Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/17042
DOI URL: http://dx.doi.org/10.21474/IJAR01/17042

RESEARCH ARTICLE

ASSESSMENT OF BODY FAT COMPOSITION PARAMETERS IN WOMEN OF POLYCYSTIC OVARY SYNDROME (PCOS) : A CASE- CONTROL STUDY

Dr. Shweta Agarwal[1], Dr. Preeti Rathi[2], Dr. Chaudhary Lalita[3], Dr.Anshu Tandon[4], Dr. Megha Kulshreshtha[5] and Dr. Aruna Verma[6]

1. Junior Resident.
2. Professor and Head, Department of Physiology, S.M.M.H Medical College, Sharanpur.
3. Professor and Head, Department of Physiology, LLRM Medical College, Meerut.
4. Associate Professor, Department of Physiology, LLRM Medical College, Meerut.
5. Assistant Professor, Department of Physiology, LLRM Medical College, Meerut.
6. Professor, Department of Obstetrics and Gynaecology, LLRM Medical College, Meerut.

Manuscript Info

Manuscript History
Received: 25 March 2023
Final Accepted: 30 April 2023
Published: May 2023

Key words:-
Body Fat Composition parameters, Polycystic Ovary Syndrome, Bioelectrical Impedance Analysis

Abstract

Introduction: Polycystic ovary syndrome is a complex condition of women characterized by menstrual irregularities, elevated androgen levels & polycystic ovarian morphology. It is often associated with psychological impairment , metabolic derangements and obesity .

Objectives: Present study has been done to assess body fat mass composition in PCOS patients & to compare it with age-matched controls. Materials and Methods – 29 newly diagnosed PCOS patients as per Rotterdam criterion were recruited from the Obstetrics and Gynaecology OPD of SVBP hospital, Meerut. The cases were compared with 30 healthy age-matched women which acted as controls. Bioelectrical Impedance Analysis was used to record Body composition parameters such as Total body water, Soft Lean Mass, Fat Free Mass, Skeletal Muscle Mass, Body Fat Mass, Percentage Body Fat, Visceral Fat level, Body Mass Index, Fat-Free Mass Index, Skeletal Muscle Index. Anthropometric parameters including weight and height were also recorded.

Results: Body Mass Index (BMI), Skeletal Mass Index (SMI), Fat-Free Mass Index (FFMI) were significantly higher in patients with PCOS ($p<0.01$). Further, as compared to control group, other body fat composition parameters were also higher in patients of PCOS.

Conclusion: This study exhibits that women with PCOS have higher Body Fat and Skeletal Muscle parameters as compared to age-matched controls. Annual Screening of patients with PCOS by performing Body Composition Analysis will help them to maintain their body fat and muscle ratio in defined values & also prevent the various diseases associated with higher body fat in PCOS.

Corresponding Author:- Dr. Shweta Agarwal
Address:- Department of Physiology, LLRM Medical College, Meerut, Uttar Pradesh (India)

Introduction:-

Poly ual irregularities, eleva gical impairment, meta PCOS phenotype. Although the pathophysiology of syndrome is elusive .

The patient presentation of PCOS may range from asymptomatic to menstrual irregularities, hirsutism, severe acne and other dermatological manifestations. In addition, metabolic disorders such as high insulin levels and risk of type II diabetes; cardiovascular diseases; and reproductive disorders such as ovulatory disorders and infertility have been reported[2]. PCOS is also associated with hypertension, dyslipidemia and central obesity,which are known to be related to sympathetic hyperactivity[3].

This heterogeneous chronic endocrinal-metabolic disorder has a global prevalence ranging from 2.2% to 33%. However the prevalence of PCOS in India ranges from 3.7% to 22.5% depending on type of study population and diagnostic criteria[4]. In a study conducted on college students, 28% were found to be at high risk[5].

Polycystic ovarian syndrome (PCOS) women have a high prevalence of obesity and alterations in cardiovascular autonomic control, mainly modifications in heart rate variability (HRV) autonomic modulation. This imbalance is an important cardiovascular diseases risk predictor[6]. Epidemiological data indicates a close link between obesity and PCOS. It is also known that obesity related co-morbidities associate with cardiometabolic dysfunctions[7]. It is challenging to decipher the complexity of co-occurrence of obesity with PCOS with cardio-metabolic dysfunction.

Differences in hormonal and metabolic profiles are observed in patients with PCOS according to their body mass index (BMI). However, BMI is an inadequate means of body composition assessment, as it measures the degree of excess body weight, but does not differentiate fat mass and fat free mass (muscle mass or bone mass). Considering the implications of PCOS, studying body composition would give a deeper insight into the physiology of the disease, as it seems to contribute to the reproductive and metabolic dysfunction of the syndrome[8].

Body composition can be defined by the added proportions of muscle, fatand bone masses and water. Bioelectrical impedance analysis (BIA) is a safe,quick, inexpensive, reproducible and non-invasive method of body compositionassessment. The technique has been compared with and validated againsttraditional measures of body composition analysis in various patient populations. BIA measures varying bioelectric resistance and reactance of differentbody tissues by recording a voltage drop of an applied low-voltage alternatingcurrent through the body. Lean tissue and fluids containing electrolytes conductthe current and cell membranes serve as capacitors and account for capacitiveresistance. Fat and bone are poor conductors . Resistance and reactance are used with height, weight, age and gender in a number of multiple regression relationships to predict body composition compartments such as fat-free mass, lean body mass, extracellular mass, body cell mass , mineral distribution between different body compartments and the percentage of body fat[8] .

As limited data is available on assessment of body composition by bioelectrical impedance in women with PCOS. Although there are studies to support high risk of PCOS in obese females but the exact relationship is inconclusive and contradictory. Therefore, we aimed to analyze the differences in body fat and mass composition in females with PCOS and also to compare them with non PCOS ones.

Materials and Methods:-

Study design-

The study was designed as case-control study.

Study population-

For the study, 29 newly diagnosed cases within reproductive age group (15-45 years) of PCOS were recruited from the Obstetrics and Gynaecology OPD of SVBP Hospital, Meerut. Thirty age matched healthy females with normal regular and uneventful menstrual cycle served as controls. PCOS was diagnosed as using the **Rotterdam criteria** comprising the presence of at least two of the following three features : 1) hyperandrogenism and/or

hyperandrogenemia, 2) oligoovulation and 3) evidence of PCO on ultrasound (presence of 12 or more follicles in each ovary measuring 2-9 mm in diameter and / or increased ovarian volume of >10 ml).
Exclusion criteria for the study were as follows : (i)Females on oral contraceptives , sex steroids or undergoing infertility treatment, (ii) Post menopausal females, hysterectomysed females, (iii) Females having hyperprolactinemia, thyroid dysfunctions, congenital adrenal hyperplasia or any other endocrinal dysfunction, (iv) Pregnant or lactating females, (v) Females having history of any systemic diseases causing autonomic dysfunctions like diabetes mellitus, acute respiratory disease, preexisting cardiac diseases, acute respiratory disease, (vi) Females with history of drug abuse, and (vii) Females on antiarrythmic or antihypertensive medications. A prior approval of the Ethical Committee of the Institution was duly taken before undertaking the study. Before starting the procedure, all the subjects were thoroughly explained about the non-invasive nature and purpose of the investigations.They were informed that they can withdraw from the study at any point of time as per their will. Finally, a written informed consent was obtained from all of them.

Body fat analysis:
The tests were performed under thermo-neutral conditions between 10 AM to 1 PM . All the participants were instructed to refrain from food intake and caffeinated beverages for 2 hours, as well as to avoid strenous exercise 12 hours prior to recording . The tests were conducted according to the recommended protocols used in clinical studies. All the measurements were performed in an isolated room the temperature of which was maintained between 25°C to 27°C. On the test day, after allowing them to acclimatize with the environment as well as experimental conditions, all subjects were interviewed in detail about their past and present medical history.

The height of all subjects was measured using a fixed stadiometer , as the distance between top of the head to bottom of the bare feet, and was expressed in meters. Body composition parameters of the subjects were measured using Bioelectrical Impedance body composition analyzer (Multi-frequency bioelectrical impedance analyzer MA601) at 5 kHz , 50 kHz, 250 kHz. Before measurement, the subjects were asked to take off shoes, socks, ornaments, metal objects & electronic equipments. Thereafter they were asked to stand straight on the test bench with arms extended and abducted at an angle of 45° with midline.The hand electrodes were gripped gently in hands while both the feet touched the foot electrodes. Subject was asked to stay motionless unless the machine indicateand body fat parameters were assessed.

Statistical analysis:
The data thus obtained was coded, entered into MS excel and analyzed.

Comparison was done by Student's unpaired t-test taking both groups. The results were expressed as Mean ± SD and the p-value of $p \leq 0.05$ was considered to be significant.

Table 1:- Comparison Of Anthropometric Parameters.

Parameters	**Control (n=30)**		**PCOS (n=29)**		**p-value**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
Age (years)	24.8	4.69	22.86	4.23	0.10
Height (cm)	158.48	8.04	154.97	5.46	0.06
Weight (kg)	53.99	8.32	58.48	11.29	0.09

* p value ≤ 0.05 significant **p value ≤ 0.01 highly significant

Table 2:- Comparison Of Muscle Fat Analysis Parameters.

Parameters	**Control (n=30)**		**PCOS (n=29)**		**p-value**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
Skeletal Muscle Mass (SMM) (kg)	18.96	1.92	19.80	2.39	0.14
Body Fat Mass (BFM) (kg)	18.43	5.87	21.76	8.08	0.07
Percent Body Fat (PBF) (%)	33.37	6.29	36.06	7.34	0.13
Visceral Fat Level (VFA) (rating)	7.57	2.24	8.69	3.02	0.11
Body Mass Index (BMI)(kg/m2)	21.54	3.3	24.33	4.57	0.009**

* p value ≤ 0.05 significant **p value ≤ 0.01 highly significant

Table 3:- Comparison Of Body Composition Parameters.

Parameters	Control (n=30)		PCOS (n=29)		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	
Total Body Water (TBW) (L)	26.05	2.46	26.86	2.93	0.25
Soft Lean Mass (SLM) (kg)	33.39	3.14	34.5	3.77	0.23
Fat-free Mass (FFM) (kg)	35.56	3.33	36.71	4	0.23

* p value ≤ 0.05 significant **p value ≤ 0.01 highly significant

Table 4:- Comparison Of Fitness Parameters.

Parameters	Control (n=30)		PCOS (n=30)		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	
Fat-free Mass Index (FFMI) (kg/m2)	14.18	1.12	15.28	1.5	0.002**
Skeletal Muscle Index (SMI) (kg/m2)	7.55	0.64	8.23	0.9	0.001**

* p value ≤ 0.05 significant **p value ≤ 0.01 highly significant

Results:-

Table 1 depicts the comparison in physical parameters between control & PCOS groups. As it can be seen, between the two groups no statistically significant difference occurs i.e., they were comparable on the criteria of age, height and weight.

Above table 2 shows comparison of muscle-fat analysis parameters in both groups. There was highly significant elevation in BMI ($p<0.01$) while no statistically significant variation was observed in other parameters.

Above table 3 shows comparison of body composition parameters in both groups. There was no significant variation observed in any parameter.

Table 4 depicts the comparison of fitness parameters in both groups. There was highly significant rise in Fat-free mass index (FFMI) ($p<0.01$) and Skeletal muscle index (SMI) ($p<0.01$) in PCOS patients as compared to the controls.

Discussion:-

Polycystic ovary syndrome (PCOS) has emerged as a serious health issues all over the world . Studies show that women with PCOS are likely to be bothered with reproductive health problems like, dysfunctional uterine bleeding, amenorrhea/oligomenorrhea and infertility. Apart from these, PCOS increases the risk for a varietyof health complications like, obesity, type 2 diabetes mellitus, cardiovasculardisease, depressive disorder and certain types of cancer. This is probably due to altered metabolic state and autonomic activity pertaining to increased weight associated with PCOS. Thus, PCOS seems to cause the impairment in health related quality of life of women during reproductive age.

It is documented that obesity and metabolic disorders, which are theemerging problems in the contemporary society appear to be associated with PCOS[9]. The current literature lacks information related to the assessment of the body composition of the patients with PCOS. Available studies reported various methods (ultrasound, bioimpedance analysis, MRI, densitometry), which was reflected in the ambiguity of the results.

Table 1 summarizes the comparison of anthropometric characteristics in the participants. It can be seen that mean age of both the groups was comparable (24.8 for controls and 22.86 for cases). No statistically significant difference was present between two groups as shown by student's t-test (p value = 0.10). Also there were no statistically significant differences in both the group based on their height and weight with p value 0.06 and 0.09 respectively. Therefore, both the groups were comparable in their anthropometric characteristics.

Table 2 depicts a comparative study of muscle fat analysis parameters in both groups. PCOS group had significantly higher body mass index (BMI) ($p<0.01$) than the control group. We also observed that Body Fat mass (BFM), Skeletal muscle mass (SMM), Percentage body fat (PBF), Visceral fat level (VFA) were increased but insignificantly in PCOS patients as compared to controls.

Literature provides conflicting results with respect to BMI, BFM, SMM and PBF. Adult PCOS females assessed by BIA exhibited significantly higher BMI which indicates a clear correlation between adipose tissue hypertrophy and androgen excess associated with PCOS. Androgen excess plays a key role in pioneering visceral fat expansion leading to visceral obesity[8]. Further hyperandrogenemia and visceral obesity associated with PCOS leads to metabolic derangements that resulting in sympathovagal imbalance.

As per the literature the main mechanism for the genesis of PCOS is accumulation of visceral fat which develops insulin resistance. Further there is higher synthesis of androgens by theca cells leading to hyperandrogenemia[10]. Therefore point of concern in PCOS patients is increased BMI which ultimately leads to cardiovascular manifestations. Thus PCOS patients should be encouraged for weight loss regimes to reduce future metabolic risks.

As cited by various studies Percentage body fat is a better indicator to predict specificity[10].The results in our study showed high PBF values (but not significant) which signifies that future studies can further peep into PBF values measured by BIA method in diagnosis of PCOS.

Unsurprisingly, the mean BMI of the PCOS group were significantly higher than the control group. The mean BMI among women in the PCOS group was 24.33. The mean BMI among women in the control group was 21.54.

Using the Asia's BMI Classification this places the PCOS group's mean BMI score in the overweight category. This difference in BMI between the PCOS and control groups is not surprising since the majority of women diagnosed with PCOS also contend with issues of overweight, obesity, or at least excess abdominal fat. The moderate health risk guidelines start at a BMI of 23 for Indians rather than at 25 with the international standard [11]. This means that for clinicians using Asian cut-offs, an ideal BMI of less than 23 rather than 25 is the goal to maintain a lower risk of metabolic health problems . In other words, a patient who has a BMI of 23 will be treated the same as one that has a 25 in regard to metabolic risk.

Table 3 depicts statistically insignificant higher values of Total Body Water (TBW) , Soft Lean Mass (SLM) and Fat-free Mass (FFM) in PCOS which is in accordance with previous studies.

In our study PCOS and non PCOS groups were age matched which limits the probability of age as a factor for affecting TBW distribution. Moreover, we did not obtain physical activity data from the subjects and thus can not comment on distribution of TBW, as physical exercise has strong association with PCOD and TBW and FFM.

We observed higher values of soft lean mass in PCOS patients as compared to control, but we did not find statistically significant differences. However, other authors have reported higher lean mass in women with PCOS in relation to higher androgens levels[12]. Our study also demonstrated that fat-free mass is increased in women with PCOS compared with weight-matched controls.

E. Carmina et al (2009)[13] demonstrated that lean muscle mass (fat-free mass) is increased in women with PCOS compared with weight matched controls, but there was no difference in total body fat. While in the study done by **Kirchengast et al (2001)[14]** reported that decrease in total lean mass (fat-free mass) in women with PCOS as compared to controls but increased total fat percentage (percentage body fat) and total fat mass (body fat mass) in women with PCOS as compared to controls.

Thus, finding an increased fat free mass values in women with PCOS may be important because muscle is one of the main target for the metabolic effects of insulin and metabolic resistance are partially dependent on quality of muscle mass, which can influence the cardiovascular phenotype of patients[13].

Table 4 comprises the fitness parameters of body fat composition i.e. Fat-free mass index (FFMI) and Skeletal muscle index (SMI) between women with PCOS and controls. It exhibits significant increase in women with PCOS.

A case control study done by **Kogure GS et al (2015)[15],** reported a higher prevalence of androgen- related fat distribution, improved muscle strength in the biceps, and lower limb and handgrip strength in PCOS patients without improving skeletal muscle ratio. Most studies concluding to a protective effect of a greater FFM on metabolic health used FFM% in their analysis. **FM. Scott** etal **(2021)[16]** argued that greater FFMI was positively correlated with FM and that the latter could have driven the risk of developing the Metabolic syndrome.

As there is no validate data directly showing FFMI and SMI values in PCOS, our study suggests that high FFMI and SMI are significantly increased in PCOS which can increase the risk of increasing metabolic consequences in PCOS. Further studies can be done to establish relationship between FFMI and SMI in PCOS patients.

One of the limitation of our study is a small sample size in the clinical group. In future we still need to further expand the sample size to summarize the population data and to establish a more accurate cut-off points of body composition analysis parameters in the prediction, screening and diagnosis of PCOS, as well as to administer lifestyle modifications and dietary plan in PCOS patients to prevent long-term complications.

Conclusion:-

In conclusion, all the body composition parameters were increased in women with PCOS as compared to control subjects. Different body composition and fat distribution may have implications for PCOS women in terms of severity. Therapeutic intervention combined with lifestyle modifications may provide better treatment for PCOS, as they could be able to reduce fat mass percentages and decrease for long-term morbidities that depend on metabolic profiles. Thus, body composition evaluation could be a complimentary and useful method in clinical practice for diagnosis and follow-ups of PCOS, but further research is needed to confirm and extend our findings.

References:-

1. Umland EM, Weinstein LC, Buchanan EM. Menstruation-related disorders. In: DiPiro JT, Talbert RL, Yee GC, et al., editors. Pharmacotherapy: A Pathophysiologic Approach. 8th ed. New York: McGraw-Hill; 2011. p. 1393.
2. Majumdar A, Singh TA. Comparison of clinical features and health manifestations in lean vs. obese Indian women with polycystic ovarian syndrome. J Hum ReprodSci 2009;2:12-7.
3. Flaa A, Aksnes TA, Kjeldsen SE, et al. Increased sympathetic reactivity may predict insulin resistance: an 18 year follow-up study. Metabolism 2008;106:2533-6
4. Ganie MA, Vasudevan V, Wani IA, Baba MS, Arif T, Rashid A. Epidemiology, pathogenesis, genetics & management of polycystic ovary syndrome in India. Indian J Med Res 2019;150:333-4
5. Chatterjee M, Bandyopadhyay SA. Assessment ofthe prevalence of polycystic ovary syndrome among the college students:A case–control study from Kolkata. J Mahatma Gandhi Inst Med Sci2020;25:28-32.
6. de Sá JC, Costa EC, da Silva E, Zuttin RS, da Silva EP, Lemos TM, et al. Analysis of heart rate variability in polycystic ovary syndrome. GynecolEndocrinol. 2011;27(6):443-7.
7. Hestiantoro A, Rachmat DKH, et al. Body fat percentage is a better marker than body mass index for determining inflammation status in polycystic ovary syndrome. Int J Reprod Biomed. 2018 Oct; 16(10): 623–628.PMCID: PMC6314644
8. Styliani A. Geronikolou, Flora Bacopoulou, and Dennis Cokkinos. Bioimpedance Measurements in Adolescents with Polycystic Ovary Syndrome: A Pilot Study. P. Vlamos (ed.), GeNeDis 2016, Advances in Experimental Medicine and Biology 987, DOI 10.1007/978-3-319-57379-3_26
9. Debarupa Sen Gupta, NiveditaSom, Chaitali Dutta Roy, SebantiGoswami, Subha Ray. Polycystic Ovary Syndrome: A study from West Bengal, India. J. Indian Anthrop. Soc. 50:133-146(2015)
10. Pan Dou, HuiyanJu, Jing Shang, Xueying Li, et al. Application of receiver operating characteristic curve in the assessment of the value of body mass index, waist circumference and percentage of body fat in the Diagnosis of Polycystic Ovary Syndrome in childbearing women. Journal of Ovarian Research (2016) 9:51
11. Snehlatha C, V. Vishwanathan and A. Ramachandran. 2003 Cutoff values for normal anthropometric variables in Asian Indian adults. Diabetes Care 26(5):1380-1384.
12. Maria L Sanchez-Ferrer, Julian J A,Maria T P et al. Anthropometric characteristics of Polycystic ovary syndrome and their associations with insulin resistance and lipid profile. Appl.Sci. 2021, 11(12), 5395.
13. E. Carmina, E. Guastella, R A Longo, G B Rini, R A Lobo. Correlates of increased lean muscle mass in women with polycystic ovary syndrome. European Journal of endocrinology (2009) 161; 583-589

14. S Kirchengast , J Huber. Body composition characteristics and body fat distribution in lean women with polycystic ovary syndrome. Hum Reprod. 2001 Jun;16(6):1255-60.
15. Kogure GS, Piccki FK, Vieira CS, Martins Wde P, dos Reis RM .Analysis of muscle strength and body composition of women with polycystic ovary syndrome. Rev Bras Ginecol Obstet. 2012 Jul;34(7):316-22.
16. Jean-Christophe Lagacé, Alexis Marcotte-Chenard, Jasmine Paquin, Dominic Tremblay, Martin Brochu, Isabelle J. Dionne. Increased odds of having the metabolic syndrome with greater fat-free mass: counterintuitive results from the National Health and Nutrition Examination Survey database. Journal of Cachexia, Sarcopenia and muscle. Vol 13: Issue 1; 377-385.