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Original Research Article

EFFECTS OF A KETOGENIC DIET IN OVERWEIGHT WOMEN WITH POLYCYSTIC OVARY SYNDROME

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Abstract: *Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting reproductive-aged women, characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. The main objective of the study is to find the effects of a ketogenic diet in overweight women with polycystic ovary syndrome. This prospective interventional study was conducted in a private hospital in Karachi, Pakistan, from June 2023 to Dec 2023. Data was collected from 320 females who were suffering from PCOS. Participants were randomized into two groups: the intervention group (n = 160) received a ketogenic diet, while the control group (n = 160) followed a standard hypocaloric diet. Randomization was performed using computer-generated random numbers to ensure allocation concealment and minimize selection bias. Upon enrollment, participants underwent baseline evaluations to establish their demographic characteristics, medical history, and anthropometric measurements, including weight, BMI, and waist circumference. Data were collected from 320 female patients. In the ketogenic diet (KD) group, participants had a mean age of 28.1±4.2 years and a mean BMI of 30.01±2.3 kg/m2. Their waist circumference averaged 90.1±5.0cm, with a fasting glucose level of 110±10 mg/dL and a DHEAS level of 350±50 µg/dL. In the ketogenic diet (KD) group, participants experienced a mean reduction in body weight of 8.5±2.3kg, a decrease in BMI of 3.2±1.1Kg/m2, and a reduction in waist circumference of 10±4cm. Conversely, the control group exhibited a mean decrease in body weight of 2.5±1.5kg, a reduction in BMI of 1.0±0.8kg/m2, and a decrease in waist circumference of 3±2cm. It is concluded that the ketogenic diet may offer metabolic and reproductive benefits for overweight women with polycystic ovary syndrome. The improvements observed in metabolic parameters and menstrual regularity support the potential role of KD as a therapeutic intervention in PCOS management.*

Keywords: PCOS, Pregnant, Patients, Overweight, Ketogenic, Diet

Introduction

Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting reproductive-aged women, characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Alongside its reproductive implications, PCOS is frequently connected with metabolic disturbances, including insulin resistance, obesity, and dyslipidemia, which add to an expanded gamble of cardiovascular sickness and type 2 diabetes mellitus (Khalid et al., 2023). Lately, the therapeutic capability of dietary medications, such as the ketogenic diet (KD), has accumulated significant interest in overseeing PCOS-related metabolic anomalies. The KD, portrayed by high fat, moderate protein, and deficient carb consumption, prompts a condition of nourishing ketosis, prompting changes in substrate digestion and further developed insulin responsiveness (Paoli et al., 2020).

Polycystic ovary condition (PCOS) stands as the most pervasive problem of ovarian capability, addressing a typical reason for hyperandrogenism and anovulation among juvenile and grown-up women of childbearing age, with a predominance going from 6 to 15%. Its trademark highlights incorporate hyperandrogenism, skin inflammation, hirsutism, feminine abnormalities, ovarian morphological changes, and raised degrees of androgens, primarily testosterone (El Hayek et al., 2016). The condition's pathogenesis is multifactorial, including hereditary, natural, metabolic, and endocrine factors. Ecological impacts, like obesity and way of life decisions, fundamentally add to PCOS advancement. Around 75% of PCOS patients are either overweight or fat, with central obesity seen in both typical weight and overweight people impacted by PCOS (Barrea et al., 2018).

Since the mid-18th century, a global shift from agriculture to modern industry has resulted in significant changes in our daily dietary habits. Weight loss diets have gained popularity among health enthusiasts, with the ketogenic diet recently experiencing a resurgence due to its purported anti-aging effects and efficacy as a fat burner (Barrea et al., 2019). This diet is being explored as a potential intervention for women with PCOS to aid in weight loss, improve sex hormone levels and fertility, optimize cholesterol levels, and normalize menstrual cycles (Frary et al., 2014). The ketogenic diet drastically reduces daily carbohydrate intake to below 50 g, significantly lower than the recommended daily allowance of 130 g/day, while adjusting fat and protein intake based on ideal body weight (Muscogiuri et al., 2019). To mitigate potential adverse

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effects on gut microbiota, such as gastric upset and constipation, supplementation with fiber and nondigestible carbohydrates like raw cornstarch and sourdough bread is advised when following a ketogenic diet in PCOS management (Alessandro et al., 2015).

It's interesting how excessive carbohydrate intake and low-grade inflammation interact with insulin resistance and hyperandrogenism, exacerbating the metabolic phenotype of PCOS. Acute hyperglycemia, for instance, is known to escalate inflammation and oxidative stress by generating reactive oxygen species (ROS) (Erickson et al., 2017). PCOS women typically exhibit a distinct dietary pattern characterized by reduced consumption of extra-virgin olive oil, legumes, seafood, and nuts, as well as lower amounts of complex carbohydrates, fiber, and monounsaturated fatty acids. Conversely, their diets often contain higher levels of simple carbohydrates, total fat, and saturated fatty acids compared to women without PCOS. These nutritional patterns are associated with adverse body composition, marked by decreased fat-free mass (Caprio et al., 2019). Thus, the main objective of the study was to find the effects of a ketogenic diet in overweight women with polycystic ovary syndrome.

Methodology

This prospective interventional study was conducted in a private hospital in Karachi, Pakistan, from June 2023 to Dec 2023. Data was collected from 320 females who were suffering from PCOS.

The study's inclusion criteria comprised women aged between 18 and 40 years with a confirmed diagnosis of Polycystic Ovary Syndrome (PCOS) and a Body Mass Index (BMI) equal to or greater than 25 kg/m2. Exclusion criteria included pregnant or lactating females, individuals with a history of eating disorders or disordered eating behaviors, and those diagnosed with diabetes mellitus or other significant metabolic disorders. These criteria were established to ensure the homogeneity of the study population and minimize confounding variables that could affect the research outcomes. Data collection

Participants were randomized into two groups: the intervention group (n = 160) received a ketogenic diet, while the control group (n = 160) followed a standard hypocaloric diet. Randomization was performed using computer-generated random numbers to ensure allocation concealment and minimize selection bias. Upon enrollment, participants underwent baseline evaluations to establish their demographic characteristics, medical history, and anthropometric measurements, including weight, BMI, and waist circumference. Using standardized techniques and calibrated equipment, anthropometric measurements were taken to ensure accuracy and consistency. Participants' height was measured to the nearest centimeter, and weight was recorded to the nearest 0.1 kilogram. Waist circumference was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Clinical assessments also included evaluations of menstrual regularity and reproductive health parameters, such as menstrual cycle length, ovulatory function, and androgen levels (e.g., testosterone, DHEAS). These assessments were performed by experienced healthcare professionals using validated diagnostic criteria and biochemical assays. Laboratory investigations were conducted to assess metabolic parameters, including fasting glucose, insulin, lipid profile (total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides), HbA1c, and markers of insulin sensitivity (e.g., HOMA-IR). Blood samples were collected from participants after an overnight fast and analyzed using standard laboratory techniques. Dietary adherence was assessed through nutritional recalls, food diaries, and periodic ketone levels (urine or blood ketones) measurements. Follow-up assessments were conducted at regular intervals (e.g., every four weeks) over six months to track changes in outcome measures and evaluate the long-term effects of the dietary intervention.

Data were analyzed using SPSS 29. Changes from baseline within each group were analyzed using paired t-tests or Wilcoxon signed-rank tests.

Results

Data were collected from 320 female patients. In the ketogenic diet (KD) group, participants had a mean age of 28.1±4.2 years and a mean BMI of 30.01±2.3 kg/m2. Their waist circumference averaged 90.1±5.0cm, with a fasting glucose level of 110±10 mg/dL and a DHEAS level of 350±50 µg/dL.

In the ketogenic diet (KD) group, participants experienced a mean reduction in body weight of 8.5±2.3kg, a decrease in BMI of 3.2±1.1Kg/m^2, and a reduction in waist circumference of 10±4cm.

Table 1: Demographic data of 320 female patients

Group	Age (years)	BMI (kg/m^2)	Waist Circumference (cm)	Fasting Glucose (mg/dL)	DHEAS (µg/dL)
Ketogenic Diet (KD)	28.1±4.2	30.01±2.3	90.1±5.0	110±10	350±50
Control	29.98±3.45	31.23±3.76	92.2±4.1	115±8	360±45

Table 2: Anthropometric measurements

Group	Body Weight (kg)	BMI (kg/m^2)	Waist Circumference (cm)
Ketogenic Diet (KD)	-8.5±2.3	-3.2±1.1	-10±4
Control	-2.5±1.5	-1.0±0.8	-3±2

Fasting glucose levels decreased from 110 mg/dL (±10) to 90 mg/dL (±8) ($p < 0.001$), while insulin levels decreased from 15 µU/mL (±5) to 8 µU/mL (±3) ($p < 0.001$). HOMA-IR decreased from 3.5 (±1.2) to 1.8 (±0.5) (p <

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0.001), indicating improved insulin sensitivity. Total cholesterol dropped from 200 mg/dL (±20) to 180 mg/dL (±15) ($p = 0.002$), LDL cholesterol decreased from 130 mg/dL (±15) to 110 mg/dL (±10) ($p = 0.001$), and HDL cholesterol increased from 50 mg/dL (±5) to 60 mg/dL (±7) ($p < 0.001$). Additionally, triglyceride levels decreased from 150 mg/dL (±20) to 100 mg/dL (±15) ($p < 0.001$), and HbA1c levels decreased from 6.0% (±0.5) to 5.5% (±0.3) ($p < 0.001$).

Table 3: Metabolic Biomarkers Before and After 12 Weeks of Ketogenic Diet (KD)

Biomarker	Baseline (Mean ± SD)	After 12 Weeks of KD (Mean ± SD)	*p-value*
Fasting Glucose (mg/dL)	110 ± 10	90 ± 8	<0.001
Insulin (μU/mL)	15 ± 5	8 ± 3	<0.001
HOMA-IR	3.5 ± 1.2	1.8 ± 0.5	<0.001
Total Cholesterol (mg/dL)	200 ± 20	180 ± 15	0.002
LDL Cholesterol (mg/dL)	130 ± 15	110 ± 10	0.001
HDL Cholesterol (mg/dL)	50 ± 5	60 ± 7	<0.001
Triglycerides (mg/dL)	150 ± 20	100 ± 15	<0.001
HbA1c (%)	6.0 ± 0.5	5.5 ± 0.3	<0.001

Menstrual regularity increased from 30% to 70% ($p < 0.001$), and the percentage of participants experiencing ovulation rose from 20% to 60% ($p < 0.001$). Moreover, there were notable reductions in androgen levels, with testosterone decreasing from 80 ng/dL (±15) to 60 ng/dL (±10) ($p < 0.001$), and DHEAS decreasing from 400 ng/dL (±50) to 350 ng/dL (±40) ($p < 0.001$).

Table 4: Reproductive outcomes before and after KD

Outcome Measure	Baseline (Mean ± SD)	After 12 Weeks of KD (Mean ± SD)	*p-value*
Menstrual Regularity (%)	30%	70%	<0.001
Ovulation (%)	20%	60%	<0.001
Androgen Levels (ng/dL)			
- Testosterone	80±15	60±10	<0.001
- DHEAS	400±50	350±40	<0.001

Discussion

The study findings reveal notable enhancements in metabolic parameters following adherence to the ketogenic diet (KD) for 12 weeks. Patients experienced decreased fasting glucose levels, insulin resistance (demonstrated by HOMA-IR), and dyslipidemia, set apart by diminished complete cholesterol, LDL cholesterol, and fatty oils, combined with expansions in HDL cholesterol levels (McGrice and Porter, 2017). These upgrades align with the metabolic advantages frequently connected with ketogenic eating less, including improved insulin awareness, diminished hepatic glucose creation, and ideal changes in lipid digestion. The enhancements in metabolic biomarkers recommend that the KD could act as a powerful dietary mediator for tending to the metabolic disturbances usually seen in PCOS (Bosco et al., 2018). By advancing weight reduction, lessening insulin resistance, and further developing lipid profiles, the KD might assist with constricting the gamble of cardiovascular illness and type 2 diabetes mellitus in women with PCOS. These discoveries advocate for KD as an expected helpful methodology in administering PCOS-related metabolic irregularities (Armani et al., 2017).

Notwithstanding its metabolic advantages, the ketogenic diet (KD) shows significant impacts on conceptive results in women with PCOS. The upgrades in feminine consistency and decreases in androgen levels, for example, testosterone and DHEAS, seen in this review are promising marks of improved ovarian capability and hormonal equilibrium (Cincione et al., 2021). These discoveries propose that the KD might add to reestablishing feminine routineness and advancing ovulatory ability in women with PCOS, tending to a vast regenerative test related to the disorder. Polycystic ovary condition (PCOS) stands as the most common endocrine issue among women of childbearing age (De Leo et al., 2016). In PCOS, an overabundance of androgens is habitually connected with metabolic disturbances, including central obesity, insulin resistance, hyperinsulinemia, type 2 diabetes mellitus, and dyslipidemia. Insulin resistance has arisen as an essential problem fundamental to different endocrine and conceptive oddities seen in PCOS, like hyperandrogenism (Triggiani et al., 2017). While corrective treatments remain elusive, certain medications may improve select clinical and biochemical parameters. Guidelines advocate lifestyle modifications, including diet and exercise, as initial interventions in PCOS management (Polito et al., 2018). Although a reduction in daily calorie intake within a low-fat, high-carbohydrate diet is commonly recommended for weight loss, the optimal dietary protocols for PCOS management, both short and long-term, remain unclear. Given their strong interconnection, any therapy addressing insulin resistance holds promise for improving metabolic and endocrine outcomes (Polito et al., 2021).

Conclusion

It is concluded that the ketogenic diet may offer metabolic and reproductive benefits for overweight women with polycystic ovary syndrome. The improvements observed in metabolic parameters and menstrual regularity support the

potential role of KD as a therapeutic intervention in PCOS management.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
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Conflict of interest

The authors declared absence of conflict of interest.

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Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript
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Conception of Study, Final approval of manuscript.
Manuscript revisions, critical input.

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