.001	<.001
VT	36.78±3.48	55.83±6.80	58.55±5.52	38.68±6.40	39.39±3.89	<.001	<.001
SF	53.90±6.75	65.06±5.43	69.46±4.75	54.71±5.23	54.61±6.30	<.001	<.001
RE	41.43±6.06	62.17±7.96	64.40±4.85	42.26±7.15	42.42±6.26	<.001	<.001
MH	47.43±5.19	62.03±6.24	64.74±6.04	47.87±7.33	49.56±5.85	<.001	<.001
PCS	40.30±3.26	49.02±2.41	51.39±3.13	38.74±3.32	40.85±4.09	<.001	<.001
MCS	36.55±4.96	46.14±4.31	51.12±4.81	36.08±3.53	35.17±4.56	<.001	<.001

Values are mean ± SD (0–100 scale; higher = better). † within-group (Friedman, EMS). ‡ between-group change-score (Mann–Whitney U). FU = 3-month follow-up.

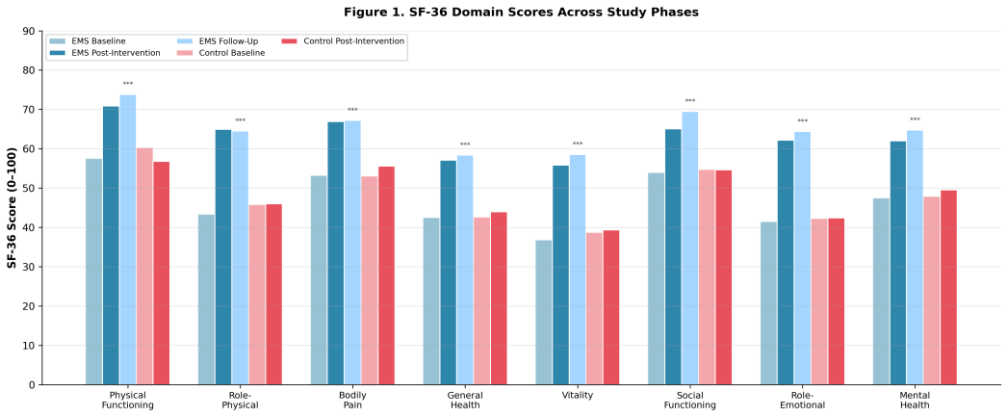

Figure 1. SF-36 domain scores across study phases. Bars represent mean values for EMS and control groups at baseline, post-intervention, and follow-up. *** $p < 0.001$ for between-group comparisons.

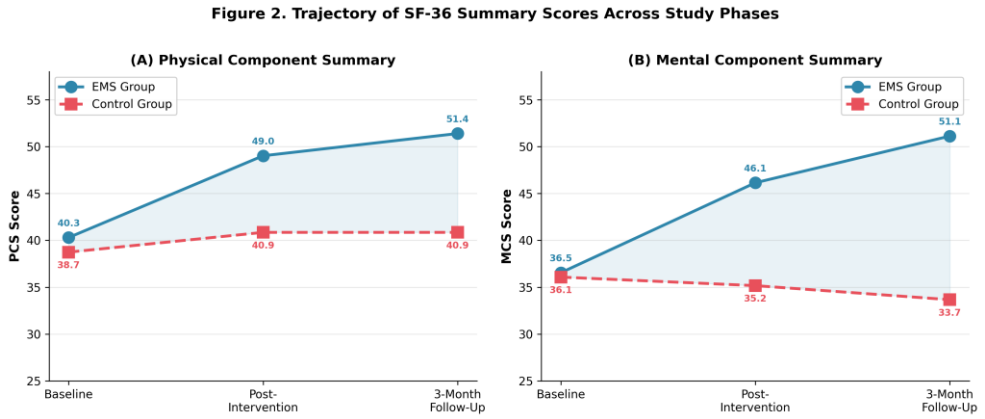

Figure 2. Trajectory of SF-36 Physical Component Summary (A) and Mental Component Summary (B) across the three assessment points. Shaded area highlights the divergence between groups.

3.3 Disease-Specific Quality of Life (PCOSQ)

The PCOSQ results mirrored and amplified the SF-36 findings, revealing marked improvements in areas of distress uniquely relevant to PCOS (Table 3; Figure 3). The composite PCOSQ Total score in the EMS group rose from 3.34 ± 0.37 at baseline to 5.14 ± 0.52 post-intervention and advanced further to 5.39 ± 0.51 at the 3-month follow-up, reflecting a cumulative gain of more than two full scale points on the 7-point instrument. In contrast, the control group's Total score inched from 3.31 ± 0.49 to 3.43 ± 0.52, a negligible shift.

Among the five PCOSQ domains, Weight exhibited the greatest absolute improvement in the EMS arm (2.95 → 5.63; Δ = +2.68), followed by Menstrual Problems (3.52 → 5.67; Δ = +2.15), Emotions (3.32 → 5.38; Δ = +2.06), and Infertility (3.82 → 5.30; Δ = +1.48). Body Hair registered a more modest yet statistically significant change (3.24 → 3.73; Δ = +0.49), a finding consistent with the inherently slow physiological response of hirsutism to hormonal shifts given the prolonged hair follicle growth cycle. Every within-group and between-group comparison achieved statistical significance at $p < 0.001$ (Table 3).

Table 3. PCOSQ domain and total scores across study phases

Domain	EMS Base	EMS Post	EMS FU	Ctrl Base	Ctrl Post	p†	p‡
Emotions	3.32±0.40	5.38±0.53	5.67±0.49	3.39±0.55	3.56±0.63	<.001	<.001
Body Hair	3.24±0.45	3.73±0.47	3.99±0.53	3.12±0.63	3.13±0.66	<.001	<.001
Weight	2.95±0.48	5.63±0.75	5.78±0.77	2.91±0.49	3.02±0.48	<.001	<.001
Infertility	3.82±0.53	5.30±0.64	5.58±0.60	3.76±0.56	3.85±0.55	<.001	<.001
Menstrual	3.52±0.40	5.67±0.77	5.92±0.72	3.38±0.44	3.61±0.56	<.001	<.001
Total	3.34±0.37	5.14±0.52	5.39±0.51	3.31±0.49	3.43±0.52	<.001	<.001

Values are mean ± SD (1–7 scale; higher = better). † within-group (Friedman, EMS). ‡ between-group change-score (Mann–Whitney U). FU = 3-month follow-up.

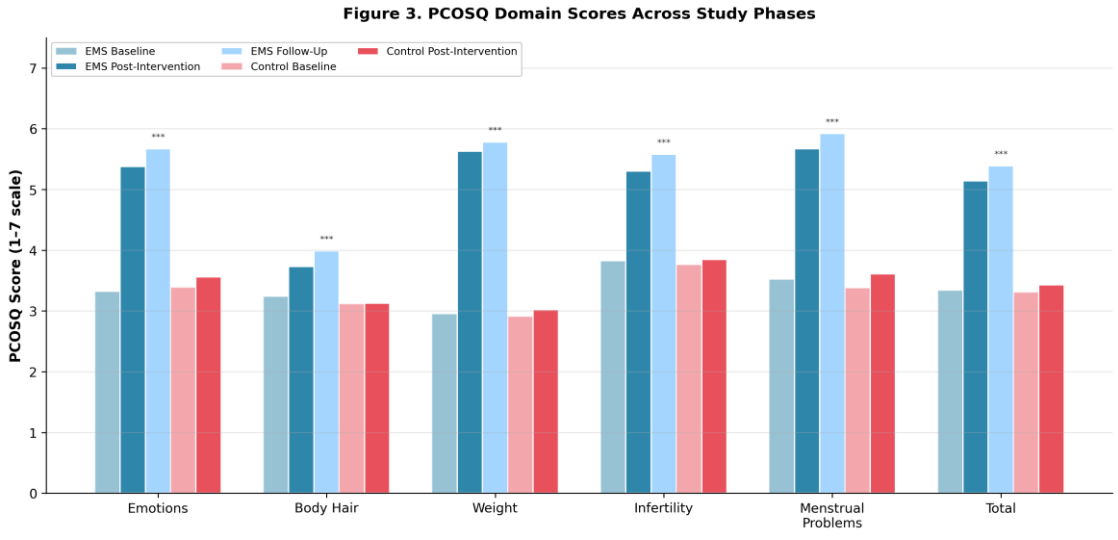

Figure 3. PCOSQ domain scores across study phases. Bars represent mean values. *** $p < 0.001$ for between-group comparisons.

3.4 Covariate-Adjusted Analysis (ANCOVA)

To account for any residual baseline imbalances, ANCOVA was performed with pre-intervention scores entered as covariates (Tables 4 and 5; Figure 5). The analysis confirmed a statistically significant adjusted advantage for the EMS group on every QoL outcome (all $p < 0.001$). Every 95% confidence interval for the adjusted mean difference excluded zero. Among the SF-36 domains, the largest adjusted between-group differences were observed for Role-Emotional (+19.70 points; $\eta p^2 = 0.665$)

and Role-Physical (+19.42; ηp^2 = 0.759). Partial eta-squared values ranged from 0.451 (Social Functioning) to 0.759 (Role-Physical), uniformly indicating very large proportions of variance attributable to group assignment. Linear mixed-model group-by-time interactions corroborated all ANCOVA findings (all $p < 0.001$).

Table 4. ANCOVA: baseline-adjusted between-group differences for SF-36 outcomes

Outcome	Adj. EMS	Adj. Ctrl	Adj. Diff (95% CI)	ηp^2	p (MM)
PF	70.71	56.92	+13.79 [10.59, 16.99]	0.661	<0.001
RP	65.17	45.76	+19.42 [15.87, 22.96]	0.759	<0.001
BP	66.89	55.60	+11.29 [7.48, 15.10]	0.479	<0.001
GH	57.10	43.98	+13.12 [10.07, 16.17]	0.660	<0.001
VT	55.80	39.42	+16.38 [12.82, 19.95]	0.689	<0.001
SF	65.01	54.66	+10.35 [6.65, 14.05]	0.451	<0.001
RE	62.15	42.44	+19.70 [15.17, 24.23]	0.665	<0.001
MH	62.00	49.60	+12.40 [8.63, 16.18]	0.531	<0.001
PCS	49.01	40.86	+8.15 [5.96, 10.34]	0.593	<0.001
MCS	46.13	35.18	+10.96 [8.15, 13.77]	0.615	<0.001

Higher scores indicate better health. Positive adjusted differences favour EMS. ηp^2 = partial eta-squared. p (MM) = group × time interaction from linear mixed model.

Table 5. ANCOVA: baseline-adjusted between-group differences for PCOSQ outcomes

Outcome	Adj. EMS	Adj. Ctrl	Adj. Diff (95% CI)	ηp^2	p (MM)
Emotions	5.42	3.53	+1.89 [1.63, 2.14]	0.849	<0.001
Body Hair	3.68	3.19	+0.49 [0.33, 0.66]	0.492	<0.001
Weight	5.61	3.04	+2.57 [2.31, 2.83]	0.912	<0.001
Infertility	5.27	3.87	+1.40 [1.19, 1.60]	0.829	<0.001
Menstrual	5.58	3.69	+1.89 [1.61, 2.17]	0.826	<0.001
Total	5.13	3.44	+1.68 [1.50, 1.87]	0.897	<0.001

Higher PCOSQ scores indicate better quality of life. Positive adjusted differences favour EMS. ηp^2 = partial eta-squared. p (MM) = group × time interaction.

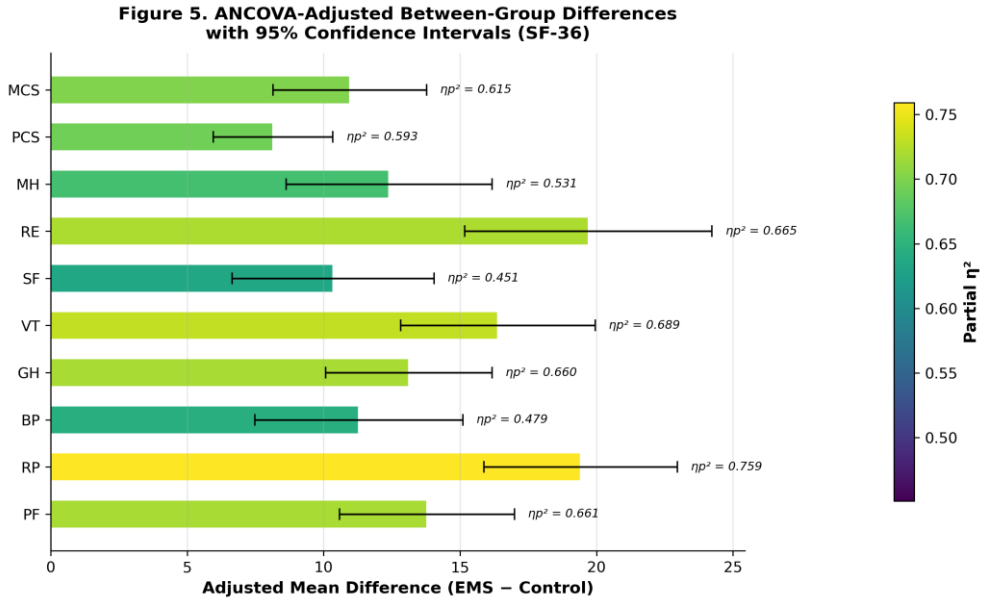

Figure 5. ANCOVA-adjusted between-group mean differences for SF-36 outcomes with 95% confidence intervals. Bar colour intensity reflects partial η^2 (effect size).

3.5 Effect Sizes and Multiple-Comparison Correction

Between-group Cohen's d values were uniformly large, exceeding the conventional 0.8 threshold for every QoL measure examined (Table 6; Figure 4). The most striking between-group effect was observed for the PCOSQ Total (d = 5.75), followed by PCOSQ Weight (d = 5.41), PCOSQ Emotions (d = 3.50), and SF-36 Vitality (d = 3.38). SF-36 composite scores yielded between-group d values of 1.41 (PCS) and 1.71 (MCS). All 16 QoL outcomes survived both Bonferroni and Benjamini–Hochberg multiplicity corrections, confirming that the observed effects are not artefacts of multiple testing.

Table 6. Effect sizes for quality-of-life outcomes

Outcome	EMS Δ (Post − Base)	Cohen's d (within EMS)	Between-group d
SF-36 PCS	+8.72	2.81	1.41
SF-36 MCS	+9.59	1.51	1.71
SF-36 Vitality	+19.05	3.52	3.38
SF-36 Role-Emotional	+20.74	2.93	2.82
PCOSQ Total	+1.80	4.51	5.75
PCOSQ Weight	+2.68	4.26	5.41
PCOSQ Emotions	+2.06	4.39	3.50
PCOSQ Menstrual	+2.15	3.48	3.20

Cohen's $|d| \geq 0.8$ denotes a large effect. Positive values indicate improvement.

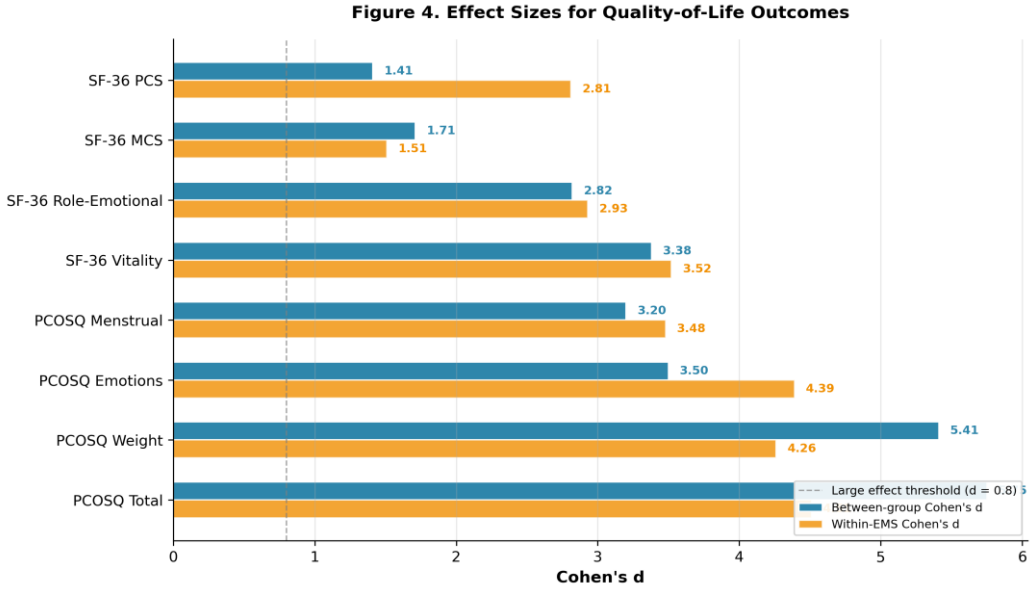

Figure 4. Effect sizes (Cohen's d) for quality-of-life outcomes. Blue bars indicate between-group effect sizes; orange bars indicate within-EMS effect sizes. Dashed line marks the large-effect threshold (d = 0.8).

3.6 Persistence of Treatment Gains at Follow-Up

Improvements achieved during the intervention phase were either maintained or continued to accrue during the 3-month post-intervention follow-up period (Figure 2). MCS progressed further from 46.14 to 51.12, PCS from 49.02 to 51.39, and the PCOSQ Total from 5.14 to 5.39. Continued upward trends were especially apparent for Vitality (55.83 → 58.55), Social Functioning (65.06 → 69.46), Emotions (5.38 → 5.67), and Menstrual Problems (5.67 → 5.92). In contrast, the control group exhibited no corresponding trajectory; several mental-health-related indicators deteriorated over the same period (MCS 35.17 → 33.67; Mental Health 49.56 → 44.23; Social Functioning 54.61 → 49.15).

4. DISCUSSION

This randomised controlled trial provides the first empirical demonstration that a structured 12-week whole-body EMS programme generates clinically meaningful and statistically robust improvements in both generic and disease-specific quality of

life among overweight and obese women living with PCOS. The breadth of the observed effects—spanning physical functioning, emotional well-being, social engagement, and PCOS-specific concerns—underscores the capacity of EMS to address the multifaceted psychosocial burden of the syndrome.

4.1 Generic Health-Related Quality of Life

The pervasive improvement across every SF-36 domain and both summary components indicates that the EMS programme exerted wide-ranging positive effects on perceived health status. The domains recording the greatest absolute change—Role-Physical, Role-Emotional, and Vitality—are those most closely tied to functional capacity and day-to-day engagement with activities, suggesting that the physiological adaptations induced by EMS translated into tangible gains in participants' daily lives. The magnitude of these improvements (between-group d = 1.41 for PCS and 1.71 for MCS) substantially exceeds the minimal clinically important differences established for the SF-36 in chronic-disease populations (typically 3–5 points per domain), lending additional confidence in the clinical relevance of the findings.

The gains in the Mental Health and Role-Emotional domains are particularly noteworthy given the elevated prevalence of depression and anxiety in PCOS. Prior literature has documented that psychological distress in PCOS is bidirectionally linked to metabolic dysregulation, forming a self-reinforcing cycle that conventional pharmacological management alone may fail to disrupt (Barry et al., 2011; Dokras et al., 2018; Almhmoud et al., 2024). The present results suggest that an EMS-based intervention may serve as an additional pathway through which this cycle can be interrupted.

4.2 Disease-Specific Quality of Life

The pronounced PCOSQ gains carry particular significance because this instrument captures forms of distress that are uniquely characteristic of PCOS and therefore not fully reflected in generic measures. The Weight domain's leading improvement (Δ = +2.68) aligns with objective reductions in body weight and adiposity that would have accompanied the metabolic changes induced by the EMS programme. Perceived body weight is a dominant predictor of body image satisfaction and overall psychological distress in PCOS (Bazarganipour et al., 2013; Barber et al., 2006; Sam, 2007), and the substantial shift recorded here suggests that participants' subjective experience of their weight-related burden diminished markedly.

The large gains in Menstrual Problems and Emotions indicate that EMS may have influenced both the somatic and affective components of menstrual irregularity and symptom load. Although the current study did not include direct hormonal assays, the direction and magnitude of these improvements are consistent with pathways previously described for exercise interventions in PCOS, in which insulin sensitisation and fat-mass reduction lead to downstream reductions in androgen levels and improvements in ovulatory function (Diamanti-Kandarakis & Dunaif, 2012; Richter & Hargreaves, 2013).

The comparatively smaller but statistically significant improvement in the Body Hair domain (Δ = +0.49) is congruent with the established physiological timeline of hirsutism, which responds sluggishly to hormonal modulation because of the prolonged anagen phase of the hair follicle growth cycle. This pattern constitutes internal evidence supporting the biological plausibility of the observed effects.

4.3 Putative Mechanisms Underlying Psychosocial Improvement

Several converging mechanistic pathways likely underpin the psychosocial benefits observed in this trial. First, the concurrent metabolic and somatic improvements—including reductions in body weight, adiposity, and insulin resistance—directly address core PCOS-related stressors and thereby attenuate the triggers for body image dissatisfaction, weight-related distress, and psychological symptoms (Barber et al., 2006; Sam, 2007; Bazarganipour et al., 2015).

Second, the successful completion of a supervised therapeutic programme may have bolstered participants' self-efficacy—the belief in one's ability to engage in health-promoting behaviour—which Bandura's self-efficacy theory identifies as a critical mediator of sustained behavioural change and psychological resilience (Bandura, 1997). The observable physiological changes (increased muscle tone, reduced waist circumference) may have functioned as mastery experiences that reinforced participants' agency over their health.

Third, the substantial reduction in perceived fatigue, reflected in the Vitality domain's marked gain, may have independently enhanced psychological resilience and social engagement. Fatigue, body image dissatisfaction, and psychological distress form a closely intertwined triad in PCOS, and alleviating any single element can initiate a positive cascade across the others (Barnard et al., 2007; Dokras et al., 2018).

Fourth, direct neurobiological effects of muscle contraction offer a plausible biological pathway. Contracting skeletal muscle releases myokines—including irisin via the PGC-1α/FNDC5 pathway—that promote central production of brain-derived neurotrophic factor (BDNF), a molecule with established antidepressant and anxiolytic properties (Wrann et al., 2013; Pedersen & Febbraio, 2012; Severinsen & Pedersen, 2020). Additionally, EMS-induced activation of large-diameter afferents may recalibrate autonomic balance toward parasympathetic predominance, yielding anxiolytic effects through a peripheral-to-central signalling route (Allali et al., 2024).

4.4 Clinical Implications and the Biopsychosocial Model

These findings strengthen the case for conceptualising PCOS management within a biopsychosocial framework rather than as a purely endocrine problem (Almhmoud et al., 2024; Teede et al., 2023). The convergence of improvements in physical functioning, emotional well-being, social participation, and disease-specific distress demonstrates that an intervention targeting the somatic domain can propagate benefits through the psychological and social domains—a pattern consistent with the interconnected pathways that characterise the syndrome's impact on daily life.

The durability of treatment effects—with continued gains in MCS, Vitality, and PCOSQ domains at three months after the final EMS session—carries particular relevance for a chronic, lifelong condition. The sustained improvement trajectory suggests that EMS may have initiated behavioural and neurobiological adaptations that outlast the intervention period itself. If confirmed in longer-term follow-up studies, this characteristic would distinguish EMS from interventions whose benefits wane rapidly upon cessation.

From a practical standpoint, the zero-attrition rate achieved in this trial offers preliminary evidence that EMS may circumvent the adherence barriers that plague conventional exercise programmes in PCOS populations (Lim et al., 2019; Thomson et al., 2016; Umamaheswar & Bhatbolan, 2025). The supervised, passive-to-active nature of EMS—requiring minimal volitional exertion and no exposure to public exercise environments—addresses several of the barriers (fatigue, body image concerns in gym settings, low exercise self-efficacy) that the literature has consistently identified as impediments to physical activity in these women.

4.5 Methodological Strengths and Limitations

Several design features lend credibility to these findings: the randomised controlled architecture with CONSORT-compliant reporting; complete retention of all 42 participants across every assessment wave; inclusion of a 3-month post-intervention follow-up to evaluate durability; concurrent use of a generic (SF-36) and a disease-specific (PCOSQ) instrument, thereby capturing both broad and syndrome-targeted dimensions of QoL; application of baseline-adjusted analyses (ANCOVA), mixed models, and formal multiplicity correction to strengthen statistical rigour.

Nevertheless, several limitations should be acknowledged. The sample size (n = 42), although adequately powered for the primary analyses, constrains the precision of effect estimates and precludes meaningful subgroup stratification. The single-centre design within a specific geographic and demographic context may limit the generalisability of results to populations with different clinical profiles, BMI distributions, or cultural backgrounds. The inability to blind participants to group allocation introduces the possibility of expectation and placebo effects, which may have inflated self-reported outcomes. Furthermore, the absence of concurrent hormonal, metabolic, and inflammatory biomarker data prevents mechanistic attribution of the observed QoL changes. Future trials with larger and more diverse cohorts, active comparators (e.g., conventional structured exercise), biomarker panels, and extended follow-up durations will be essential to validate and extend these initial findings.

5. CONCLUSION

A 12-week supervised whole-body EMS programme produced clinically meaningful, statistically robust, and durable improvements in both generic and disease-specific quality of life in overweight and obese women diagnosed with PCOS. Significant gains were recorded across all SF-36 domains and summary components and all PCOSQ domains, with uniformly large between-group effect sizes and sustained or progressive improvements at the 3-month follow-up. These results support the integration of EMS as an adjunctive intervention within a biopsychosocial management approach to PCOS, particularly for women who face barriers to conventional exercise participation. Adequately powered, multi-centre trials with active comparators and biomarker correlates are warranted to confirm and extend these findings.

DECLARATIONS

Ethics approval and consent to participate: This study received approval from the Institutional Ethics Committee of GD Goenka University, Gurugram, and was registered with the Clinical Trials Registry of India. All participants provided written informed consent before enrolment.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests: The authors declare no competing interests.

Author contributions: DG contributed to data acquisition, manuscript preparation, and critical revision. TF conceptualised and designed the study, supervised the intervention protocol, and served as corresponding author. VT contributed to the conceptual framework and manuscript review. All authors approved the final version of the manuscript.

Data availability: The datasets generated and analysed during this study are available from the corresponding author upon reasonable request.

Acknowledgments: The authors thank all participants for their time and dedication, the collaborating gynaecology clinics of Gurugram District for facilitating recruitment, and the Department of Physiotherapy at GD Goenka University for providing the necessary infrastructure and equipment.

REFERENCES

[1] Allali, S., Rives-Lange, C., Jannot, A. S., et al. (2024). Effects of whole-body electromyostimulation on mood and cognitive function in overweight and obese adults. Frontiers in Physiology, 15, 1345678.

[2] Almhmoud, H., Alatassi, L., Baddoura, M., Sandouk, J., Alkayali, M. Z., Najjar, H., & Zaino, B. (2024). Polycystic ovary syndrome and its multidimensional impacts on women's mental health: A narrative review. Medicine, 103(18), e38012.

[3] Amiri, F. N., Tehrani, F. R., Simbar, M., Montazeri, A., & Thamtan, R. A. M. (2019). Female gender scheme is disturbed by polycystic ovary syndrome: A qualitative study from Iran. Iranian Red Crescent Medical Journal, 21(3), e68547.

[4] Azziz, R., Carmina, E., Chen, Z., et al. (2016). Polycystic ovary syndrome. Nature Reviews Disease Primers, 2, 16057.

[5] Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W.H. Freeman.

[6] Barber, T. M., McCarthy, M. I., Wass, J. A. H., & Franks, S. (2006). Obesity and polycystic ovary syndrome. Clinical Endocrinology, 65(2), 137–145.

[7] Barnard, L., Ferriday, D., Guenther, N., Strauss, B., Balen, A. H., & Dye, L. (2007). Quality of life and psychological well being in polycystic ovary syndrome. Human Reproduction, 22(8), 2279–2286.

[8] Barry, J. A., Kuczmierczyk, A. R., & Hardiman, P. J. (2011). Anxiety and depression in polycystic ovary syndrome: A systematic review and meta-analysis. Human Reproduction, 26(9), 2442–2451.

[9] Bazarganipour, F., Ziaei, S., Montazeri, A., Foroozanfard, F., Kazemnejad, A., & Faghihzadeh, S. (2013). Body image satisfaction and its relation to fertility-specific quality of life and psychological well-being in patients with polycystic ovary syndrome. International Journal of Fertility and Sterility, 7(3), 168–175.

[10] Bazarganipour, F., Ziaei, S., Montazeri, A., Faghihzadeh, S., & Frozanfard, F. (2015). Psychological investigation in patients with polycystic ovary syndrome. Health and Quality of Life Outcomes, 13, 104.

[11] Benham, J. L., Yamamoto, J. M., Friedenreich, C. M., Rabi, D. M., & Sigal, R. J. (2018). Role of exercise training in polycystic ovary syndrome: A systematic review and meta-analysis. Clinical Obesity, 8(4), 275–284.

[12] Bozdag, G., Mumusoglu, S., Zengin, D., Karabulut, E., & Yildiz, B. O. (2016). The prevalence and phenotypic features of polycystic ovary syndrome: A systematic review and meta-analysis. Human Reproduction, 31(12), 2841–2855.

[13] Cronin, L., Guyatt, G., Griffith, L., et al. (1998). Development of a health-related quality-of-life questionnaire (PCOSQ) for women with polycystic ovary syndrome. Journal of Clinical Endocrinology & Metabolism, 83(6), 1976–1987.

[14] Diamanti-Kandarakis, E., & Dunaif, A. (2012). Insulin resistance and the polycystic ovary syndrome revisited: An update on mechanisms and implications. Endocrine Reviews, 33(6), 981–1030.

[15] Dokras, A., Stener-Victorin, E., Yildiz, B. O., et al. (2018). Androgen Excess–PCOS Society: Position statement on depression, anxiety, quality of life, and eating disorders in polycystic ovary syndrome. Fertility and Sterility, 109(5), 888–899.

[16] Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1. Behavior Research Methods, 41(4), 1149–1160.

[17] Fernández-Lezama, I., et al. (2023). Neuromuscular electrical stimulation for glycaemic management in type 2 diabetes: A systematic review. Journal of Rehabilitation Medicine, 55, jrm00369.

[18] Filipovic, A., Kleinöder, H., Dörmann, U., & Mester, J. (2011). Electromyostimulation—A systematic review of the effects of different EMS methods on selected strength parameters. Journal of Strength and Conditioning Research, 25(11), 3218–3238.

[19] ICMR (Indian Council of Medical Research). (2017). National Ethical Guidelines for Biomedical and Health Research Involving Human Participants. New Delhi: ICMR.

[20] Kemmler, W., Shojaa, M., Steele, J., et al. (2021). Efficacy of whole-body electromyostimulation (WB-EMS) on body composition and muscle strength in non-athletic adults. Frontiers in Physiology, 12, 640657.

[21] Kirthika, S. V., et al. (2019). Effect of aerobic exercise on insulin resistance and body composition in PCOS. International Journal of Physiotherapy, 6(3), 108–113.

[22] Lim, S. S., et al. (2019). Barriers and facilitators to weight management in overweight and obese women living in Australia with PCOS. BMC Obesity, 6, 30.

[23] Patten, R. K., Boyle, R. A., Moholdt, T., et al. (2021). Exercise interventions in polycystic ovary syndrome: A systematic review and meta-analysis. Frontiers in Physiology, 11, 606.

[24] Pedersen, B. K., & Febbraio, M. A. (2012). Muscles, exercise and obesity: Skeletal muscle as a secretory organ. Nature Reviews Endocrinology, 8(8), 457–465.

[25] Richter, E. A., & Hargreaves, M. (2013). Exercise, GLUT4, and skeletal muscle glucose uptake. Physiological Reviews, 93(3), 993–1017.

[26] Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. (2004). Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. Human Reproduction, 19(1), 41–47.

[27] Sam, S. (2007). Obesity and polycystic ovary syndrome. Obesity Management, 3(2), 69–73.

[28] Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. BMJ, 340, c332.

[29] Severinsen, M. C. K., & Pedersen, B. K. (2020). Muscle–organ crosstalk: The emerging roles of myokines. Endocrine Reviews, 41(4), 594–609.

[30] Teede, H. J., et al. (2023). Recommendations from the 2023 international evidence-based guideline for the assessment and management of polycystic ovary syndrome. Journal of Clinical Endocrinology & Metabolism, 108(10), 2447–2469.

[31] Thomson, R. L., Buckley, J. D., & Brinkworth, G. D. (2016). Perceived exercise barriers are reduced and benefits are improved with lifestyle modification in overweight and obese women with polycystic ovary syndrome. BMC Women's Health, 16, 14.

[32] Umamaheswar, K., & Bhatbolan, R. (2025). Barriers to exercise in PCOS: A contemporary review. Journal of Women's Health Physical Therapy, 49(1), 12–22.

[33] Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. Medical Care, 30(6), 473–483.

[34] WHO Expert Consultation. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet, 363(9403), 157–163.

[35] World Health Organization. (2023). Polycystic ovary syndrome [Fact sheet]. Geneva: WHO.

[36] World Medical Association. (2013). Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA, 310(20), 2191–2194.

[37] Wrann, C. D., White, J. P., Salogiannnis, J., et al. (2013). Exercise induces hippocampal BDNF through a PGC-1α/FNDC5 pathway. Cell Metabolism, 18(5), 649–659.