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Original Research Article

Evaluation of body composition in body mass index matched PCOS and eumenorrheic non-PCOS college women

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ABSTRACT

Background: Poly cystic ovarian syndrome (PCOS) is a genetic, hormonal and metabolic disorder that affects the women of reproductive age. PCOS is considered as one of the leading causes of infertility in women. Body composition evaluation is considered as one of the predictive factors in metabolic risk assessment. The present study was undertaken with an objective to assess the body composition distribution in body mass index (BMI) matched PCOS and non-PCOS women.
Methods: A comparative case control study was conducted in BMI-matched, PCOS (n=55) and non-PCOS (n=55) college women aged between 18-25 years. PCOS subjects were selected based on the Rotterdam criteria. Prior to the study, ethical clearance certificate was obtained. Based on the BMI of PCOS cohort, non-PCOS healthy subjects (n=55) were selected with matched BMI. Body composition including anthropometry was analysed through bioelectrical impedance and standard protocols.
Results: Non-PCOS and PCOS groups showed the non-significant differences in most of their anthropometric parameters except weight, neck size, and height. However, total per cent body fat and visceral fat levels were found to be significantly high in PCOS women with the p value of <0.001** and p=0.005 respectively. Additionally, skeletal muscle index, skeletal muscle mass, and total protein content were found to be significant low in PCOS at 99% CI.
Conclusions: Visceral fat deposition and high percent body fat is generally associated with metabolic disturbance and hormonal changes and it was found to be highly prominent in the BMI matched PCOS women compared eumenorrheic healthy controls.

Keywords: Anthropometric parameters, Body composition, PCOS

INTRODUCTION

Poly cystic ovary syndrome (PCOS) is an endocrine related problem characterized by both reproductive and metabolic abnormalities known to affect women of childbearing age. According to the Rotterdam criteria, is characterized by irregular ovulation, clinical with or without biochemical hyperandrogenism and poly cystic ovaries.[1] In addition to clinical and hormonal changes, it is hypothesized that women with PCOS are at increased risk of metabolic syndrome, such as obesity, dyslipidemia, insulin resistance and this known to make them to prone towards cardiovascular disease and type 2 diabetes mellitus.[2] Recent studies have shown an early onset of abnormal cardiovascular risk patterns associated within PCOS. The World Health Organization (WHO) data reported that global prevalence of PCOS in reproductive-aged women is estimated to be between 8 to 13 per cent and also predicted that globally, 70 per cent of women with PCOS are undiagnosed.[3] PCOS prevalence in Indian women is near to 10 per cent, as per Rotterdam's and AES criteria.[4] However, in general prevalence rate ranges from 3.7 to 22.5 which varies on the population being studied and the criteria used for diagnosis.

Many of women develop abnormal glucose and lipid metabolism, hypertension, obesity, insulin resistance and other features suggestive of systemic inflammatory response.[5] PCOS is associated with obesity, insulin resistance (IR), hyperinsulinemia, and vitamin D deficiency.[6] Most of women with PCOS have shown the higher BMI and abdominal fat, which are associated with insulin resistance and greater metabolic and cardiovascular risks.[7] Stress response and inflammation play a significant role in metabolic disturbances in PCOS, highlighting the link between mental health and the disease.[8] Besides, it is also reported that nearly 70 per cent of women with PCOS shown to have dyslipidemia, which is commonly considered as one of the indicators of metabolic syndrome. In one of the Nigerian's research studies, it was also revealed that dyslipidemia is observed to be in 80.1 per cent PCOS between the age group of 18-42 years.[9] Ahmadi et al, revealed that android-type body fat distribution, which is most commonly associated with metabolic disturbances, has been found to be more prevalent among women with PCOS. In fact, studies pointed to the anthropometric parameters in women PCOS has revealed a higher body mass index (BMI) increased waist circumference (WC) in women with PCOS.[10] Obesity is common in PCOS exacerbates symptoms and promotes adverse health consequences. Obesity and fat distribution are thought to play a major role in the aetiology of PCOS. Approximately 40% of PCOS patients are obese with abdominal fat distribution. These changes in body composition exacerbate many of the clinical manifestations associated with this disease such as hyperandrogenism and insulin resistance.[11,12] Some of the research studies reported that body fat distribution in PCOS women not elucidated by either obesity or ectopic fat deposition.[13] However, most of studies in PCOS, have been focused without considering the obesity as separate entity. With this background, the present study was undertaken to determine and compare body composition, anthropometric dimensions in BMI matched women with PCOS and non-PCOS subjects.

METHODS

A comparative case control pilot study was conducted during June 2024 to September 2024 to compare the body composition in BMI matched PCOS and eumenorrheic non-PCOS healthy women aged between 18-25 years. The main moto behind the body composition comparison in PCOS and non-PCOS in the context of matched BMI was to know the metabolic risk in PCOS, irrespective of obesity. Assessment of visceral fat level and total per cent of fat distribution and other weight related anthropometric parameters in both BMI matched groups help in metabolic risk assessment in PCOS women with specific prediction without presumption.

PCOS and non-PCOS subjects' selection

A total sample size of 55 in each cohort was selected from the department of nutrition and dietetics, Jagadguru Sri Shivarathreeshwara Academy of Higher Education and Research, Mysuru. Rotterdam criteria was used to diagnose the PCOS by undertaking individual consent of participation along with ethical committee clearance certificate from the institute.[14] While selecting PCOS subject poly cystic ovary confirmatory test was considered as mandatory choice along with other obligatory criteria of anovulation/irregular cycle. Based on the body mass index of PCOS, non-PCOS eumenorrheic healthy cohort was decided and selected for the study from the same department. For body mass index (BMI) categorisation, Asian reference for adults was used.[15]

Ethical clearance certificate

This study was approved by the institutional ethical committee and the study center (JSSMC/IEC/130624/52NCT/2024-25). Data was collected only from the study subjects who provided written consent after the assurances of privacy and clear convey of study purpose.

Anthropometric measures

Anthropometric measurements such as height, weight, body mass index, waist circumference, hip, circumference, waist-hip ratio, skin fold thickness at different regions were assessed by using appropriate tools and techniques. Weight was measured by using weighing scale and was calibrated on a regular basis to minimize the error and the subjects were asked to stand with barefoot. Non-stretchable measuring tape was used to measure the height and during height assessment process, subjects were instructed to position themselves in straight and motionless manner, asked them to keep their hands straight and heads in the Frankfurt plane. Based on height and weight of the subject, BMI (body mass index) values were derived. A non-stretchable measuring tape was also used for the measurement of waist and hip circumferences. Further, waist to hip ratio index was derived by calculation. Skin fold thickness was measured using a digital calliper. While taking skin fold thickness, callipers was held in the right hand and placed the jaws of the callipers in the assessing region about ¼" fingers of left hand which remains to hold the fold of skin. Mid upper arm circumference indicates the nutritional status of an individual. For BMI categorisation, reference given for Asian adults was used.[16]

Body composition analysis

The body composition in PCOS and non-PCOS women was analysed through InBody bio-electrical impedance-270 analyser. Prior to the analysis, subjects were asked to fast for 2 hours, instructed to avoid intense physical exercise for at least 24 hours, to wear light clothing. During the examination, precaution has taken to make them stand with their bare feet on the feet electrodes, without any jewellery and wearable electronics to avoid

variability. InBody body composition analyser works with principle of impedance created by body composition against electrical flow, the resistance created will be transformed to measurable unit with inbuilt standardised proven formula in the machine's software. The body composition parameters viz., total body water, total protein, mineral content, total body fat mass, per cent body fat at trunk region, visceral fat and skeletal muscle mass were analyzed in PCOS and non-PCOS women.

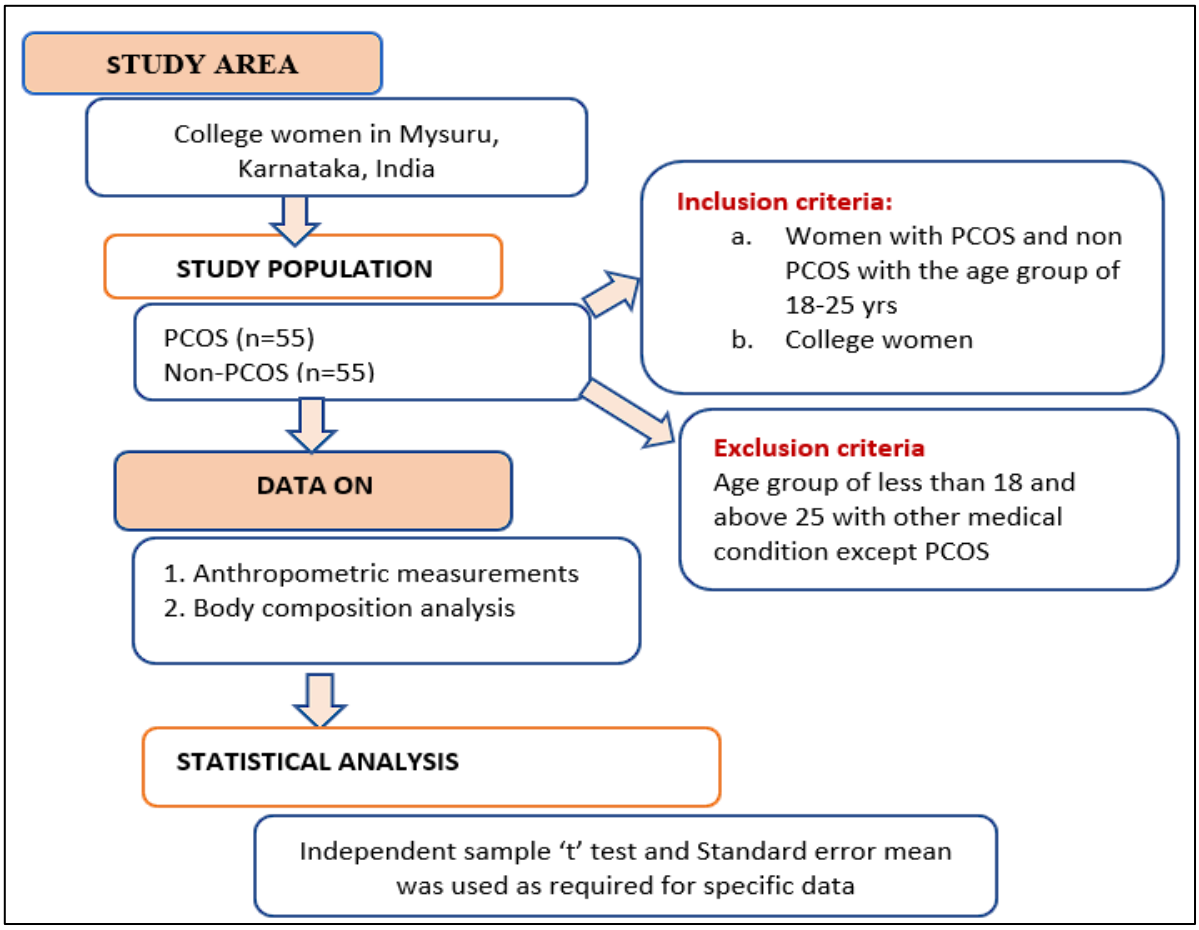

Figure 1: Study design applied.

RESULTS

Anthropometric measurements

The detailed data on anthropometric parameters in both PCOS and non-PCOS subjects is presented in Table 1 and graphical representation of BMI distribution is depicted in Figure 2 through box pleat.

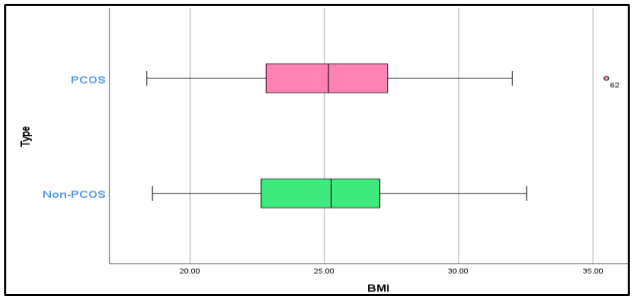

Figure 1: Body mass index of PCOS and non-PCOS subjects.

Non-significant difference was observed between non-PCOS and PCOS cohorts in all the anthropometric parameters except weight, neck size, and height. A highly significant difference was observed in height parameter of both cohorts, higher average value of BMI was observed in non-PCOS women with 95 per cent confidence interval. BMI among both groups was found to be non-significant, since in the current study, non-PCOS group was selected in congruence with BMI of PCOS subjects. Significant difference was observed between the two cohorts in their weight with 95 per cent of confidence interval (<0.026*). It was observed that weight was significantly lower in PCOS subjects (64.07±1.34) compared to non-PCOS (68.52±1.44). Non-significant difference found between the two cohorts in their waist circumference ($p=0.510^{ns}$), and the result was contrast to the research study conducted by BMI matched PCOS and non-PCOS subjects and it was reported that central obesity increased with the odds of insulin resistance. It was evidenced in the earlier studies that abdominal obesity prominent in PCOS than non-PCOS.[17]

Table 1: Anthropometric dimensions of BMI matched PCOS and non-PCOS women.

Anthropometric parameters	Non-PCOS (mean±SEM)	PCOS (mean±SEM)	't' test p value
Height (cm)	166.07±1.11	160.24±1.06	<0.001**
Weight (Kg)	68.52±1.44	64.07±1.34	0.026**
BMI (kg/m^2)	24.85±0.47	24.99±0.49	0.841^{ns}
Neck size	30.65±0.27	31.67±0.35	0.023**
Waist circumference (cm)	77.32±1.41	78.87±1.88	0.510^{ns}
Hip circumference (cm)	99.34±1.42	98.40±1.97	0.701^{ns}
Waist hip ratio	0.78±0.009	0.81±0.02	0.148^{ns}
Triceps thickness (mm)	24.33±0.64	25.67±0.74	0.172^{ns}
Biceps thickness (mm)	19.98±0.70	20.70±0.84	0.512^{ns}
Suprailiac thickness (mm)	23.40±0.89	22.15±0.92	0.300^{ns}
Subscapular thickness (mm)	22.90±0.78	22.51±0.75	0.204^{ns}
Thickness at abdominal region (mm)	28.27±1.19	28.90±1.31	0.727^{ns}
Mean calf circumference (cm)	35.00±0.94	35.19±0.95	0.892^{ns}
Thigh circumference (cm)	48.98±0.88	50.35±0.90	0.280^{ns}

**Statistically significant. Ns-non significant.

Table 2: Body composition in PCOS and non-PCOS women.

Body composition parameters	Non-PCOS (n=55)	PCOS (n=55)	't' test p value
Total body water (l)	35.05±0.80	29.78±0.82	<0.001**
Protein (kg)	9.49±0.22	8.04±0.23	<0.001**
Mineral (kg)	3.28±0.07	2.89±0.07	<0.001**
SMM (kg)	26.62±0.67	22.28±0.69	<0.001**
Body fat mass (kg)	20.71±0.96	23.38±0.99	0.055ns
FFM (%)	47.82± 1.09	40.84±1.11	<0.001**
PBF (%)	30.13±1.08	36.05± 1.22	<0.001**
BF % at trunk	254.75±11.87	242.99±9.85	0.448ns
SMI (kg/m^2)	7.20±0.13	6.46±0.13	<0.001**
Visceral fat level (%)	9.13±0.51	11.31±0.56	0.005 **
BMR (Kcal)	1409 ± 24.76	1255 ± 24.24	<0.001**

Note: SMM- skeletal muscle mass, FFM- free fat mass, PBF- percent body fat, BF- body fat, SMI- skeletal muscle index.**Statistically significant. Ns-non significant.

However, the present study age group was contrast with other research study, where the age range was between 18 to 40 years in their study, the contradictory result might also be due to difference in the stage of detection.

Average thickness at triceps region was found to be 24.33±0.64 in non PCOS and 25.67±0.74 mm in case of PCOS cohort. Mean value of biceps thickness was found to high in PCOS (20.70±0.84) however it was found to be non-significant with the average thickness observed for non-PCOS (19.98±0.70). Thickness at abdominal region (p=0.727^{ns}) in both cohorts found to be on par with non-significant difference.

Major body composition parameters viz., total body water, total protein, mineral content, total body fat mass, per cent body fat, body fat per cent at trunk region, visceral fat level, skeletal muscle mass and skeletal muscle index were observed in PCOS and non-PCOS women is presented in Table 2. Along with this basal metabolic rate was also compared in both groups. In the present study, all the experimental women had the confirmatory test report for presence of polycystic ovaries (n=55; 100%).

From the result, it was observed that there was a significant difference in all the parameters except body fat mass and per cent body fat at trunk region. Highly significant difference was observed in the total body water content between the two groups and comparatively high-water level was observed in non-PCOS group (35.05±0.80) than PCOS (29.78±0.82) with the p value of <0.001**. Same trend was observed in both protein and mineral content between the groups, with significant difference at 99 per cent confidence interval. Total protein content was found to be 9.49±0.22 gm and was comparatively higher than experimental group (8.04±0.23), mineral content was observed to be 3.28±0.07 in non-PCOS and in case of PCOS it was observed to be 2.89±0.07. Skeletal muscle mass and skeletal muscle index were also found to be low in PCOS group compared to the non-PCOS cohort and the statistical interpretation shown the significance difference at 99 per cent confidence interval in both the parameters.

It has also been noted that fat free mass in PCOS women was low in compared to the non-PCOS cohort and this result is in accordance with earlier report which was elucidated with significantly lower total skeletal muscle in a PCOS group compared to a control group.[18]

The results showed that average value of per cent body fat in subjects who have been diagnosed with PCOS (36.05±1.12) was significantly higher at 99 per cent confidence interval ($p<0.001^{**}$) than that of control group (30.13±1.08). However non-significant difference was observed for total fat content between the groups. Mean body fat percent in the trunk region was found to be 254.75±11.87 in non- PCOS and 242.99±9.85 in PCOS, with non-significant difference. However standard error mean was found to be high, indicating wide difference within the cohorts. Average value for visceral fat was found to be 9.13±0.51 in non-PCOS where it was observed to be 11.31±0.56 in PCOS subjects. Significant difference was observed for per cent body fat ($p<0.001^{**}$) and visceral fat level ($p=0.005^{**}$) and both parameters were found to be high among PCOS subjects. This study results suggest new insights of body fat in individuals with PCOS. Independent sample 't' test analysis showed highly significant ($p<0.005^{**}$) differences in visceral fat level between the PCOS cases and the non-PCOS. These results are similar but are at the higher end of the range found in other studies where adipose tissue deposition has analyzed using ultrasound.[19] The results shown for basal metabolic rate (BMR) in subjects diagnosed with PCOS has the significantly (1255±24.24) lower BMR than that in the non-PCOS group (1409±24.76) and difference was found to be highly significant at 99 per cent level.

DISCUSSION

Non-significant difference was observed between the two cohorts in their waist circumference($p=0.510^{ns}$), and the result was contrast to the earlier reported research studies conducted in BMI matched PCOS and non-PCOS subjects and it was reported that central obesity increased with the odds of insulin resistance. It was evidenced in the earlier studies that abdominal obesity prominent in PCOS than non-PCOS.[20] However, the present study age group was contrast with other research study, where the age range was between 18 to 40 years in most of other research studies. The contradictory result might also be due to difference in the detection stage at which PCOS was diagnosed. PCOS confirmation with external phenotype existence and experienceable symptoms appearance might remain undiagnosed in early stage might be a confounding factor.

Despite of non-significant difference in the total body fat mass between two cohorts, significant difference was observed in per cent body fat ($p<0.001^{**}$) distribution and visceral fat level ($p=0.005^{**}$) and both parameters were found to be high among PCOS subjects. This can suggest new insights of body fat distribution and metabolic risk in PCOS women. The accumulation of adipose fat causes metabolic and endocrine irregularities that impair insulin action. This causes impaired glucose uptake as it interacts with the progression of hyperandrogenism, which again increases the deposition of visceral fat, and was independent with body mass index.[7,8]

Skeletal muscle index, skeletal muscle mass and total protein contents were found to be significantly low in PCOS subjects at 99 per cent of confidence interval. Lower skeletal muscle distribution in the PCOS group, can reduce insulin sensitivity, as reported in 2014.[9] These results also support the results of previous studies reporting that increased waist and hip circumferences increase the incidence of PCOS and associated complications involving infertility in PCOS.[14] The results shown for basal metabolic rate (BMR) in subjects diagnosed with PCOS has lower BMR (1255±24.24) than that in the non-PCOS group (1409±24.76) and difference was found to be highly significant at 99 per cent level ($p<0.001^{**}$). Previous studies reported a positive association between basal metabolic rate with biochemical integrant like blood glucose triglycerides and blood pressure and positive correlation was observed with waist circumference.[21-25] It is also considered that low basal metabolic rate is one of the predictors for development of obesity and associated metabolic risk along with cardiovascular diseases.[6] Present investigation gives the insight on metabolic difference between the groups. However, further validation needs to be done with large population which helps in deriving the proper conclusion since in the current data standard error was found to be high.

Sample size was comparatively small with only 55 subjects in each cohort, so it might narrow the scope for generalization. Further its essential to strengthen the study with large population in integration with biochemical parameters at initial screening along with Rotterdam criteria. Predictive biochemical parameters for metabolic syndrome need to be done. In the present study, lifestyle variables like nutrition, physical activity, and stress level were not considered, which known to bring change in body composition. Larger, more diverse sample and longitudinal design studies are suggested for future research

CONCLUSION

It is considered that visceral fat deposition is generally associated with metabolic disturbance and hormonal variations and was found to be highly prominent in the current research in BMI matched PCOS women compared eumenorrheic healthy controls. Basal metabolic rate was also found to be low in PCOS, and is considered as one of the predictors for development of obesity and associated metabolic risk along with cardiovascular diseases. Hence, it is important to focus on finding the effective strategies to attain desirable visceral fat in

PCOS through holistic approach of medical therapy, life style modification, inclusion of nutraceutical foods in the diet, physical activity. This further helps in reducing the metabolic risk in PCOS women.

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