

Low carbohydrate ketogenic diet as a dietary remedy for infertile women with polycystic ovary syndrome

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ABSTRACT

Poor diet is found to be a contributor to many of the infertility cases. Polycystic ovary syndrome (PCOS) is the most common endocrine disorder affecting women of reproductive age and is associated with obesity, hyperinsulinaemia, insulin resistance and infertility. Objectives: The main objective of the study was to assess the macronutrient intake of PCOS infertile women and to formulate a Low Carbohydrate Ketogenic Diet (LCKD) and comparison of the nutritive value of formulated diet with regular diet of infertile women with PCOS. Materials and Methods : Sample size of 100 infertile women were selected from an infertility clinic in Pathanamthitta district after obtaining prior consent. Among them 55 Infertile PCOS subjects were selected for in depth study based on Rotterdam criteria. 24 hour dietary recall and dietary practices were assessed using interview schedule and 24 hour dietary recall. Results : It was found that the mean total calorie intake of infertile women with PCOS were less than the recommended levels. The mean value for calories is 1757.36 ± 344.94 kcal. CHO and Protein intake were adequate compared to RDA, 260g CHO and 55 g protein, respectively but fat intake was very much higher than the recommended levels. From LCKD diet the carbohydrate (178g) and fat intake was adequate (22g) whereas the diet was low in calories (1289 kcal). The calcium (661 mg), iron (38mg), folic acid (240 μ g), vitamin C (148mg) and zinc (16mg) contribution were higher compared to RDA.

Key Words : Infertility, Polycystic Ovary Syndrome, Low Carbohydrate Ketogenic Diet, Macronutrients

INTRODUCTION

Infertility is 'a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse' (Hochschild *et al.*, 2009). Polycystic ovary syndrome (PCOS) was first reported in modern medical literature by Stein and Leventhal in 1935 as women suffering from amenorrhoea, hirsutism, and enlarged ovaries with multiple cysts. It is now recognized as a common, heterogeneous, heritable disorder affecting women throughout their lifetime characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovaries (Broody, 2014). Most of the reported PCOS women were concentrated in the consumption of enriched carbohydrate diet, *i.e.* they are more dependent on soft drinks, fast-food, sweets, cured and smoked meats, salted nuts, canned and processed vegetables, meats, marinades and sauces and less on traditional dietary habits. The sedentary lifestyle and unhealthy dietary patterns have mostly contributed to the prevalence of PCOS (George and Malini, 2014).

Women with PCOS exhibited a dietary pattern that was marked by consumption of a greater amount of specific foods with a high glycaemic index: however diet composition was not associated with the greater fasting insulin concentration or with lower glucose-insulin ratio that was observed in PCOS group (Douglas *et al.*, 2006). Obese women with PCOS was reported to consume more servings of meat, fish, poultry, and eggs than the obese controls. Women with PCOS consumed higher amounts of carbohydrates, protein, dietary fat, saturated fat, monounsaturated fat, polyunsaturated fat, sugar compared to reference population (Annie *et al.*, 2014). A Low-Carbohydrate Ketogenic Diet (LCKD) led to improvement in body weight, per cent free testosterone, LH/FSH ratio, fasting serum insulin, and symptoms in women diagnosed with PCOS. The hyperinsulinemia of PCOS appears to increase androgen secretion from the ovary as well as decreased circulating sex hormone binding globulin (SHBG). A Low Carbohydrate Ketogenic Diet led to a reversal of these processes. We speculate that reduction in hyperinsulinaemia due to the LCKD would decrease stimulation of ovarian androgen production as well as increase SHBG levels, synergistically limiting the amounts of circulating free-androgens in the serum (Yancy *et al.*, 2005).

METHODOLOGY

The area selected for the study was Infertility Clinic- Lifeline Super Specialty Hospital, situated at Adoor, Pathanamthitta. For the present study 100 women undergoing infertility treatment in infertility clinic in the age group of 20 -35 years, primigravida were selected by judgmental sampling. Among them 55 women with PCOS based on Rotterdam criteria were selected and their nutritional intake was assessed by 24 hour dietary recall and food frequency to assess the dietary pattern. Comparison of nutritive value of formulated LCKD diet to Normal diet was also carried out. For the present study “interview schedule” was used to assess the clinical signs of PCOS.

RESULTS AND DISCUSSION

Table 1 shows the causes of infertility based on the interpretation of ultra sound scanning image results of the infertile women with and without PCOS. Results depicts that 55 per cent of the selected subjects were having PCOS. 75 per cent of them had Uterine fibroid, 45 per cent of subjects had some other reasons, 9 per cent of them had endometriosis, 9 per cent have tubal problems and 4 per cent of them had ovulatory problems and some doesn't have any problems.

Table 3 shows the range of intake of macronutrients consumed by the PCOS subjects compared to the recommended intake of adult normal women. Total energy obtained from daily diet is the sum total of the major macronutrients carbohydrate, protein and fat. The recommended daily intake

Table 1 : Causes of infertility	
Causes for infertility	Number
PCOS	55
Endometriosis	9
Fibroid	7
Tubal problems	9
Ovulatory disorders	4
Others	16
Total	100

for an adult women is about 1900 kcal (ICMR-2010). Above results shows that 43.63 per cent of the non-PCOS infertile women were having a total energy intake of about 1400-1800 kcal, 25.45 per cent between 1200-1400 kcal, 23.63 per cent >1800 kcal and only 7.27 per cent consumed <1200 kcal. Majority of them had higher intake of fat than normal. 70.9 per cent of the infertile subjects were having fat>35 grams a day, 23.63 per cent in a range 25-35g and 5.45 per cent <25 g. Majority of them (61.8 %) were having proteins >65g, 23.63 per cent were in the range between 55-65 g and 14.5 per cent <55 g.

Lipids are rich sources of energy and the critical components of the physical and functional structure of oocytes. They play a vital role in development during and after fertilization. Dietary fat intake can affect the fatty acids (FAs) composition in ovarian compartments. Some of these effects, such as lipid storage into lipid droplets in oocytes could be altered by the type of eaten FAs. The increase in composition of free FAs may impair fertility by affecting oocyte quality due to transport of FAs into the oocyte. Eating high levels of fat may influence reproduction by affecting oocyte competence as defined by the ability of oocyte to undergo fertilization and to reach specific cleavage stages at appropriate time intervals (Kazemi *et al.*, 2014).

Table 4 shows the nutrient contribution of LCKD compared to RDA. From LCKD diet the carbohydrate (175g) and fat intake was adequate (22g) whereas the diet was low in calories (1280 kcal). The calcium (660 mg), iron (38mg), folic acid (240µg), vitamin C (150mg) and zinc (18mg) contribution was higher compared to RDA.

High protein is essential for the patient for energy supplementation and also for tissue generation and egg formation. Millets especially ragi and Italian millet were found to have high fiber content, calcium, iron and other microelements essential for infertility. Regular consumption of fruits and vegetables were also recommended. Citrus fruits *viz.*, orange, gooseberry, Guava were included

Table 2 : Mean nutrient intake and per cent excess or deficit of nutrients of regular diet

Nutrients	Mean± SD	t value	Interpretation
Energy(kcal)	1757.36± 344.94	-3.07	Energy level <1900 kcal
CHO(g)	260.6± 54.13	0.83	CHO level >260g
Fat ^a (g)	48.4± 16.235	12.99	Fat consumption >20g

^aFat consumption is associated with PCOS, P>0.05

Table 3 : Macronutrient consumption of Infertile women with PCOS (N=55)

Nutrients	Nutrient categories	Number	Percentage
Energy(Kcal)	<1200	4	7.27
	1200 – 1400	14	25.45
	1400 – 1800	24	43.63
	>1800	13	23.63
Carbohydrate(g)	<250	36	65.45
	250 – 300	11	20
	>275	7	12.72
Protein(g)	<55	8	14.5
	55 – 65	13	23.63
	>65	34	61.8
Fat(g)	<25	3	5.45
	25-35	13	23.63
	>35	39	70.9

more, as they are rich in vitamin C and folic acid. Sweets, confectionaries and fried fatty meals were fully avoided to decrease the free calories which are harmful to the body. The role of formulated LCKD diet in promoting weight loss and fertility were addressed among sub samples.

For women with PCOS, the most effective diet for achieving and maintaining weight loss is low in carbohydrates, rather than low in fat. Without being extreme, women with PCOS should reduce their carbohydrate intake overall and in particular avoid sugars and refined carbohydrates. They should instead select foods high in fiber made from whole grains, as unprocessed as possible. They are also advised to avoid eating carbohydrate-rich foods by themselves, and space them out during the day to keep insulin levels from spiking. Consuming four or more small meals instead of a few large one each day is also helpful (Brody, 2014).

A low GL diet may contribute to an improvement in symptom relief in patients with PCOS such as carbohydrate craving and hypoglycemia. Hypocaloric diet supplemented with protein reduced fat mass and body weight more than diet supplemented with simple sugars. It seems that the subjects receiving higher protein may have more successful weight loss because of satiating effect

Table 4 : Low carbohydrate ketogenic diet

Time	Menu	Quantity(ml/g)
Early morning	Greentea	100
	Egg white –Boiled	50
Breakfast	Ragi puttu	50
	Bengal gram curry	50
Mid morning	Lime juice	100
	Raw veg salad	100
Lunch	Whole wheat chapathi	2 nos
	Fish curry	70
	Avial	50
	Orange	
Tea time	Skimmed milk	50
	Green gram sprout-boiled	50
Evening	Guava/Pomegranate	50
Dinner	Foxtail millet boiled	100
	Soya bean curry	50
Bed time	Almond	5 no.s

Table 5 : Comparison of nutrient contribution of LCKD Diet to normal RDA

Nutrients	LCKD	RDA
Energy (kcal)	1280	1900
Carbohydrate(g)	175	250-300
Protein(g)	80	55-60
Fat(g)	22	30
Calcium(mg)	660	400-500
Iron(mg)	40	30
Folic acid(µg)	240	100
Vitamin C(mg)	150	50
Zinc(mg)	18	15

of diet, but there were no significant differences in hormonal changes attributed to the composition of diet. A hypocaloric diet with increased protein content and reduced GL would decrease insulin concentration and this in turn, results in lowering androgen concentrations. The levels of total testosterone and Dehydro-epiandrosterone sulphate also known as androstenedione, a hormone that comes from adrenal gland, decreased similarly in both groups after weight loss (Mehrabani *et al.*, 2012).

Conclusion :

Mean intake of calories consumed by the PCOS subjects compared to the recommended intake of adult normal women (ICMR, 2010) were found to be less than the recommended levels. The mean intake for calories was 1757.36 ± 344.94 kcal. CHO and Protein intake were adequate viz 260g CHO and 55 g protein, respectively but fat intake was very much higher than the normal levels. From LCKD diet the carbohydrate (178g) and fat intake was adequate (22g) whereas the diet was low in calories (1289 kcal). The calcium (661 mg), iron (38mg), folic acid (240µg), vitamin C (148mg) and zinc (16mg) contribution was higher compared to RDA.

Acknowledgement :

We are thankful to the KSCSTE for the financial assistance provided for the completion of this project.

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