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Comparative effects of resistance training and aerobic exercise on ovulation and female reproductive physiology

Olajumoke Oyedoyin[a,b,*]

[a]*Department of Health Education and Promotion, Pogil College of Health Technology Oke Eri, Via Ijebu Ode, Ogun state, Nigeria*
[b]*Department of Physical Education, Universidade Federal de Viçosa (UFV), Minas Gerais, Brazil*

Abstract

Physical exercise plays an important role in reproductive health, particularly through its influence on the hypothalamic–pituitary–ovarian (HPO) axis and ovulation. Although both resistance training (RT) and aerobic exercise (AE) benefit women's health, their comparative effects on ovulatory function remain unclear. This narrative review evaluates the differential effects of RT and AE on ovulatory function from a sports physiology perspective, with emphasis on training type, intensity, and frequency. Literature was identified through major scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar, with a focus on exercise and female reproductive health. The evidence suggests that RT and AE may have beneficial but distinct effects on ovulatory function mediated by metabolic and hormonal mechanisms. Moderate- to high-intensity AE has been reported to improve body mass index (BMI), insulin sensitivity, and menstrual regularity, whereas RT may support muscle development, androgen regulation, and metabolic health. However, excessive exercise or insufficient energy intake can disrupt gonadotropin-releasing hormone (GnRH) pulsatility and suppress gonadotropins, which may lead to menstrual dysfunction. Overall, AE has more consistent evidence for improvements in BMI and menstrual-cycle regularity, while RT shows promising but still emerging benefits for androgen regulation and metabolic health. These findings may guide women, healthcare providers, and policymakers in tailoring exercise choices to protect women's ovulatory and reproductive health. Future studies should prioritise comparative exercise trials, diverse populations, and the incorporation of nutritional factors.

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1. Introduction

Exercise is an integral part of a healthy lifestyle and provides multiple benefits for cardiovascular, metabolic, musculoskeletal, emotional, and mental health [1–3]. Exercise has been reported to be helpful for the treatment of depression and anxiety and for the management of conditions such as obesity, osteoporosis, and musculoskeletal pain [4, 5]. Beyond these general health benefits, increasing attention has been directed toward its role in female reproductive and hormonal function. Physical activity has been identified as a potential intervention for managing ovulatory disorders in women, including polycystic ovary syndrome (PCOS), anovulation, and irregular menstrual cycles [6–8].

*Corresponding author Tel. No.: +234-703-232-8732.
Email address: olajumoke.oyedoyin@ufv.br (Olajumoke Oyedoyin)

Ovulatory function is regulated by the hypothalamic–pituitary–ovarian (HPO) axis, a complex system that, when disrupted, can result in fertility-related problems such as amenorrhoea, anovulation, and irregular cycles [9]. The hypothalamus secretes gonadotropin-releasing hormone (GnRH), which acts on gonadotroph cells in the anterior pituitary. These cells secrete follicle-stimulating hormone (FSH) and luteinising hormone (LH) into the bloodstream. GnRH release is pulsatile, with low-frequency pulses favouring FSH secretion and high-frequency pulses stimulating LH secretion [10]. Continuous GnRH release suppresses both LH and FSH, leading to reduced oestrogen production and impaired ovulation [11].

While exercise is beneficial, excessive or improperly regulated training can increase the risk of ovulatory dysfunction [12]. The intensity, type, and duration of physical activity may differentially influence the HPO axis and related hormonal pathways, including FSH, LH, and GnRH secretion [10]. Aerobic exercise (AE) interventions have been shown to reduce BMI and improve menstrual regularity in women with PCOS [13], and in some cases, exercise-based interventions perform similarly to pharmacological or dietary therapies in improving fertility-related outcomes [14].

Recent studies indicate that resistance training (RT) and AE trigger distinct physiological and hormonal responses. For example, differences in insulin sensitivity, adiposity reduction, and sex-hormone regulation may lead to different outcomes for ovulation and menstrual health [15, 16]. Additionally, exercise may improve metabolic and hormonal disturbances in PCOS through epigenetic mechanisms, such as increased genome-wide DNA methylation [17].

Understanding these differences is therefore critical for developing tailored exercise guidelines for women aiming to optimise reproductive health. This review compares the effects of RT and AE on ovulatory function from a sports physiology perspective, with emphasis on training type, intensity, and frequency. It also identifies key knowledge gaps and provides guidance for exercise prescription to support women in balancing physical activity with reproductive and overall health goals.

2. Literature search strategy

This study was conducted as a narrative review to synthesise existing literature on the effects of RT and AE on ovulatory function and female reproductive physiology. Relevant literature was searched using electronic databases including PubMed, Scopus, Web of Science, and Google Scholar.

The search combined keywords such as aerobic exercise, resistance training, ovulation, female reproductive health, hormonal regulation, and PCOS. Peer-reviewed articles published in English were prioritised.

Studies were included based on their relevance to exercise interventions and their reported effects on hormonal profiles, metabolic parameters, and ovulatory function in women. Both observational and interventional studies were considered to provide a broad and balanced overview of the topic. Review articles were also consulted to support background understanding and contextual interpretation. Studies that did not directly address exercise-related effects on female reproductive or hormonal outcomes were excluded.

Given the narrative nature of this review, the selection process was not restricted by strict systematic criteria, but emphasis was placed on including recent, high-quality, and widely cited studies to ensure a balanced and comprehensive synthesis of current knowledge.

3. Exercise, hormonal regulation and ovulatory function

3.1. Effect of aerobic exercise on ovulatory function

Aerobic training consists of exercises that utilise large muscle masses in repetitive and rhythmic movements [18]. Aerobic exercise includes activities such as brisk walking, jogging, cycling, swimming, jumping, skipping, and dancing, among others (Figure 1). These steady, rhythmic activities use oxygen to create energy in the body and involve large muscles.

Light AE, such as walking, running, cycling, or swimming for a longer period, can improve heart health, boost metabolism, and support hormone balance [19]. In line with these benefits, AE is an important natural option that supports women's reproductive and hormonal health. Koman *et al.* [20] reported that AE helps improve lipid profiles, reduce cardiovascular disease risk, and promote healthy metabolism and hormonal balance.

Other studies have demonstrated beneficial effects of long-term AE on ovulatory function and sex-hormone regulation in women. For example, Afzal *et al.* [21] reported that high-intensity interval training (HIIT) and moderate-intensity AE significantly increased estradiol and progesterone levels, with HIIT being more effective at improving hormonal profiles and shortening menstrual-cycle length. Similarly, Ramadan *et al.* [22] reported that HIIT led to a 150% increase in oestrogen levels, compared with a 72.3% increase with traditional resistance training in a controlled intervention study. However, these findings are likely influenced by factors such as sample size, participant characteristics, and intervention duration, and may not be generalisable to broader populations.

The physiological response to exercise may also differ between phases of the menstrual cycle, with increased core body temperatures after exercise recorded in the mid-luteal phase, when progesterone is higher [23]. In addition, higher progesterone levels were associated with lower parasympathetically mediated heart rate during exercise, further suggesting that hormones may modulate the relationship between heart-rate vagal control and exercise in a complex manner [24]. Moreover, AE positively modulates adipokine levels, thereby reducing insulin, triglycerides, leptin, and interleukin-6 concentrations, further supporting hormonal balance [16].

Figure 1: Examples of aerobic exercise modalities for women's ovulatory and reproductive health.

Overall, these findings suggest that AE, particularly HIIT, may serve as a useful intervention to enhance reproductive health in women, although further well-designed studies are needed to confirm these effects.

3.2. Effect of resistance training on ovulatory function

Resistance training refers to any form of exercise in which muscles work against an external force, such as weights, resistance bands, machines, or body weight (Figure 2). It helps improve muscle strength, endurance, and overall functional capacity. In women with PCOS, moderate- to high-intensity AE for at least 12 weeks improved insulin sensitivity, reduced androgen levels, and enhanced body composition [19].

Evidence regarding the impact of RT on ovulatory function remains limited and heterogeneous. However, preliminary studies show potential improvements in menstrual regularity and metabolic health [13, 25]. Some studies suggest that RT may promote changes in hormones across phases of the menstrual cycle, such as increased progesterone, testosterone, and estradiol, which may contribute to ovulatory stability. However, the available evidence remains limited and heterogeneous, and these findings should be interpreted with caution [15]. Prolonged stress, such as that experienced during the COVID-19 pandemic, can overwhelm the hypothalamic–pituitary–gonadal axis and cause ovulatory dysfunction. RT may help reduce metabolic and hormonal issues in these cases [26, 27]. The action of RT may improve lean body mass and androgen regulation, complementing the benefits of AE on BMI reduction. While these findings are promising, further adequately powered clinical studies are essential to confirm the therapeutic benefits of RT for women with reproductive disorders [25, 27].

Meta-analyses suggest that high-volume RT may be effective for improving cardiorespiratory fitness, body composition, and insulin resistance in women with PCOS [28]. However, translating these improvements into measurable benefits for ovulation requires further clarification.

3.3. Comparative analysis of resistance training and aerobic exercise

Resistance training offers unique benefits for women with PCOS and gestational diabetes mellitus (GDM). In PCOS, RT can ameliorate metabolic and hormonal parameters such as glycaemia, fat-free mass, testosterone, and sex hormone-binding globulin [27]. For GDM, RT can reduce insulin requirements and fasting glucose and improve short-term postprandial glycaemic control [29].

While increased AE improves insulin sensitivity in PCOS, RT may also increase androgen concentrations [30]. However, the evidence is very limited and inconsistent regarding the effects of RT on reproductive disorders in PCOS [19]. AE has demonstrated a low-certainty effect in reducing BMI in women with PCOS [13].

Overall, findings suggest that AE may better enhance weight loss and menstrual regularity, whereas RT may more strongly influence androgen and metabolic profiles. However, the strength and consistency of evidence differ between these exercise modalities

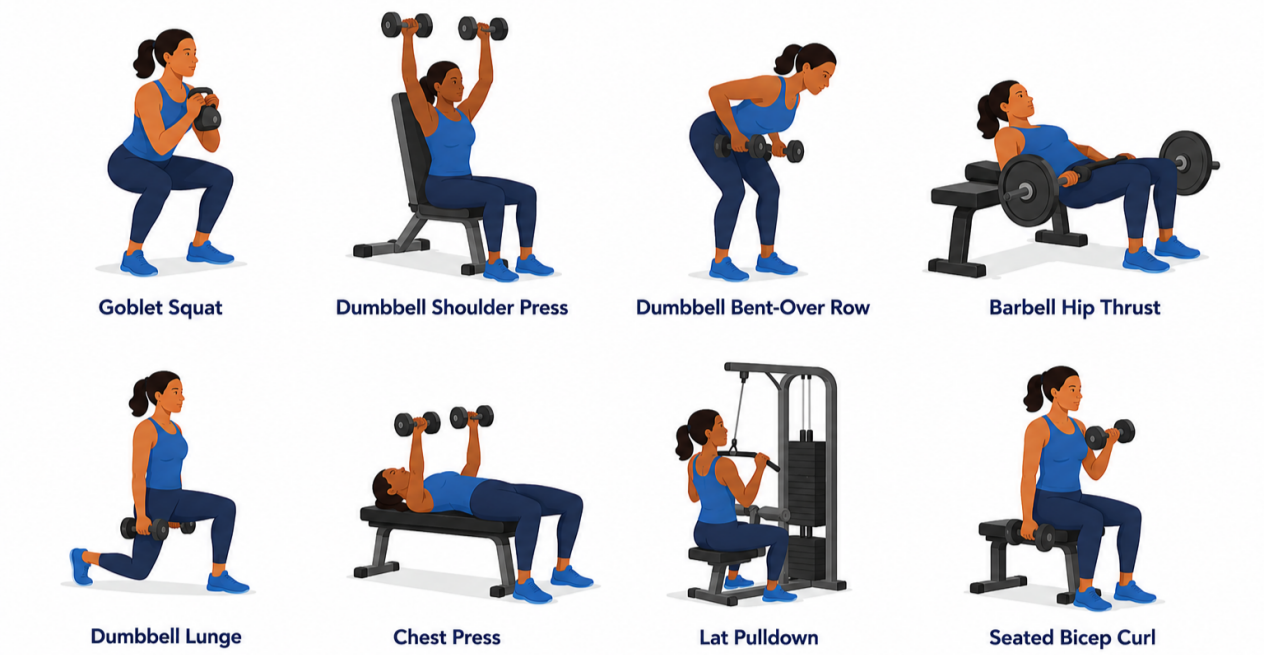

Figure 2: Examples of resistance-training exercises for metabolic and hormonal regulation in women.

[13, 15]. Evidence supporting AE is relatively more consistent, particularly in relation to improvements in body composition and menstrual-cycle regulation, with several studies demonstrating similar outcomes across different populations [31–33]. In contrast, evidence for RT remains more limited and heterogeneous, with fewer studies and greater variability in reported outcomes, particularly regarding direct effects on ovulatory function [25, 27].

Furthermore, many RT studies are based on smaller sample sizes or indirect outcome measures, such as metabolic improvements rather than ovulation-specific endpoints, which reduces the certainty of conclusions. As a result, while RT shows promising potential, particularly for metabolic and androgen-related outcomes, its direct role in improving ovulatory function remains less clearly established compared with AE (Table 1).

Therefore, AE currently has a more robust and consistent evidence base for supporting ovulatory and menstrual health, while RT should be considered a complementary strategy with emerging but less conclusive evidence. High-quality comparative trials are needed to determine whether combined AE and RT interventions offer the greatest improvements in ovulatory function and reproductive outcomes. As shown in Table 1, although both exercise types influence hormonal and metabolic parameters, the consistency and direct relevance of outcomes to ovulatory function are more evident in AE than in RT.

Both AE and RT influence ovulatory outcomes through metabolic and hormonal modulation, including changes in adiposity, insulin sensitivity, inflammation, and androgen regulation (Figure 3). These effects act on the HPO axis by altering GnRH pulsatility and gonadotropin secretion (LH and FSH), thereby affecting ovarian steroidogenesis and ovulation [10, 13, 34]. Excessive exercise or low energy availability may disrupt this axis through increased cortisol and reduced GnRH pulsatility, leading to menstrual dysfunction (Figure 3).

4. Research gaps and future directions

4.1. Limited comparative data on resistance and aerobic training

Despite the substantial body of research on exercise and reproductive health, limited direct comparative studies have examined the effects of resistance versus aerobic training [35–37]. Most existing studies have evaluated these modalities in isolation, which limits understanding of their relative effectiveness in supporting ovulatory function. Longitudinal studies that assess both forms of exercise under comparable conditions are needed to draw definitive conclusions regarding their comparative impacts.

4.2. Population diversity in research

Existing studies have been conducted in specific populations, mostly young, healthy, or athletic women. The homogeneity of samples limits the generalisability of findings to women with varying physiological states, such as PCOS, obesity, or hypothalamic

Table 1: Comparative effects of aerobic exercise and resistance training on hormonal profiles and reproductive function in women.

Outcome category	Aerobic exercise (AE)	Resistance training (RT)	Sources
Estradiol (E2)	Some studies show increased follicular-phase E2 with regular AE, especially at moderate intensity. Effects are inconsistent at high intensity.	RT shows small or no direct effect on E2, although improvements occur indirectly through fat reduction.	[38–40]
Progesterone (P4)	Consistent ovulation with moderate AE. Excessive training reduces P4.	Some studies show a slight increase in luteal P4 after long-term RT.	[15, 41]
LH (luteinising hormone)	Improves LH pulsatility in overweight women. Intense AE may suppress LH.	RT shows modest improvement in LH, especially in women with metabolic dysfunction, such as PCOS.	[34, 42]
FSH (follicle-stimulating hormone)	Generally stable; AE rarely alters FSH unless training is excessive.	Minimal change; studies show RT does not significantly affect FSH.	[15, 43]
Androgens (testosterone, DHEA-S)	Slight reductions or stable levels; AE is particularly helpful in reducing hyperandrogenism in PCOS.	Stronger reduction of androgens than AE; RT improves insulin sensitivity, lowering androgen levels in women with PCOS.	[13, 42]
Body composition (BMI, fat %)	Strong reduction in fat mass and overall weight; AE is preferred for weight loss.	Increases lean mass and reduces visceral fat moderately; less impactful on weight loss.	[13]
Ovulation and menstrual-cycle consistency	AE improves cycle regularity and reduces anovulatory cycles when done at moderate intensity; consistent improvements in dysmenorrhoea, premenstrual syndrome, and cycle length.	RT supports ovulation indirectly by improving metabolism; it reduces symptoms primarily through reduced inflammation and stress.	[31–33]
Overall reproductive-health impact	Strong evidence for improving hormonal balance, cycle regularity, and ovulatory frequency, especially at moderate intensity.	Moderate evidence; RT benefits are indirect, moving from metabolic to hormonal to ovulatory effects.	[13, 44]

amenorrhoea [45]. Future research should include diverse age groups, ethnicities, and reproductive-health profiles to enhance the applicability of findings.

4.3. Intensity and duration thresholds

There are no clear guidelines on exercise intensity and duration that maximise ovulatory health. Such studies are critical to understand the level of exercise that leads to HPO-axis dysregulation [28, 34]. Exploring moderate-intensity resistance and aerobic regimens and their effects on systemic markers can help identify optimal exercise parameters.

4.4. Mechanistic insights into hormonal responses

The precise physiological mechanisms underlying exercise-induced alterations in endogenous ovarian function remain unclear [39, 46, 47]. Further research is needed to clarify how hormonal axes, including cortisol and insulin regulation, interact with the HPO axis during resistance and aerobic training. Advanced methodologies, such as molecular and imaging techniques, could provide deeper insights.

4.5. Integration of nutrition and exercise

The interaction between exercise and nutritional status is a crucial but still underexplored area in women's ovulatory health [38, 48, 49]. Future studies should evaluate how caloric intake, macronutrient composition, and meal timing affect the relationship between reproductive function and exercise. This integration could provide more comprehensive lifestyle recommendations for women.

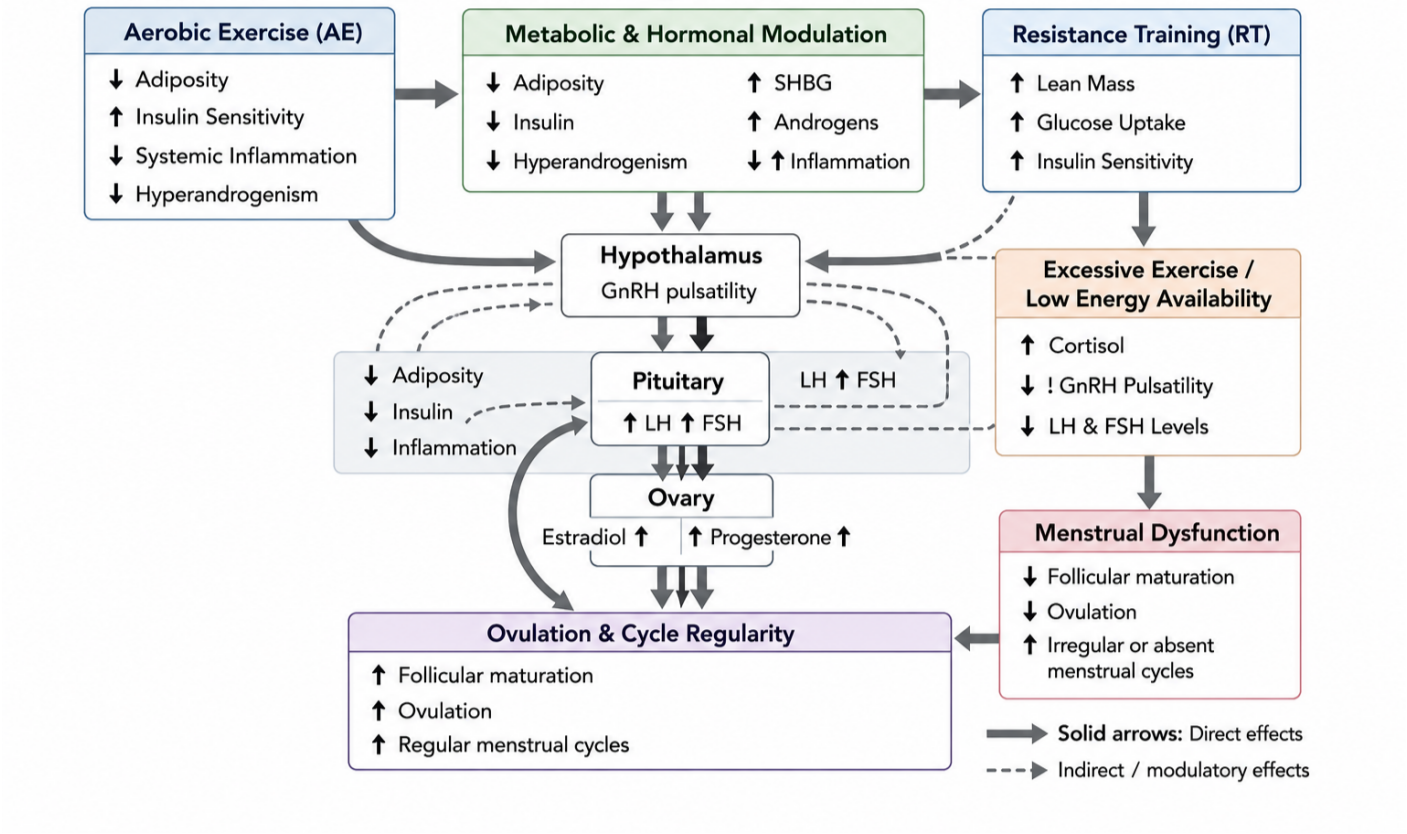

Figure 3: Mechanistic pathways linking aerobic exercise and resistance training to ovulatory function.

4.6. Impact of psychological factors

Exercise-induced changes in stress levels and their subsequent effects on ovulatory function are not well characterised. Stress is a key modulator of the hypothalamic–pituitary–adrenal (HPA) axis, which has significant interaction with the HPO axis [26, 50]. Studies show that chronic stress elevates cortisol levels, disrupts GnRH, suppresses the secretion of LH and FSH, and impairs ovarian function [51, 52]. Future research should explore how psychological well-being and stress-reducing interventions interface with exercise to enhance reproductive outcomes.

5. Recommendations

5.1. Balancing resistance and aerobic training to prevent exercise-induced reproductive issues

Research suggests that a combination of resistance and aerobic exercise can offer significant benefits for ovulatory and overall health in women. Progressive resistance training has been shown to improve hyperandrogenism, menstrual-cycle regularity, and functional capacity in women with PCOS [52].

For postmenopausal women, combined resistance and aerobic training performed three times a week for 12 weeks can reduce arterial stiffness and improve cardiovascular outcomes [53]. Resistance training can positively influence various health factors, such as insulin resistance, glucose metabolism, and body composition, even in brief weekly sessions [33, 44, 54, 55].

These findings support the complementary advantages of integrating both RT and AE to maintain hormonal balance and improve overall quality of life in women. Therefore, achieving a balance between the two modalities is crucial, as moderate structured exercise supports optimal ovulatory function, while both very low and excessively high training loads may increase the risk of reproductive dysfunction through disrupted metabolic and hormonal regulation (Figure 4).

5.2. Preventing exercise-induced reproductive issues

High-intensity exercise can disrupt the female reproductive system, leading to delayed menarche, menstrual irregularities, and amenorrhoea [56]. These disturbances are primarily caused by energy deficiency, where energy expenditure exceeds dietary intake, rather than exercise itself [57]. The resulting suppression of GnRH pulsatility disrupts the HPO axis, potentially leading to infertility and compromised bone density [58].

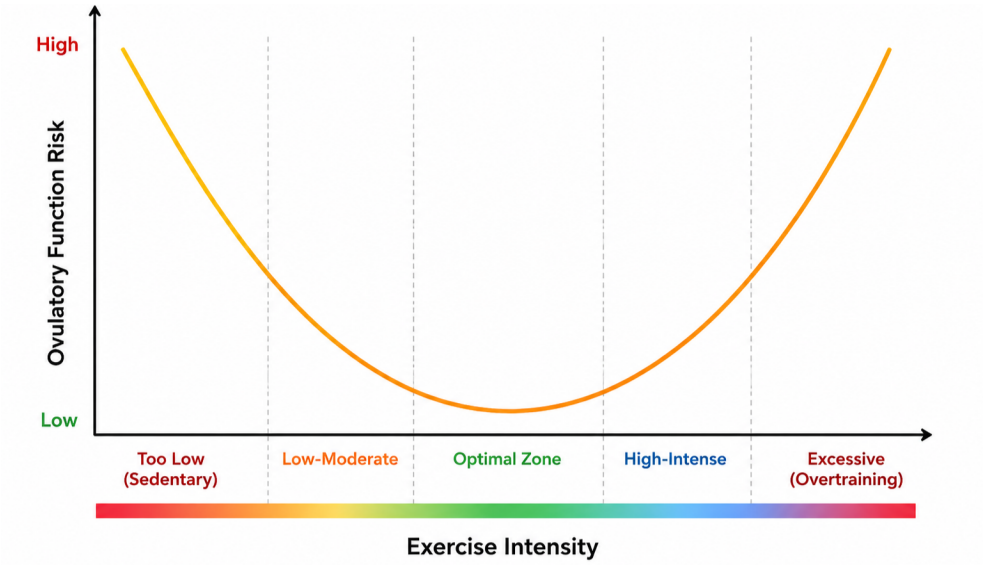

Figure 4: U-shaped relationship between exercise intensity and ovulatory function. Both low physical activity and excessive exercise with low energy availability increase the risk of ovulatory dysfunction, while moderate, well-fuelled exercise supports optimal reproductive and endocrine health.

Strategies that prioritise adequate nutrition, such as increasing caloric intake to match exercise demands, have been shown to restore menstrual function, improve hormonal status, and support bone health in affected individuals [16]. Education on these strategies, monitoring of excessive training, and early detection of cycle disturbances are recommended, especially for athletes and highly active women.

6. Conclusion

This narrative review provides a comparative overview of how RT and AE influence ovulatory function through hormonal and metabolic pathways and highlights their relevance for women's reproductive health. Both AE and RT appear to contribute to ovulatory function by improving metabolic balance and hormonal regulation.

Studies suggest that moderate, well-monitored training generally confers ovulatory benefits by improving hormonal balance and metabolic fitness, including insulin sensitivity and cardiovascular health. By contrast, excessive training, when combined with low energy availability, can inhibit the HPO axis and thereby cause menstrual disturbances and reproductive impairment. Furthermore, current evidence suggests that AE shows more consistent benefits, particularly in improving menstrual regularity and body composition, while RT appears promising but less consistent, with its effects largely linked to metabolic and androgen-related changes.

Combining both RT and AE in a well-designed training protocol may exert synergistic effects on metabolic health while attenuating the risk of ovulatory dysfunction and enhancing long-term reproductive fitness. Future research should identify ideal intensity thresholds, energy-availability targets, and training periodisation models to inform evidence-based prescriptions for exercise in women of various life stages.

Data availability

No new data were generated or analysed in this study. Data sharing is not applicable to this article.

Declaration of competing interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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