



BASAL METABOLIC RATE – AN IMPORTANT FACTOR TO CONSIDER IN YOUR HEALTH STATE

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Abstract

The Basal metabolic rate is one of the key factors, that affects an individual's daily energy requirement, its role in maintaining good health and fitness is vital (Xinyan et al., 2019). An impaired basal metabolic rate can lead to several conditions impacting health and cause deficiency and diseases if left untreated. The Bioelectrical impedance analysis is one of the advanced methods to perform body composition assessment. This is one of the best ways to find out basal metabolic rate easily and non-invasively, it includes various interpretations and is also helpful to identify any imbalances in basal metabolism that can affect the health and weight imbalances (Boothby et al., 1936; Henry, 2005). The primary goal of this research is to find out the basal metabolic rate for adult age group subjects and check their nutritional status alongside their health state, while the secondary goal is to provide nutrition consultation based on the body composition assessment findings. All 255 adult male and female subjects were observed prospectively during the one year at the dietetics department of Choithram Hospital and Research Center, their body composition analysis was performed with consent and the bioelectrical impedance method four-compartment model was used to do the analysis. The mean age was 39.86 years, the M/F ratio was 1.48, and the mean basal metabolic rate (BMR) reported was 1449.74 kcal, anthropometric data revealed that mean height in centimeters was 164.93 cm and weight 73.43 kgs while the body composition analysis showed that mean fat percentage was 33%, Fat mass 26.439 kg, Fat free mass 48.80 kg, muscle mass 45.80 kg, Body mass index 28.42 kg m² and metabolic age 46.98 years. The overall health or physique rating showed interesting and alarming facts that a total of 185 (72.33%) were obese, only 55 (21.5%) healthy and 15 (5.88%) under fat subjects.

Keywords- Basal Metabolic Rate, Health, Nutrition assessment, Bioelectrical impedance analysis, Body composition

Highlights

Basal metabolic rate and its impact on overall health state.

Body composition analysis using the bioelectrical impedance technique is an easy, and useful tool to assess basal metabolic rate.

Considering body weight vs fat and muscle mass status to define good health.

Other contributing factors related to lifestyle and health state.

INTRODUCTION

The Basal metabolic rate is defined as the rate of energy required at an absolute resting state of digestion, mental and physical activities. Our daily total energy expenditure is the sum of resting energy expenditure, the thermic effect of food, and physical activity levels, where resting energy expenditure contributes a major amount (60 %) of total energy expenditure, and it does not include physical activity levels. Interestingly based on this distribution larger portion of daily energy expenditure is dependent on basal metabolic rate (Roth & Buckingham, 1939).

On the other side, resting energy expenditure (REE) or resting metabolic rate (RMR) is defined as the energy required for oxygen uptake when the body is in an alert and active state, not similar to the basal metabolic rate where an individual should be sleeping. The resting energy expenditure is always measured in supine laying condition, without exercise, 4-5 hours before any food consumption. This is 10 % higher than the basal metabolic rate (medicine, 2023).

Importantly this major expenditure is the contribution from different body functions out of which normal body cellular homeostasis along with vital organ functions like pumping of blood, supply of oxygen and nutrients, and motor neuronal activities (Shetty, 2005). The BMR is directly associated with weight and the simple way of calculation is $BMR (Cal/day) = 24 \times \text{Body weight (kg)}$ as per John W. Pelley in Elsevier's Integrated review article named Nutrition (Benedict, 1918).

Basal metabolic rate (BMR) is a very important factor in all age groups, in different age groups people have variant degrees of metabolism (Aub et al., 1921). Metabolic rate is the key component that defines an individual's health status regarding weight balance (Krogh, 1923). The pathophysiology of weight changes is significantly associated with metabolic changes, fat percentage, muscle mass, and bone health status (Verma et al., 2023). The most important factor is to find out the body composition nowadays, there are several different methods available (Lewis et al., 1943). A few of them are bioelectrical impedance, DEXA, and BOD- POD is the modern method (Abeltino et al., 2024). While the Harris benedict equation is used as the traditional method to calculate the basal metabolic rate for adult males and females, among all of them Bioelectrical Impedance is proven to be the best method (Franco-Villoria et al., 2016; Frankenfield et al., 1998; Ramirez-Zea, 2005).

As per the World Health Organization, health is defined as "a state of complete physical, mental and social well-being" and a healthy individual reflects a normal metabolic rate (Nobile, 2014).

Basal metabolic rate and its impact on overall health- Basal metabolic rate helps in maintaining weight balances, while low BMR indicates weight gain and Higher BMR reflects underweight conditions (Dubois et al., 1952). An individual's health is dependent on weight and muscular status, excessive weight gain from fat leads to several health-related problems like obesity, cardiac diseases, diabetes, etc. (Luke & Schoeller, April 1992).

Aging is the natural process of the life cycle. Aging brings several changes to physiologic and metabolic activities in the human body. Lower basal metabolic rate is reported during aging (Cooney et al., 2021; Zampino et al., 2020). A low basal metabolic rate indicates the body's tendency to weight gain or fat gain, while a higher metabolism defines the lower weight gain pattern (Dubois et al., 1952).

MATERIAL AND METHOD

Study design

The present study describes the prospective findings of a total of 255 adult male and female subjects studied during the period of six months from January 2023 to January 2024. This is an observation research monitoring non-invasive body composition parameters using bioelectrical impedance in non-diseased adult subjects, in a tertiary care facility based in the central India region.

Site of Study

The study took place at the Dietetics Department, Choithram Hospital and Research Center Indore India.

Subjects Selection

All walking adult subjects, both male and female, aged between 18 to 70 years who visited to outpatient dietician clinic were enrolled and willingly gave their consent to participate in this study by performing their Body composition analysis through the bioelectrical impedance analysis method using the Tanita 780 machine, which is four electrode conduction machines.

Bioelectrical impedance is a non-invasive method to check the health status (Baumgartner et al., 1990).

Subjects who had cardiac pacemakers and metal implants in their body were excluded, also pregnant females were excluded from this research.

Assessment Tools

A detailed history was recorded from each subject using the 24-hour diet recall method, which included their lifestyle, fitness goals, attitude, and diet pattern along with the body composition analysis and then further nutrition plan and counseling were given to every subject on an individualized basis by senior dieticians based on the body composition analysis findings.

Results

All enrolled subject's data were analyzed and reported in the following manner here.

Table 1. Demographic and basic anthropometric data (N=255)

S. No	Parameters	Results (Total)	Mean ±SD
1.	Chronological age (Years)	10166.2	39.867 yrs
2.	Gender M / F	148 / 107	
3.	Weight (Kg)	18725.7	73.43 Kg
4.	Height (C.M)	42056	164.93 cm
5.	Ideal body weight (Kg)	-	-
6.	Fat %	8566 %	33.59 %
7.	Fat mass (Kg)	6742	26.439 kg
8.	Fat-free mass (Kg)	12352	48.44 kg
9.	Muscle mass (Kg)	11679.8	45.80 kg
10.	Body mass index (Kg / m ²)	7247.1	28.42
11.	Metabolic age	11976	46.98 yrs

The result showed that the mean age of all enrolled adult subjects was 39.867 years, and the male population was 148, female 107 subjects out of 255. The mean values of weight in kilograms were found 73.43 Kg and height in centimeters was 164.93 centimeters. The average fat percentage was found 33.59 % which is very high and considered as the health risk indicator with profound/ established factors for several diseases such as Fatty liver, cardiac diseases, and metabolic syndrome.

The total body weight is divided broadly into two major parts – Fat mass and Fat-free mass. The mean fat mass in kilograms was found 26.439 kgs, and the average fat-free mass was 48.44 kgs. This is further distributed into muscle mass and the mean of muscle mass was found 45.80 kgs, muscle mass contributes towards fitness and promotes good health. The body mass index was reported as 28.42 kg / m² with a mean metabolic age of 46.98 years and showing a significant difference between chronological age vs metabolic age, which is another remarkable indicator of metabolic syndromes and a sign of early aging.

Table 2. Basal metabolic rate, Visceral fat analysis, and Total body water (N=255)

S. No	Parameters	Total	Mean values	Percentile values
1.	Basal Metabolic Rate	369686	1449.74	NA
2.	Visceral Fat	2904	11.38	NA
3.	Total Body Water			35 % / 40 % / 45 %

The bioelectrical impedance analysis finding revealed that the basal metabolic rate was lower than the normal in majority of subjects and the mean basal metabolic rate reported 1449.74 kcal. The visceral fat is the fat surrounding the viscera or internal organs and also another important factor that defines the health risk, known as the health risk indicator, strongly associated with fatty liver, dyslipidemia, and metabolic syndrome. The higher the visceral fat, the more the chances of having all the above disease conditions.

Table 3. Physique rating based on fat and muscle mass (N=255)

S.NO	Rating parameters	Rating		
1.	Obese (185) 72.54 %			
	Super obese	Hidden obese	Obese	Solidly obese
	1	4	108	72
3.	Healthy (55) 21.56%	Under exercised	Standard	Standard muscular
		7	44	4
4.	Under fat (15) 5.88%	Thin	Thin and Muscular	Very muscular
		8	3	4

The overall physique rating through the body composition analysis reported that the huge population of our subjects belongs to the obese category, which is 72.54 % including super obese, hidden obese, obese, and solidly obese (Harris & Benedict, 1918). While 21.56 % of the total subjects were observed in a good health state and considered as healthy including under-exercised, standard, and standard muscular. A very low percentage of subjects was found in the under-fat category, which was just 5.88 % including subcategories of thin, thin muscular, and very muscular (Janssen et al., 2000).

The finding of this research indicated that the huge adult population belonging to the urban group of Indore is at the highest health risk due to a sedentary lifestyle, no exercise, and faulty food habits. All these factors are modifiable and if identified on time can be resolved and preventable for all the diseases with a reduction in health risk.

Table 4. Health status and Basal metabolic rate

S. No	Health status	Basal metabolic rate total	Mean	Rating
1.	Healthy (N=55)	72557	1319.2	Normal
2.	Obese (N=185)	279795	1504.27	Lower
3.	Under fat/ Thin (N=15)	18510	1234	Higher

The health state is dependent on several factors and basal metabolic rate one out of them, basal metabolic rate is dependent on certain factors age, sex, and body surface area, hence we consider it should be taken care of on priority to maintain good health. Our study reported that the average basal metabolic rate for all healthy subjects was 1319.2, for obese subjects 1504.24, and under-fat people 1234.

Table 5. Health status and Visceral fat

S. No	Health status	Visceral fat total	Mean	Rating
1.	Healthy (N=55)	342	6.21	Normal
2.	Obese (N=185)	2510	13.49	High
3.	Under fat/ Thin (N=15)	48	3.2	Under

In our study, all 185 obese subjects were found with very high visceral fat, which indicates the highest risk of metabolic diseases, diabetes, and several other disease conditions.

Discussion

A larger number of research shows that measuring basal metabolic rate in adult age is the key to finding out the current health state, basal metabolic rate contributes significantly to the daily energy expenditure. It is also considered an important indicator to identify the risk related to metabolic diseases (Frankenfield et al., 1998; Henry, 2005; Roth & Buckingham, 1939).

A lower basal metabolic rate leads to obesity, while a higher metabolic rate is well known for underweight and several nutritional deficiencies. (Janssen et al., 2000). Keeping a balance between basal metabolic rates is important to maintain good health and fitness. The direct association between positive and negative calorie balancing and weight imbalance reflects very clear insight into the value of basal metabolic rate in individuals' lives (Cooney et al., 2021). In our study, we observed 255 adult male and female subjects' basal metabolic rates through the bioelectrical impedance technique, and the results showed that a huge number of the study population is falling into the obese state which is an alarming sign of several other metabolic diseases (Ning et al., 2024).

Most of the subjects 185 /255 (72.65%) who were identified with obesity were reported with lower basal metabolic rates and higher fat percentages in our study. The reason related to these results was found commonly a sedentary lifestyle, excess energy consumption, and a diet containing higher simple sugars and alcohols. Since all these are proven facts leading to obesity, we decided to perform bioelectrical impedance to find out the overall body composition and based on the findings to give guided nutrition support on an individualized basis (Zhao et al., 2024). Only 55 (21.48 %)

identified as healthy based on their muscular status and normal basal metabolic rate, interestingly 15 (5.88 %) subjects were observed under the fat category, and 4 out of these 15 were very muscular and higher metabolic rate.

This is important to understand the significance of maintaining an ideal basal metabolic rate concerning good health and disease-free health state. People generally lack the awareness of this terminology in relevance to health impact and fitness. We suggest as nutrition or dietetic professionals one should always mention it in the general practice to create more awareness among the community and the general public. Sometimes people misunderstand this fact and consider basal metabolic rate as the only factor related to health while this is one of the three major contributing factors in overall health state. Also, in our study, we found that lower muscle mass is associated with poor health state and needs to be paid attention to good health.

The additional attraction of our results related to a huge difference between the chronological age (39.8 years) vs metabolic age (46.98 years) which defines the associated risk of metabolic syndrome and signs of early aging in all obese subjects. One of the research reported a significant risk of metabolic diseases associated with higher metabolic age than the chronological age (Ng & Schooling, 2023; Zampino et al., 2020).

Conclusion

Basal metabolic rate is a very important factor in association with good health and fitness. This research showed clear evidence of its derangements and the health status with the high risk of metabolic diseases and illnesses. Every individual should monitor their basal metabolic rate and so weight regularly to ensure their health and fitness.

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