

A Review on the Effect of Polycystic Ovary Syndrome on Some Hormonal and Metabolic Disturbances in Women

Sarah Hasan Kadhum AL Huchaimi^{1,*}, Maysoon Khudair AL Hadrawi², Raja Jawad Mohmad³

Abstract

Polycystic ovary syndrome (PCOS) is a common hormonal condition that affects women of reproductive age. It usually begins to appear during adolescence. The ovaries produce abnormal amounts of “androgens”, which are male sex hormones that are usually found in women in small quantities. Ovarian syndrome causes hormonal imbalances, irregular menstrual cycles, increased cysts in the ovaries, in addition to hair growth all over the body, acne, and pain in the pelvic area. Irregular menstrual cycles, often accompanied by a lack of ovulation, can make it difficult to get pregnant and cause infertility. The cause of polycystic ovary syndrome is unknown, but women with a family history or those with type 2 diabetes are more susceptible to it. The risk factors for polycystic ovary syndrome are obesity and lack of movement, in addition to genetic factors and family medical history. Where PCOS is associated with insulin resistance and obesity also diabetes mellitus type 2, and heart disease, as well as recurrent miscarriage and various cancers, cardiovascular diseases (CVD), chronic inflammation, and various cancers, such as uterine and ovarian cancer. One of the most important pathological symptoms in women with polycystic ovary syndrome is the formation of several ovarian cysts containing immature eggs that grow at the same time, then their growth stops without reaching the appropriate size, and ovulation does not occur, and this is determined by ultrasound examination. The patient also suffers from infertility despite not taking contraindications for pregnancy. Some of its symptoms are relieved by lifestyle changes, medications, and fertility treatments. so we designed this review to assess the relationship between polycystic ovary syndrome and some hormonal disturbances and Metabolic disturbances in an infected woman’s body.

Keywords: CVD, PCOS ovary, metabolic, Infertility

INTRODUCTION

Polycystic ovary syndrome (PCOS) is one of the most common hormonal and hereditary disorders

in women. It was first described by the two scientists Stein and Leventhal in 1935, and the incidence of the syndrome is estimated at 15–20% of women in the world of childbearing age (12–45) years [1], and it is the main cause of infertility, whether primary or secondary in women, [2]. Polycystic ovary syndrome is a clinically heterogeneous condition in affected women, as PCOS occurs in most societies, and environmental and genetic factors have a major impact in causing the disease, but the main cause of its occurrence is not known accurately and with certainty. [3]. There are many clinical and biochemical features of the syndrome, including increased levels of androgenic hormones (hyperandrogenesis) [4]. Insulin-resistant (IR) (disorders (MD) is the main metabolic disorder associated with women with the syndrome. About

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70% of people develop insulin resistance and develop type 2 diabetes [5]. Genetics plays a major role in causing the syndrome [6]. at least about 100 candidate genes contribute to the occurrence of the disease [7], including genes responsible for manufacturing steroid hormones or that contribute to inflammation (CYP19), CYP11A, CYP21, and (CYP17), such as chronic inflammation (steroids hormones) genes, such as (TPA, PTI) genes, INF-a) or which praps et (FSHR. INSR and (IL-6) are involved in the reproductive process and insulin resistance, including genes. The disease causes other complications in the long term. [8] as high blood pressure obesity chronic cardiovascular diseases (CVD) [9], recurrent miscarriage [10], the occurrence of stroke and endometrial carcinoma, breast cancer, and ovarian cancer [11].

POLYCYSTIC OVARY SYNDROME

Polycystic ovary syndrome (PCOS) is known as a complex, genetically heterogeneous disorder [12]. The syndrome is characterized by hyperandrogenism, absent or infrequent menstruation, hirsutism, and the appearance of facial acne [13]. In most common cases, infertility occurs among affected women of normal reproductive age, as it is one of the most common hormonal diseases in various countries of the world [14].

SYMPTOMS OF POLYCYSTIC OVARY SYNDROME

Ovarian Sacs

Women with polycystic ovary syndrome have a large number of cysts containing immature eggs ranging in size from 2–9 mm, as in each menstrual cycle the cyst grows to form a mature egg whose size ranges from (18–22) mm, but Several cysts grow at the same time, then they all stop growing halfway through, and thus none of these eggs reach the appropriate size and ovulation does not occur. This is diagnosed using ultrasound imaging, which shows an increase in the size of the ovary and the appearance of cysts. Like beads [15]. When ovulation does not occur for some reason, the granulosa region of the ovary, which surrounds the ovarian follicle, self-destructs, leading to programmed cell death (apoptosis), leading to the follicle breaking up into parts and disappearing [16]. However, the theca cells do not die and are preserved due to the high content of insulin, which prevents the follicle from turning which leads to the formation of the ovarian cyst [17]. Theca cells produce the hormone androstenedione, and after a short period, the granulosa cells convert it into estrogen, while the theca cells convert it into testosterone [18, 19].

Infertility

Infertility is defined as the failure to obtain pregnancy after a full year of regular sexual intercourse and without the use of contraceptives [20], or the pregnancy is repeated in the woman but does not continue, and does not include infertility resulting from surgery, such as removing the ovaries or using an implant. Medical treatments that have side effects on reproductive health, such as chemotherapy and radiation therapy [21]. A couple is not considered fertile unless the woman carries a full-term child and is born alive, and the resulting child is healthy [22].

The hormones of the (hypothalamus, pituitary gland, and ovary) participate in regulating the reproductive and physiological functions in the body by stimulating some hormones and inhibiting others through a feedback mechanism. An imbalance in this hormonal balance leads to PCOS syndrome, which affects women, especially in the reproductive age [23], the high percentage of infertility in women with polycystic ovary syndrome may be attributed to several explanations, including the presence of an imbalance in the hypothalamic-pituitary axis, which may increase the ratio of secretion of luteinizing hormone to follicle-stimulating hormone (LH\FSH ratio) and as a result stimulate the theca cells of the ovary to secrete higher levels of testosterone hormone, which may cause an imbalance in the growth and development of the follicles and may be a result of the hypothalamus [24, 25]. The egg and the imbalance in the secretion of its hormones that release GnRH agonists play an important role in causing infertility in polycystic ovary syndrome [26].

Hypothyroidism may contribute to the infertility of women with polycystic ovary syndrome. Also, a decrease in the hormone T3 and Thyroxine (T4) and an increase in the concentration of thyroid-stimulating hormone (TSH) may lead to an increase in the secretion of testosterone and cause infertility through the effect of (TSH) on estrogen metabolism and reduce the production of (SHBG), which transports androgens and estrogens in the blood and delivers them to the target tissue, thus increasing the level of free testosterone in women with the PCOS syndrome, causing infertility [27, 28].

The state of infertility is also due to women suffering from type 2 diabetes, which may stimulate the ovaries to secrete androgens, which may contribute to the state of infertility or cause a high level of insulin, which slows the liver's production of SHBG, causing an increase in free androgens [29]. More than 60% of PCOS women suffer from primary and secondary infertility [30] usually pregnant women and women with PCOS are exposed to problems of miscarriage, high gestational diabetes, and recurrent gestational diabetes [31].

Metabolic Disturbances in PCOS Women

Women with PCOS often suffer from metabolic disorders with a decrease in insulin secretion or a decrease in its effect [30]. Insulin resistance with compensatory hyperinsulinemia is the main feature of PCOS, as well as metabolic syndrome [5]. Women with PCOS are usually at risk of developing type 2 diabetes [30]. The state of excess androgens can be considered a pathogenetic component of the female metabolic syndrome [31], and women with PCOS suffer from an increased prevalence of multiple risk factors that increase the risk of cardiovascular disease, such as high blood pressure, obesity, type 2 diabetes, and lipid dyslipidemia [32].

Insulin Resistance (IR)

The normal state of glucose homeostasis is defined as a state of delicate balance between the effect of insulin in target tissues and insulin secretion by pancreatic beta cells. Skeletal muscles, liver, and adipose tissue are usually exposed to insulin, as the effect of insulin in skeletal muscles is estimated at 85% of the total amount of insulin. Which is proportional to the amount of glucose taken [33]. Skeletal muscle is the important target for glucose homeostasis, while adipose tissue has a central role in determining the insulin sensitivity of the entire body [34] 70% of women infected by PCOS are suffering from insulin resistance [35]. Insulin resistance can be defined as the response to impaired insulin bioavailability with a state of compensatory hyperinsulinemia, making patients vulnerable to infection with impaired glucose tolerance and type 2 diabetes, studies have shown that 30–40% of women with PCOS have impaired glucose tolerance and 10% of them developing type 2 diabetes at the age of 40 years and such a condition is attributed to defects in insulin secretion and decreased hepatic insulin clearance in the blood [5].

Insulin resistance is considered the key to many pathophysiological characteristics of PCOS, causing a lot of imbalances in the reproductive and metabolic processes. Insulin is responsible for stimulating the product of androgens in the ovaries and reducing the formation of hepatic SHBG through the increase in Free and total androgens [36].

Obesity

Women infected with polycystic ovary syndrome (PCOS) are more likely to develop the condition of obesity than other women in the world, and the prevalence of overweight and obesity in women with PCOS varies between countries and ethnic groups, ranging between (60–80%) [37, 38] women with PCOS showed a decrease in SHBG levels and an increase in free androgen levels compared to their normal weight counterparts [39]. It has been found that the distribution of fat in the body affects the concentration of SHBG and androgen [40].

Obesity negatively affects reproductive function independently in women with PCOS, and obese women with the syndrome are more have more difficult pregnancies and less responsive to anabolic

drugs [41]. Obesity and factors associated with adipose tissue play an extremely important role in inducing and sustaining PCOS. Abnormal fat distribution leads to metabolic imbalances in addition to the effect on endocrine function [24]. Adipokine, such as Adiponectin, is secreted exclusively from adipose tissue in increasing insulin resistance and other disorders. Some adipokines are secreted abnormally from adipose tissue and can affect the function of the adrenergic gland and the ovary. It has been found that tissue releases many adipokines in PCOS women. Alarming, these changes may reflect the degree of obesity or insulin resistance instead of reversing it on the PCOS itself [42].

Obesity is usually linked to insulin resistance and the distribution of lipids in the body is considered a specific marker of irregular metabolism. Among the metabolic imbalances associated with insulin resistance are high plasma glucose, problems in regulating lipids, increased plasma triglycerides, low-density lipoprotein, high-density lipoprotein, and high blood pressure. The effect on prothrombotic state and obesity, and these problems and imbalances in metabolism stimulate the occurrence of type II diabetes atherosclerosis, and heart disease [43].

Hormonal Disturbances of PCOS

The ovaries in women with the syndrome do not respond appropriately to pituitary hormones as in natural ovulation, as both LH and FSH hormones affect the ovary and its hormones directly. FSH is the main hormone in the follicular phase of the menstrual cycle, which stimulates the formation and maturation of eggs and thus the secretion of the hormone estrogen from the Graffian follicle [44] while LH is the main hormone in the luteal phase, which stimulates ovulation, and then combines estrogen and progesterone in the corpus luteal phase after ovulation, and any imbalance in FSH and LH levels reflected in the level of the hormones progesterone and estrogen, as well as in the production of the male hormone, and thus causes disorders in the reproductive function of the ovary, such as menstrual cycle disruption, delayed childbearing, or infertility, which is called reproductive disorders [23]. Research has indicated that menstrual cycle disorder in adolescence from 16 years and above leads to an increased risk of developing PCOS, especially in obese girls, or when there is an increase in the level of the abnormal LH hormone, which causes anovulation, as the syndrome is at its peak between the ages of (18–30) year (Büyükyılmaz et al., 2024) that infection with PCOS at an early age and failure to ovulate for a long period leads to delayed childbearing, and if pregnancy occurs, it is subject to spontaneous miscarriage or accompanied by gestational diabetes disease [45, 46].

Hyperandrogenism is one of the most common biochemical features in women with polycystic ovary syndrome (PCOS). It is found in approximately 70–80% of PCOS women and is associated with a high concentration of free testosterone and hirsutism [47]. The state of hyperandrogenism appears in the form of hirsutism, acne as well as male pattern alopecia, androgen excess affects both the oxidant process and antioxidant activity in PCOS women [48].

Hirsutism means hair growth on the face, lower abdomen, chin, upper lip, and upper and lower back. It represents a condition where villus hair turns into terminal hair, and the distribution is in a male pattern because of the high level of androgens in those suffering from the syndrome [49]. Hirsutism affects (60–90%) of women with polycystic ovary syndrome [50] the distribution and density of hair differs according to humans. For example, Caucasians have denser and more widespread male hair than Americans and Indians, and it appears that the genetic influence is greater than the hormonal factors in hair growth, and increased androgen production leads to hirsutism and acne, which appears approximately (35%) of PCOS [51] and acne is mainly associated with high levels of Sebaceous secretion [52].

Insulin resistance, hyperinsulinemia, and oxidative stress (OS) play an important role in the pathogenesis of PCOS [53]. Oxidative stress, as is known, contributes to the occurrence of cardiovascular disease (CVD) in women with PCOS. OS usually occurs because of an imbalance between oxidant agents and antioxidant agents [54].

Nitrogen oxide species (NOS) is one of the most important oxidation agents. It is a free radical with nitrogen centers that include nitric oxide (NO) and nitrogen dioxide (NO₂). NO is formed through the conversion of L-L-arginine to citrulline in the presence of the argininosuccinate synthetase and lyase enzyme [55]. In normal physiological conditions, NO works to regulate the cellular functions of the cell, while its excess leads to cellular toxicity, as well as damage to all carbohydrates, proteins, lipids, and nucleic acids [56]. As for reactive oxygen species (ROS), they are one of the main forms of free radicals contained in central oxygen. They are unstable and fast compounds that interact with other molecules to form compounds containing pairs of electrons in their outermost shells [57]. About 98% is consumed of the oxygen inhaled through the process of lipolysis and the generation of necessary chemical energy, and 2% is reduced to three main forms of ROS sources, including (O₂⁻.H₂O₂, OH) [58].

When there is not a sufficient amount of antioxidants, ROS are generated and cause cell damage and the process of replacing purines with pyrimidines, which leads to the process of breaking the DNA strand and damaging it [59], protein carbonyl from the strong oxidizing factors, which associated with PCOS syndrome. It was observed that women with PCOS had a high increase in protein oxidation and protein carbonyl levels, which documents the relation between insulin resistance and protein carbonyl in women infected with PCOS [60].

ROLE OF ANTIOXIDANTS FACTORS IN PCOS

Antioxidant factors in PCOS women prevent or reduce the harmful effects that occur as a result increase in oxidizing factors in the body, which plays an important role in the reproductive system and reduces infertility [56].

Changes in the concentration of some antioxidant compounds in the serum and surrounding fluids have been observed in women with PCOS, which are considered indicators of the modification or elimination of factors: oxidative stress, metabolic disorders, obesity, type 2 diabetes, and heart disease [61]. The Bakken group concluded that oxidative stress induces programmed cell death (apoptosis), and many of the substances that induce programmed cell death are either oxidants or stimulate oxidative metabolic. In contrast, many of the inhibitors of programmed death are substances that have antioxidant activity or enhance the cell's antioxidant defenses [62].

CONCLUSIONS

As for reactive oxygen species (ROS), they are one of the main forms of free radicals contained in central oxygen. They are unstable and fast compounds that interact with other molecules to form compounds containing pairs of electrons in their outermost shells.

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