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High Intensity Interval Training For Cardiometabolic Disease Prevention In Polycystic Ovarian Syndrome Females: Literature Review

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Abstract

Aims: Thisnarrative review aims to examine the effect of high intensity interval training (HIIT) for prevention ofcardiometabolic disease in females with polycystic ovarian syndrome (PCOS). Also,itaims to provide a framework for future research to be able to formulate more comprehensive, lifestyle-centered guidelines intreating women with PCOS.

Methods: A literature search was elicited in PEDro, Cochrane library, PubMed, and Google Scholar databases with the keywords"Physical therapy modalities", "PCOS", "HIIT", "Exercise protocol","Cardiometabolic Risk", "Insulin Resistance (IR)" and "Metabolic syndrome".Reviewed literature was analyzed and summarizeddescriptively.

Results: HIIT can lower IR and improve metabolic syndrome when performed in regular basis.

Conclusion: HIIT is effective in prevention of cardiometabolic disease in polycystic ovarian females.

Keywords

Polycystic ovarian syndrome,High intensity interval training, Insulin resistance.

Introduction

Polycystic ovarian syndrome (PCOS) is one of the most common endocrinopathies in femaleswith a prevalence of 6–10% worldwide[1]mostly diagnosed in reproductive age group[2]. It's characterized by hyperandrogenism (HA) in the ovaries, ovarian enlargement of > 9 mm, presence of 10 or morecysts (2 to 8mm)and clinical signs of oligomenorrhiaand /or hirsutism[3].So, it is recognized as a leading cause foranovulatory infertility[4].

Phenotypically,PCOS is classified into 4 types; type A with ovulatory dysfunction, polycystic ovarian (PCO) morphology and HA,type B with ovulatory dysfunction and HA, type C withPCO morphology and HA, and type D with ovulatory dysfunction and PCO morphology[5]. The most common type identified in clinical populationsis phenotype-A and they were at increased risk for cardiovascular disease and metabolic syndrome[6].

There are several first-line treatments-despite the unknown etiology of PCOSimproving the clinical factors as ovulation inducing medications and insulin sensitizing agents[7].

Exercise andlifestyle modification, remains the most effective method for managing PCOS. Exercise and diet improve cardiovascular risk factors and help with hormonal dysfunction and weight loss[8].

Exercise training and its effects in PCOS patients has been done in some domains as: body composition, reproductive function[9], IR[10]and cardiorespiratory capacity[11]. However a systematic review regarding exercise interventions in PCOS, concluded that we can't make definite results due to high heterogeneity in outcomes and designs and this suggests that there is still need for more studies regarding the effectiveness of exercise in PCOS[12]

Methods: A literature search was elicited in PEDro, Cochrane library, PubMed, and Google Scholar databases with the keywords"Physical therapy modalities", "Polycystic ovarian syndrome", "High intensity interval training", "Exercise protocol","Cardiometabolic Risk", "Insulin Resistance" and "Metabolic syndrome".Reviewed literature was analyzed and summarizeddescriptively.

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Results:

Insulin resistance (IR) in PCOS

Polycystic ovarian syndrome(PCOS) is a metabolic disorder with increased prevalence of IR, dyslipidemia, hyperinsulineamia and low-grade inflammation [13] and increased prevalence of obesity and excessive body fat and central adiposity even in lean women with PCOS[14], thismakes thosewomen at a greater risk for developing cardiovascular disease (CVD) and type 2 diabetes[15].

The mechanism of IR is suggested to be due to chronic mild inflammation with higher level of several cytokinesthan normal, including Tumor Necrosis factor (TNF-α), Interleukin-6 (IL-6), and c-reactive protein (CRP)inflammatory markers [16]. Another mechanism suggests that it is due to higher rates of impaired glucose tolerance (IGT) which is even seen in non-obese in comparison with weight-matched control women[17].IR could be either intrinsic (underlying) or extrinsic(obesity-related)which even exacerbates IGT andrisk of type 2 diabetes mellitus[18].

Intrinsic related IR is due to impaired insulin signaling ofskeletal muscle [19]and mitochondrial dysfunction[20]leading to impaired response ofskeletal muscle to glucose and hence exacerbating the condition[11].

Cardiometabolic risk in PCOs

Cardiometabolic risk is the risk to develop type 2 diabetes and cardiovascular diseases (CVD).Endothelial dysfunction is evident in women with PCOS, even if they are young and nonobese. It is an early important event in the development of atherosclerosis, which precedes gross morphological signs and clinical symptomssuggesting that women with PCOS are at greater risk of CVD[21].

The associated risk factors which enhance cardio-metabolic risk include increased abdominal girth, increased blood pressure, low levels of high density lipoprotein (HDL), high triglycerides levels (TG)and impaired fasting glucose[22]. These associated risks are not explained by the diagnostic criteria but may be affected by abdominal visceral adiposity than subcutaneous abdominal fat(fat deposition and/or distribution)[15].High visceral adipose tissue surrounding the intra-abdominal organs leads to where there is altered sensitivity to insulin, lipolytic activity and a pro-inflammatory state releasing adipocytokinessuch as leptin, adiponectin, TNF-α and resistin[23] which predisposes to diabetes, hypertension, lipid abnormalities and high mortality rate[24].

On clinical basis, visceral adipocyte dysfunction can be predicted by visceral adiposity index (VAI). It increases in relation to the severity of anovulation, IR and inflammation [15].It also predicts the conversion of metabolically healthy obesity to metabolically unhealthy obesity [25].It predicts the cardio-metabolic risk of oligomenorrheic phenotype of PCOS. It can be estimated by using simple anthropometric measures; body mass index (BMI) and waist circumference (WC) and biochemical parameters;triglycerides (TG) and high-density lipoprotein (HDL)[26]. The equation as follows:

$$\text{VAI} = \left(\frac{WC}{36.58+(1.89\times BMI)}\right) \times \left(\frac{TG}{0.81}\right) \times \left(\frac{1.52}{HDL}\right)$$

The quantitative analysis of visceral and cutaneous fat is carried out via Magnetic Resonance Imaging (MRI) or Computed Tomography (CT) and remain the gold standard for assessment of visceral adipose tissue [27].

High intensity interval training(HIIT) in PCOS

High intensity interval training (HIIT) is a fitness program that includes short bouts of high intensity exercise with intervening active recovery [28]. It is safe,acceptablewith less barriers reported as those reported in most women of reproductive age, which includes time limitations and competing commitments in addition to PCOS-specific barriers as physical limitations and low confidence [29]

HIIT has a superior effect on IR, cardiovascular risk factors[30]and cardiorespiratory fitness in clinical populations, including women with PCOS[31].

Other usually used types of training includes continuous aerobic physical training (CAT) which is characterized by a submaximal power output which Is constant during the whole session, this promotes higher rate for fat oxidation. Researches have shown that moderate-intensity CATor high-intensity interval training (HIIT) treats metabolic diseases including Type 2 diabetes mellitus[32,33]and obesity[34]. This is consideredimportant for PCOS women as IR and obesity are prevalent in them and aggravate thedisease process. In PCOS,different health-enhancing effects are evident inintermittent aerobic training protocols and other protocols of large intensitiesrange. For example, a study concluded that moderate-intensity intermittent aerobic exercise training (IAT)more than 150 minutes a week is more effective than CAT in weight loss in obese and overweight women[35]. IAT consists of alternating periods of high and low intensity within an exercise session, which increases metabolic capacity (aerobic and anaerobic)[36]. In contrast, another study concluded thatHIIT and moderate CATfor five weeks were effective to reduce sexual hormones in young

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obese women [37]. In type 2 diabetes mellites individuals, thesame intensity of IATand CAT is effective for glycemicreduction and acute pressure reduction, whilethe intermittent method is safer for patients with greater risk of hypertension[38].

Also, it is not clear whethervigorous intensity intermittent training adds any physiological effects than continuous training of moderate-to-vigorous intensity in PCOS women but it is already known that with the same exercise volume, higher exercise intensity is more effective for improving physical fitness than lower exercise intensity in healthy adults[39].

Intrinsic motivations and achievement are important for long-term adherence. HIIT, due to constantly changing stimulus, seems to be more motivating and enjoyable than continuous aerobic training (CAT) [30]. Despite the fact that vigorous exercises is usually avoided by many people, they tend tomaintain the intervention due to the feeling of improved physical performance after they perform aerobic exercises[40].

Table 1: The characteristics of the studies using HIIT in PCO women

First author, year	Study design	Intervention duration	Number Of cases	Participants criteria	Comparators	Outcomes	Conclusion
Aktas et al., 2019[41]	-CT quasi - Experimental	12 w	31	-Age: 25.1 (4.6) -BMI: 28.7 (6.9) kg/m2	-MICT (running) VS HIIT (walking/ running)	-Leptin -Adiponectin -Serum insulin - TG -Total cholesterol -LDL& HDL	-HIIT increased the adiponectin levels and provided more weight loss -Serum levels of insulin, TG, total cholesterol & LDL decreased.
Almmening et al., 2015[42]	-RCT -Pilot	10 w	31	-Age: 27.2 (5.5) -BMI: 26.7 (6.0) kg/m2	-HIIT (walking/ running and/or cycling) VS -Strength training (eight dynamic strength drills with a resistance/machines) VS - Control group (no intervention)	-HOMA-IR -HDL -Endothelial function -Fat percentage -CRP -Adiponectin or leptin in any group	-Improved insulin resistance, without weight loss. -Body composition improved significantly after both strength training and HIIT. -This pilot study indicates that exercise training can improve the cardiometabolic profile in pcos in the absence of weight loss.
Bahar et al., 2019[43]	-CT quasi - experimental	12 weeks	24	Age: 34.34 (4.69) BMI: 21.19 (1.74) kg/m2	HIIT (running) VS Control group (no intervention)	-HOMA-IR -Serum CRP level	. HIIT is associated with improvement of insulin resistance and decrease in hs-CRP in PCOS patients. HIIT is associated with improvement of insulin resistance and decrease in hs-CRP in PCOS

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							patients. HIIT is associated with improvement of insulin resistance and decrease in hs-CRP in PCOS patients. -HIIT is associated with improvement of IR and decrease in CRP in PCOS patients.
Danielle Hiam et al., 2019[44]	-RCT	12 weeks	60	Age: 18-45 BMI:> 25kg/m2	HIIT VSMICT	-Measure the improvements in metabolic health; specifically changes in insulin sensitivity, HDL and BMI	-HIIT shows more improvements in insulin sensitivity and high-density lipoprotein cholesterol and a decrease in fat percentage than MICT
Harrison et al., 2012[10]	RCT	10 weeks	60	Age: 25.2 (5.5) BMI: 23.7 (4.0) kg/m2	HIIT VS Strength training	Improved HOMA-IR and CRP levels, but strength training did not affect CRP level.	HIIT is better than strength training in improving IR and CRP in PCO women.
Samadi et al., 2020[45]	RCT	12 weeks	30	Age: 20–35 years BMI: 32.80 (4.49) kg/m2	HIIT VS Control group (use Metformin-1500 mg)	-HOMA-IR -BMI - VO2peak (mL/ min) -WHR (cm) -LH (mIU/mL) -Hirsutism (F-G score) -Premenstrual period (between 38 and 28 days)	HIIT exercises increase in VO_{2peak}, weight loss and reduction in insulin level, improvement in insulin sensitivity and hormonal levels cause improvement in endocrine condition, hirsutism severity and menstrual order in obese women with PCOS.
Rhiannon et al., 2020[46]	RCT	12 weeks	24	Age: 20–40 years BMI: 30.20 (4.49) kg/m2	-HIIT VS -MICT(cycling)	-WHR -BMI -AMH -HOMA-IR	Body composition, fasting insulin and AMH remained unchanged in both groups, while IR showed non sig. change compared to other group. HIIT is recommended for improving cardiometabolic

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							health in PCO women.

MICT: moderate intensity continuous training. RCT: randomized controlled trial. CT: continuous training. LH: leutinizing hormone. LDL: low density lipoprotein.

SUMMARY

It was recommended that HIIT caneffectively prevent and improvecardiometabolic parameters in PCO patients. It effectively reduces insulin resistance, BMI, hyperandrogenism, improves hormonal profile and increases cardiorespiratory fitness. However in some patients, other forms of exercise are shown to be equally effective to HIIT and in others it doesn't show any effect. This emphasizes the need for more studies with different exercise intensities to determine the efficacy of HIIT on preventing and treating cardiometabolic dysfunction in PCO women.

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