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Body Composition Analysis is an Integral Part of the Nutrition Process: A Comparative study

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Abstract

It is possible to infer a person's nutritional status and the presence or absence of certain health conditions by analyzing their body composition. Furthermore, it externally represents aspects of the body. This retrospective analysis compared the means of two groups (male 51 and female 29) with 80 participants aged 21-60 from the northern area in Kolkata and 24 PGS (N). They all had visited a dietitian in north Kolkata to treat obesity and related lifestyle issues. From January 2022 through January 2023, Dr. Trust used his body composition analysis equipment (model 509) to take readings across 12 different body composition variables. Every patient's age, height, and weight had to be recorded before any other composition measurements could be taken. The food plan was then tailored to their specific needs, considering their current weight and any co-morbidities. We conducted an independent sample T-test to compare the male and female groups' means. Therefore, the research hypothesis states that men and women in West Bengal have distinct average body compositions. In contrast, the null hypothesis states that the two populations have similar mean body compositions.

Keywords: Body composition analysis; Nutrition assessments; Obesity; Underweight; Nutrition care process.

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INTRODUCTION

An individual's body composition can indicate their nutritional state and the presence or absence of specific health issues. It also represents bodily characteristics externally.

Body Mass Index (BMI)

BMI is an anthropometric measure of excess weight that shows the grades of weight status in

response toan individual's height. Hence, BMI is body mass in kilograms divided by the square of the body's height in meters (kg/m^2). This is proportional to the mass and inversely proportional to the square of the size. There is a difference between Asian BMI and other countries' BMI. Asian people are more prone to cardiovascular disorders, which may be the reason for the lower cut-off value: overweight 23.0-24.9, obesity-I >25, and obesity-II >30.[1-2]

Basal Metabolic Rate (BMR)

Energy expenditure can be calculated by monitoring the rate of thermogenesis, the process by which the body produces heat. The basal metabolic rate (BMR) often decreases with age and a loss of muscle mass.[5] Building muscle has been shown to raise basal BMR. It was once believed that aerobic fitness through cardiovascular exercise influenced BMR. However, lean body mass is inversely related to BMR, but burns, fractures, infections, fevers, and other acute diseases can all increase BMR.[3-5]

Body fat (BF%)

BMI cannot conclude on a body's fat percentage or adiposity. BF% can predict CVD and other metabolic syndromes better than other body composition parameters. High BF%, both in general and central, is very common in Indians. They also have less muscle, lean and skeletal mass than other population categories defined by WHO. Women population globally contain ~10% more body fat than men generally. A BF% <18 is for males, and BF% <25 is for females, have been considered a reference or standard among Indians.[4]

Table 1: Male vs. female body fat percentage

Classification	Male	Females
Acceptable	18-25	25-31
Fitness	14-17	21-24
Athletics	6-13	14-20
Essential	2-4	10-12

Fat Mass (FM)

Fat mass is the weight of the body fat. Body fat grows with age but begins to decline gradually after age 70. Compared to BMI, which is affected by muscle mass, Fat Mass Index (FMI) is a more reliable indicator of whether a person is overweight. Fat mass index = FM in kilogram/height^2 (meter^2).[6]

Lean Body Mass (LBM)

Lean body mass, or fat free mass, is the difference between the body's total weight and fat mass. Lean body mass is the sum of total body water and dry lean mass. There is a common way of gaining lean muscle where lean is meant 'no fat,' but all muscles are lean muscles in the human body. To understand in gross, we can say that LBM is the total weight of all organs, skin, bones, and most importantly, body water and skeletal muscle mass. Cardiac and smooth muscles under LBM cannot be grown biologically through diet and exercise, but skeletal muscle can be managed by diet and body building exercise.[6]

Muscle Mass (MM/SMM)

Muscle mass, or skeletal muscle mass alone, is often used to indicate a person's dietary and physical activity levels regarding health and illness. Muscle mass is a constant determined by the amount of fat found within muscle cells and the amount of contractile and cytoskeletal proteins. Conditions like these suggest that skeletal muscle contractile activity may be a more sensitive diagnostic indicator, especially in chronic disease. In such cases, it could affect muscle mass. One such correlation is between weaker forearm muscles and an increased risk of death or illness.[7-9]

Body Water (BW)

TBW, or Total Body Water, is the primary constituent of lean body mass. From a maximum of 75% water at birth, the average adult body contains between 50-60%, with the percentage dropping to under 40% in obese adults. Water makes up about 73% of the body in adults, and the total water is found within the FFM. Water makes up about 57% of the body in a fully grown adult.[10]

Role of Protein

Protein is essential for various bodily processes, including blood clotting, fluid balance, hormone, enzyme production, eyesight, cell repair, etc. Along with water, it is a primary component of muscle and can be found throughout the body, including the brain and heart. At 15% of the average man's body weight, protein makes up a sizable portion of a healthy adult's mass (around 11 kg).[11-13]

Bone Mass (BM)

According to genetic research, Peak Bone Mass

(PBM) accounts for 60% of the human body. It is influenced by dietary calcium and vitamin D levels, medication use, obesity, physical activity, and certain chronic conditions such as type 1 or type 2 diabetes, inflammatory bowel disease, and cystic fibrosis.[17] Obesity may be linked to Vitamin D in sufficiency and secondary hyper parathyroidism because of the decreased availability of Vitamin D3 from cutaneous and dietary sources due to its deposition in body fat compartments.[14-16]

METHODS AND MATERIALS

A two group (male vs. female) retrospective comparative study that compared two means of two independent groups. Eighty northern Kolkata and 24 PGS participants with sedentary activities in the age group 21-60 participated in the study. The body composition data were collected from all visited a dietitian in north Kolkata for the significant complaints of obesity and other lifestyle disorders. The body composition comprised twelve variables measured by Dr. Trust's body composition analysis machine (model 509) from the study period from January 2022 to January 2023. This was the first task to ask every visited patient about their age, height, and weight, followed by the body composition measurements. Later the diet plan was prepared based on their weight and related comorbidities status.

Table 1: Descriptive analysis of all variables related to body composition components of the participants

Analysis	Sex	BMI	Body Fat	Muscle Rate	Body Water	Bone Mass	BMR	Metab. Age	Visceral Fat	Subcuta-neous Fat	Protein Mass	Muscle Mass	Weight without Fat
Mean	M	26.3	23.1	51.3	54.9	2.84	1404	34.9	10.2	21.4	16.4	40.7	56.7
-	F	29.5	37.3	40.1	48	2.5	1225	38.8	9	34.1	12.9	30.2	45
Median	M	25.6	23.8	49	53.4	2.7	1285	35	10	21.3	16.3	34.1	52.8
-	F	28.3	34	37.9	50.4	2.4	1247	35	9	31.4	13.2	30.9	44.3
Standard deviation	M	7.1	10.8	7.2	6.49	0.376	245	15.4	4.91	8.51	2.26	17.1	9.12
-	F	7.54	11	5.48	7.08	0.273	142	14.4	4.28	9.75	2.14	9.2	6.36
Minimum	M	16.3	5	40.4	46.9	2.3	1072	17	3	10	13.3	18	42.4
-	F	15.8	10.6	33.7	36.8	2	909	23	2	10.9	10.2	13.2	35
Maximum	M	38.6	37.7	65.8	68.2	3.6	2026	80	18	33.8	20.1	73.8	74.5
-	F	46.3	50	52.2	63.9	3	1409	63	16	45.4	17.8	42.2	57.1
Skewness	M	0.198	-0.362	0.514	0.636	0.583	0.71	1.18	-0.071	-0.091	0.296	0.572	0.42
-	F	0.349	-0.822	1.43	0.443	0.298	-0.455	0.428	0.003	-0.775	0.647	-0.143	0.649
Std. Error skewness	M	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333
-	F	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434

Table 2: Independent Sample T-test related to body composition components of the participants

Variables	Tests	Statistic	df	p	Type of Effect Size	Effect Size
Body Weight	Welch's t	0.521	70.2	0.604	Cohen's d	0.117
	Mann-Whitney U	738		0.992	Rank biserial correlation	0.002
BMI	Welch's t	-1.908	55.4	0.062	Cohen's d	-0.447
	Mann-Whitney U	563		0.078	Rank biserial correlation	0.239
Body Fat	Welch's t	-5.572	57.4	<.001	Cohen's d	-1.299
	Mann-Whitney U	299		<.001	Rank biserial correlation	0.596
Muscle Rate	Welch's t	7.787	71.4	<.001	Cohen's d	1.743
	Mann-Whitney U	135		<.001	Rank biserial correlation	0.817

table cont...

Body Water	Welch's t	4.323	54.3	< .001	Cohen's d	1.017
	Mann-Whitney U	378		< .001	Rank biserial correlation	0.489
Bone Mass	Welch's t	4.711	73.3	< .001	Cohen's d	1.048
	Mann-Whitney U	337		< .001	Rank biserial correlation	0.544
BMR	Welch's t	4.15	77.9	< .001	Cohen's d	0.897
	Mann-Whitney U	445		0.003	Rank biserial correlation	0.399
Metabolic Age	Welch's t	-1.12	61.5	0.267	Cohen's d	-0.258
	Mann-Whitney U	625		0.251	Rank biserial correlation	0.156
Visceral Fat	Welch's t	1.1	65.1	0.275	Cohen's d	0.251
	Mann-Whitney U	643		0.331	Rank biserial correlation	0.131
Subcutaneous Fat	Welch's t	-5.837	52.1	< .001	Cohen's d	-1.383
	Mann-Whitney U	277		< .001	Rank biserial correlation	0.625
Protein Mass	Welch's t	6.78	61	< .001	Cohen's d	1.565
	Mann-Whitney U	188		< .001	Rank biserial correlation	0.746
Muscle Mass	Welch's t	3.575	77.8	< .001	Cohen's d	0.766
	Mann-Whitney U	501		0.017	Rank biserial correlation	0.323
Weight without Fat	Welch's t	6.684	74.6	< .001	Cohen's d	1.479
	Mann-Whitney U	200		< .001	Rank biserial correlation	0.730

Note. $H_a\ \mu_{Male} \neq \mu_{Female}$; ES means Effect Size

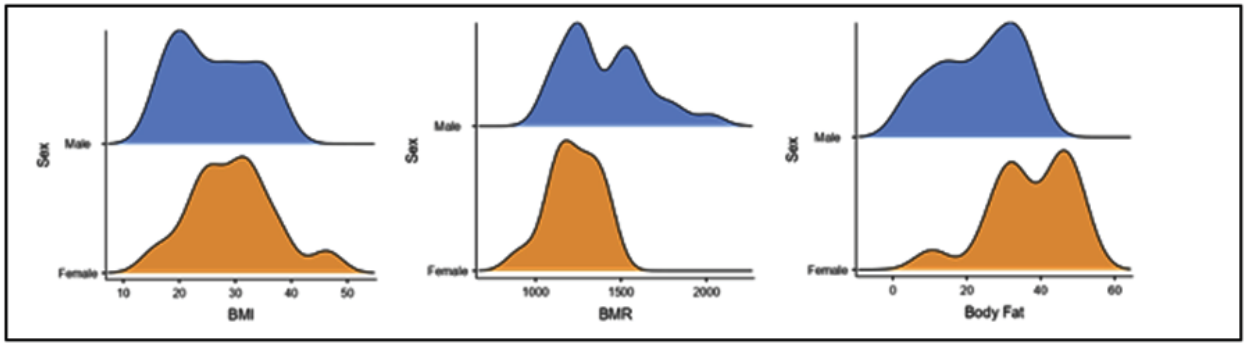

Fig. 1: Male vs. Females: Graphical analysis of BMI, BMR, and BF%

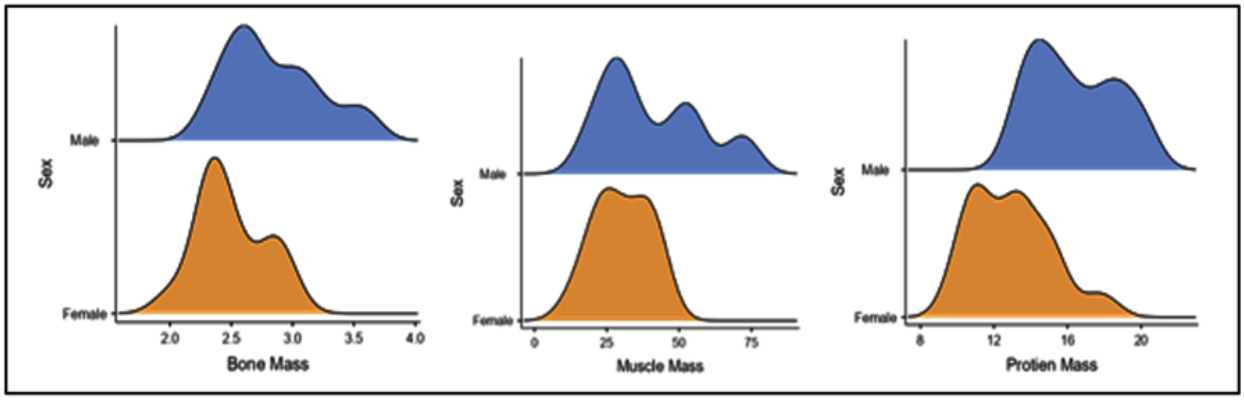

Fig. 2: Male vs. Females: Graphical analysis of BM, MM, and PM

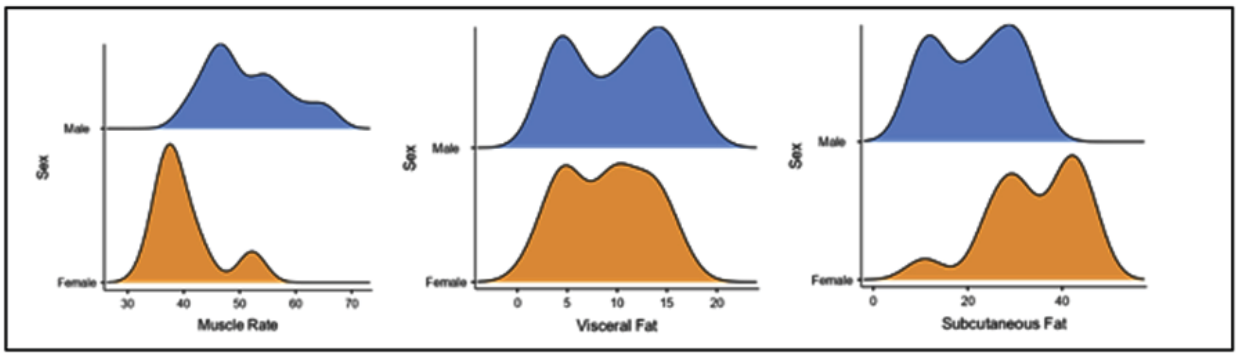

Fig. 3: Male vs. Females: Graphical analysis of MR, VF, and SF%

RESULTS AND DISCUSSIONS

Table 1 shows the descriptive analysis of both groups, including mean, median, standard deviation, and skewness. Table 2. All body composition variabl esexcept body weight, BMI, metabolic age, and visceral fat are statistically significant. In such variables, we performed an independent sample T-test to compare the two means of the male vs. female group. So, the null hypothesis: The means for the male and female body composition in the populations of West Bengal, are the same, whereas the research hypothesis: The means for the male and female body composition in the populations of West Bengal, are different.

In our study, except for four variables (Table 4), all p-value was less than 0.05; hence null hypothesis is rejected, and the research hypothesis is accepted. Welch's t and Mann-Whitney U were tested to cross check the significance of both groups in the Independent T-test. We also presented (ES) effect size regarding Cohen's d and Rank biserial correlation. Effect size is essential to quantify the differences between means and the relationships between groups and variables.

CONCLUSION

Body composition analysis is an essential and integrated part of the nutrition care process. Precisely, measuring various components of body composition should be the mandatory task under the nutrition assessments while a patient suffering from obesity or lifestyle disorders. Even an underweight or normal person should have a mandatory body composition assessment with future needful actions. Sports persons and body builders need periodical estimates of this. Overall, males and females must carefully consider changing body composition while reducing or gaining weight, apart from the indirect progress of other comorbidities.

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