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Relationship between Basal Metabolic Rate and Body Fat Percentage in Obese and Non-obese Females: A Comparative Study

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Abstract

Background: Obesity and its associated disorders are a growing epidemic across the world. Many genetic, physiological, and behavioral factors play a role in the etiology of obesity which causes disturbance in energy equilibrium. Balance should be maintained between energy intake and its expenditure. This can be assessed by an individual's basal metabolic rate (BMR). *Aims & Objectives:* To measure and correlate variations in basal metabolic rate in obese and non obese individuals. *Materials and Method***:** 140 female subjects were grouped into 70 obese and 70 non obese categories. Anthropometric measurements like height, weight, BMI and waist circumference were recorded. Body fat percentage and BMR were measured using Omron HBF 306 body fat analyzer. *ResuIts and Conclusions:* This study is done by random sampling with power > 80% and Level of significance being 5%. The present study shows statistically significant higher values of waist circumference, BMI and body fat percentage ($p < 0.000$) in obese. Basal metabolic rate (BMR) shows statistically significant higher values ($p < 0.000$) in obese. BMR showed positive correlation with body fat percentage and Body Mass Index (BMI).

This shows that the increased adiposity contributes for increased respiring cells thus resulting increased metabolism, resulting in higher BMR values in obese.

Keywords: Obesity; Body Fat Percentage; BMR; BMI; Lipid Profile; Fasting Blood Glucose.

Introduction

Obesity, a chronic non-communicable disorder is associated with abnormal, excessive body fat accumulation. Approximately 1.2 billion people in the world are overweight and at least 500 million of them are obese [1]. According to the World Health Organization, obesity is one of the 10 most preventable health risks. WHO estimates that approximately 58% of diabetes mellitus, 21% of ischemic heart disease, and 8-42% of certain cancers can be attributed to BMI above 21kg/m^2 [2]. Moreover, there is greater realization that both the amount of body fat and its distribution are important in determining health risks associated with overweight conditions. In many Asian populations, abdominal or central obesity (measured by waist circumference or the ratio of waist to hip circumference) is found to be more common than obesity defined by BMI [3]. A study in India observed that about 20% of adults who were not overweight or obese as per the BMI definition still had abdominal obesity [4].

Obesity is related to an imbalance between energy intake and expenditure. However, more recent research has suggested that genetic, physiological, and behavioral factors also play a significant role in the etiology of obesity. Body composition, i.e., the proportion of body fat and active protoplasmic tissue, has a great influence upon the basal metabolism. Basal metabolism of an individual is a function of the total mass of active protoplasmic tissue [5].

This study was designed to examine the associations of several measures of adiposity

like BMI and % BF and body fat distribution (waist circumference) with basal metabolic rate.

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Materials and Methods

In present study a total number of 140 female subjects were considered and grouped into 2 groups of 70 obese and 70 non obese medical and paramedical students of Mysore Medical College and Research Institute belonging to age group of 18-25 years. Females with BMI more than 25 are grouped as obese (Classification of weight by BMI in Asian and Euripides adults by WHO) and also with Body fat percentage more than 39% are considered as obese [6].

Subjects with history of diabetes mellitus, hypertension, cardiovascular diseases, drug intake, active sports training, yoga, aerobic exercise, and other metabolic disorders were excluded from the study. Study was conducted after obtaining ethical clearance from the ethical committee of MMC&RI. Informed consent was taken from all the participating subjects

Anthropometric measurements such as Height in meters, Weight in kilograms, Waist circumference in centimetres, Body Mass Index were recorded. Body fat percentage and Basal Metabolic Rate was recorded using bioelectric impedance body fat analyzer Omron Model HBF 306 which gives values of body fat % and BMR after feeding input of height, weight, age and gender details. For measurement of BMR, subjects were instructed to undergo 12 hours overnight fast and to reach the study centre without undue exertion. Subjects were then allowed to relax for half an hour before measurement. Recording was taken within the first ten days of menstrual cycle (the first day of menstruation taken as day 1) of the subjects. All measurements were carried out between 6am-8.30am, in a room, with temperature maintained between 23^0C-26^0C.

Results

This is a comparative study done by random sampling with power > 80% and Level of significance being 5%. Statistical analysis is done using SPSS software.

The distribution of age is not showing any statistically significant values between case and control. Maximum number of subjects belong to age group of 20 years (27.1% obese and 34.7% non-obese).

Graph 1: Age wise distribution of controls and obese cases

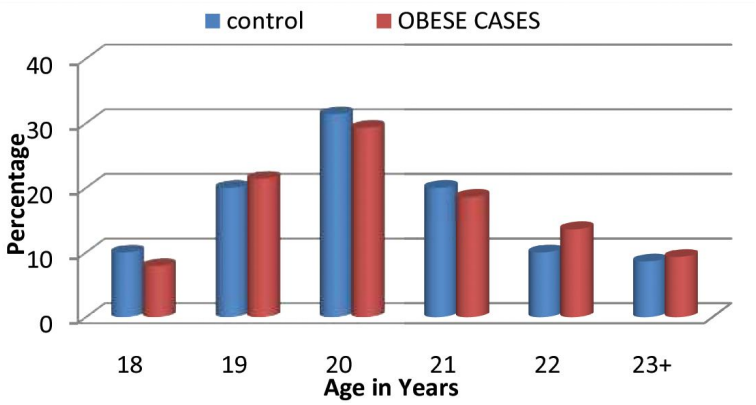
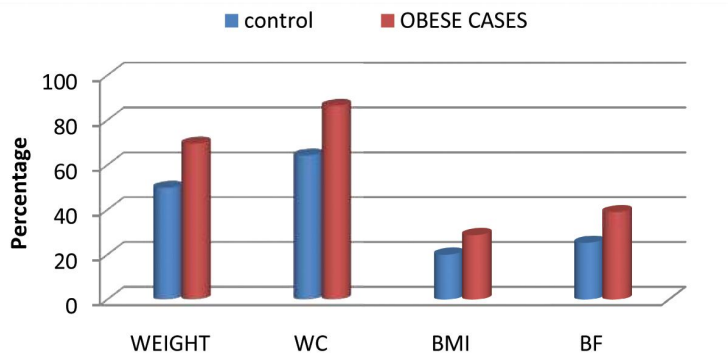


Table 1: Anthropometric measurements

Variables	Mean ± SD of Case	Mean ± SD of Control	P- Value
Height in cms	155.78 ± 5.38	157.41 ± 6.60	0. 112
Weight in kg	69.58 ± 6.17	49.88± 6.08	0.000*
Waist circumference in cms	86.41 ± 9.47	64.28± 4.05	0.000*
BMI	29.77 ± 2.27	20.05± 1.62	0.000*
Body Fat %	38.99± 2.66	25.29± 2.74	0.000*

*p-value (<0.05): considered as significant

Graph 2: Anthropometric measurements



The above table and graph shows statistically significant higher values of weight, waist circumference, BMI, Body fat % in obese (p- value = 0.000) . Height is not showing any significant variation (p-value = 0.115).

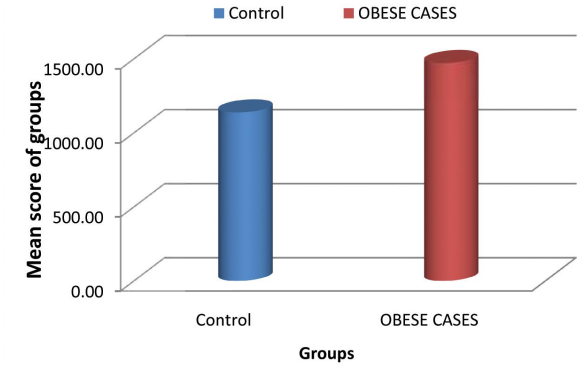
Table 2: Basal Metabolic Rate

Variables	case	control	p-value
Basal Metabolic Rate	1470.74±195.08	1137.42 ± 85.43	0.000*

*p-value (<0.05): considered as significant

The above table shows statistically significant higher values of BMR in Obese (p- value = 0.000)

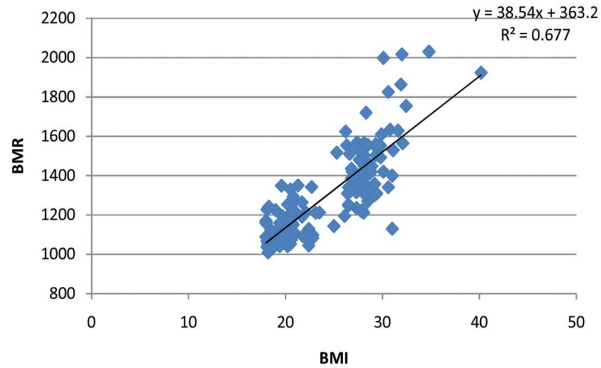
Graph 3: Comparison of basal metabolic rate between control and obese cases



Basal metabolic rate is higher in obese group compared to control group which is statistically highly significant with p value of 0.000.

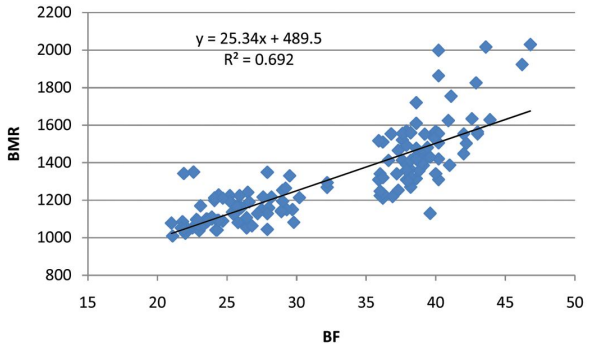
Correlations of BMR with BMI and Body Fat %

Graph 4: BMR with BMI



The above graph shows linear positive correlation between BMI and BMR

Graph 5: BMR with Body Fat %



The above graph shows linear positive correlation between BMR and Body fat per cent.

Discussion

Obesity is a major public health problem resulting in serious social, physical and psychological damages. The prevalence of obesity and overweight among adult and children is increasing in developed and developing countries including India.

During earlier studies done during 20th century obesity prevalence was higher in middle aged individuals, in contrast to present scenario where it is showing increasing trends in children and adolescents as a result of their genetic and environmental influences. Increasing prevalence of obesity in younger age groups is contributing its major share for global epidemic of obesity [7, 8, 9]. Several studies done in different parts of the world

have shown high prevalence of obesity in females. Girls with early menarche (age ≤ 11 years) are twice as likely to become obese adults as are late ones (age ≥14 years) [10]. The probable reasons for higher incidence of obesity in females might be due to hormonal influences and intensity of physical activities. In females, oestrogen causes increased deposition of fat in the subcutaneous tissues. This leads to particular pattern of fat distribution resulting in increased fat mass in them compared to males [11].

Basal metabolic rate (BMR) is the rate of energy expenditure by humans and other animals at rest, and is measured in kJ per hour per kg body mass. The results of the present study which shows significantly high values of BMR in obese, are in accordance with a study done on prediction of the basal metabolic rate in obese by Robert S Bernstein, John C Thornton, Mei Uih Yang, et al which showed significant correlation of basal metabolic rate with weight and fat mass in both sexes and also they reported that the adipose tissue has a high basal metabolic activity compared to other cells [12]. Another study done by Bray et al [13] also found a much greater effect of body fat on BMR than Fat Free Mass (FFM).

In contrast, studies by Ljunggren et al [14] and by Halliday et al [15] have concluded that FFM and not the body fat, is the sole predictor of BMR in obese individuals. A study done by James et al [16] found that body fat had no significant influence on BMR.

Age factor greatly influences basal metabolism. Studies done by Du Bois, on Basal Energy Requirement in June, 1916 shows that basal metabolic rate (BMR) varies greatly with age [17]. It is highest during growing period till 18- 20 years of age and till forty years shows little change and falls thereafter. This increased BMR in younger age group may be due to increased active protoplasmic tissue and greater cellular activity. As age advances this is replaced by atrophic protoplasmic tissue leading to decreased metabolism [5]. As this study group consists of subjects belonging to age group of 18-25 years, this may contribute for increased BMR values in both the groups. But, it is significantly higher in obese group because, body fat beyond its contribution to FFM also has a high basal metabolic activity compared to other cells. Studies have been done to assess the separate effects of fat cell size and number because it was possible that they would have separate influences on metabolic rate. Enlarged human fat cells in vitro have increased rates of lipolysis and basal glucose utilization. In addition, their increased surface area might require increased energy utilization through Na-K ATPase in order to maintain internal electrolyte balance. Regardless of cell size, the ratio of cell membrane surface area to cytoplasmic volume is higher in adipocytes than other cells, because most of the cell volume is occupied by the lipid. Similarly increase in fat cell number increases the number of actively respiring cells which utilises energy in the form of ATPs which are obtained as bi products of cellular metabolism and contributes for thermogenesis [6, 12, 13]. Hence there will be increased basal metabolic rate in obesity with increased adiposity which may be either in the form of increased adipocyte size or increased number or both. Adipocyte has generally been regarded as a storage depot for fat but it is also an endocrine cell that releases numerous molecules in a regulated fashion. These include the energy balance-regulating hormone leptin [18]. As obese individuals have increased adipose depots, there will be excessive leptin production and release which increases basal metabolic rate. This is in accordance to a study done by Ruffin M and Nicolaidis S, who inferred that the adipocytokine leptin is involved in the regulation of BMR by conducting several experiments on rats with leptin infusions which led to increase in their BMR [19].

Conclusion

The present study shows significant higher values of BMR in obese females than non obese group. This is attributed by increased respiring tissue in obese individuals compared to lean ones. Maintaining optimum energy balance in these obese individuals in the form of increased physical activity which burns extra calories and increases energy expenditure and dietary modification by increased intake of low calorie, highly nutritious food helps in reducing storage of extra calories as fat. All these measures help in preventing development and progression of obesity associated complications. Thus, assessment of BMR in obese individuals plays a key role in understanding their energy dynamics and to bring modifications in their lifestyles and lead them towards healthy life.

References

1. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological

studies with 960 country-years and 9.1 million participants. Lancet. 2011; 377: 557-67.

2. World Health Organization (WHO) 2002. The World Health Report 2002: Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization.
3. McKeigue, P.M., Shah, B., & Marmot, M.G. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet, 1991; 337 (8738): 382-386.
4. Gopalan, C. (1998). Obesity in the Indian urban middle class'. Bulletin of the Nutrition Foundation of India, 1998; 19(1): 1-5.
5. Benedict Francis G. Factors affecting Basal Metabolism. Journal of Biological Chemistry. 1915; 20: 263-299.
6. Gallagher et al. Am J Clin Nut 2000; 72: 694-701.
7. Burstein M, Scholnic HR, Morfin R. J Lipid Res, 1970.
8. Kalra S, Unnikrishnan AG. Obesity in India: the weight of the nation. J Med Nutr Nutraceut, 2012; 1: 37-41.
9. Strauss RS. Childhood obesity. Pediatr Clin North Am. 2002 Feb; 49(1): 175-201.
10. Garn SM, LaVelle M, Rosenberg KR, Hawthorne VM. Maturational timing as a factor in female fatness and obesity. Am J ClinNutr.1986 Jun; 43(6): 879-83.
11. Guyton and Hall. Textbook of medical physiology. 11th Edition; p: 1005 and 1018.
12. Robert S Bernstein, John C Thornton, Mei Uih Yang, et al Prediction of the resting metabolic rate in obese patients, Am J Clin Nuir 1983: 37: 595-602.
13. Bray G, Schwartz M, Rozin R, Listen J. Relationships between oxygen consumption and body composition of obese patients. Metabolism 1970; 19: 4 18- 29.
14. Ljunggren H, Ikkos D, Luft R. Basal metabolism in women with obesity and anorexia nervosa. Br J Nutr 1961; 15: 21-34.
15. Halhiday D, Hesp R, Stalley SF, Warwick P, Altman DG, Garrow iS. Resting metabolic rate, weight, surface area and body composition in obese women. Int J Obesity 1979; 3: 1-6.
16. James WPT, Bailes J, Davies HL, Dauncey MJ. Elevated metabolic rates in obesity. Lancet 1978; 1: 1122-5.
17. Du Bois, E. F.: Basal Energy Requirement of Man Jour. Wash. Acad. Sc, June 1916; 6: 347-357.
18. Harrison's principle of Internal Medicine, Sixteenth edition, 2005; p 423-424.
19. Ruffin M and Nicolaidis S. Intracerebro-ventricular injection of murine leptin enhances the postprandial metabolic rate in the rat. Brain Res 2000; 874: 30–36.