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ASSESSMENT OF FAT MASS INDEX (FMI) AND IMPACT ON THYROID STIMULATING HORMONE (TSH) AMONG YOUNG HEALTHY FEMALES FROM WESTERN UTTAR PRADESH, INDIA

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Abstract

INTRODUCTION: Fat Mass Index (FMI) which is a measure of obesity, calculated by the ratio of Body Fat Mass (BFM) in kg and height in meter square. Adiposity is strongly associated with health risk including thyroid disorders, predominantly hypothyroidism leading to obesity. The present study intends to evaluate the relationship of FMI with serum TSH through Bioelectrical Impedance (BIA) to help in better intervention of thyroid dysfunction and adiposity in females of child bearing age. **AIM:** To determine the implications of Fat Mass Index (FMI) on Serum TSH in young healthy female subjects from Western Uttar Pradesh. **MATERIALS & METHODS:** A cross-sectional study conducted on 100 young healthy female subjects of 18-24 years after approval from Institutional Ethical Committee (IEC). Height was measured using standard height chart according to WHO norms. Bioelectrical Impedance (BIA) method was used to measure BFM and the FMI was computed as a ratio of body fat mass (in kg) and height (in m^2). Serum TSH level was estimated by ELISA method. **RESULTS:** Among 100 subjects, between 18-24 years of age, subjects were grouped on the basis of FMI as subjects with normal fat (n=66, FMI<9 kg/m^2) & as overfat/obese (n=34, FMI≥9 kg/m^2). A slight increase within the reference range was found in serum TSH level in overfat/obese group than normal fat subjects. A significant positive correlation ($p<0.05$) between serum TSH & FMI was found in subjects with overfat/obese group. However, no significant association was found in subjects with normal fat. **CONCLUSION:** Fat Mass Index (FMI) can be a better indicator of fat mass as it reflects true body fatness. Increase in FMI in women increases the level of serum TSH in overweight/obese subjects, presenting a risk of hypothyroidism. It may be useful in appropriate interventional measures like healthy lifestyle & diet which may lower the risk of thyroid disorder by controlling fat accumulation.

Keywords: Obesity**,** BMI, FMI, ELISA, Subclinical Hypothyroidism (SCH), TSH, Abdominal Obesity

INTRODUCTION

Obesity is characterized by the accumulation of body fat, which is typically a consequence of an imbalance of increased energy intake and decreased energy expenditure, which is controlled by both genetic and environmental factors. In India, Obesity has increased from 21% to 24% in males while from 19% to 23% in females (1). Alteration in body composition, due to an increase in BFM and a decline in lean mass may leads to metabolic consequences (2). Adipose tissue distribution is primarily linked to wellbeing of women (3). Currently, body fat content and distribution indices are used as markers of health and mortality risk (4,5). Fat Mass Index (FMI) is another measure to assess body fat distribution defined by the ratio of BFM in kg and height in meter squared (kg/m^2). The International Society for Clinical Densitometry (ISCD) has proposed using FMI as an alternative method to define body fat categories. FMI categories are as follows (6):

FMI (in kg/m^2)	Fat Deficit	Normal fat	Overfat	Obese
Males	<3	3-6	>6-9	>9
Females	<5	5-9	>9-13	>13

FMI considered over other obesity parameters as it offers a singular measurement for body fat, distinguishing it from various other indices (7). When examining FMI within the context of a two-compartment model, it appears to be a more precise instrument for assessing excessive fat, potentially yielding a more precise depiction of the associations between Metabolic Syndrome (MetS) and what is often termed genuine obesity (8,9). The development of obesity is rooted in an imbalance within the body's energy metabolism. Both obesity and thyroid disorders are prevalent in the general population. Thyroid hormones play a crucial role in regulation of energy expenditure and have an impact on appetite (10). The anterior pituitary gland stimulates the production of Thyroid Stimulating Hormone (TSH) and the normal reference range for TSH levels is between 0.5 and 4.5 µIU/L. TSH plays a crucial role in regulating thyroid hormones (11-13). Subclinical hypothyroidism, which is characterized by elevated TSH levels ranging from 4.5 to 10.0 µIU/L, may be the initial factor responsible for changes in energy expenditure that subsequently lead to weight gain (11,12). The transformation from adolescence to adulthood is marked by significant physiological, hormonal and metabolic changes, particularly in females, which can include the accumulation of fat around the breasts and hips (14). Various factors contribute to increased adiposity, such as unhealthy dietary habits, a sedentary lifestyle, lack of physical activity, and underlying biochemical dysfunctions, including thyroid disorders, as well as inflammatory and immunological processes (15,16).

Identification of a precise approach for diagnosing obesity is of utmost importance in order to implement accurate intervention strategies like dietary education and management, pharmacotherapy and physical activity programs, to modify the related health risks and mortality. The unique aspect of this study was to explore the implications of FMI on serum TSH. The findings of this study highlight the potential value of using anthropometric measurements which can provide better information than BMI and enables to screen females of reproductive age group. Consequently, this approach can aid in raising awareness about necessary lifestyle modifications to prevent obesity and its associated complications.

MATERIAL & METHODS

This cross-sectional' study was carried out on 100 healthy female subjects between 18-24 years of age from Western part Uttar Pradesh, visiting Sharda-University, Greater Noida, India, after getting an approval from Institutional Ethical Committee (IEC).

Inclusion Criteria: Healthy female subjects of 18-24'years and willing to volunteer in the study.

Exclusion Criteria: The subjects with known thyroid disorder, Type II Diabetes Mellitus, Hypertension and history of pregnancy were excluded from the study.

Height was measured using standard height chart according to WHO norms and Body Fat Mass (BFM) was measured by using Bioelectrical Impedance (BIA) method and the Fat Mass Index (FMI) was computed as a ratio of BFM in kg divided by height in m^2. The fasting serum samples of selected subjects were collected and stored at -20ºC, and was tested for Serum TSH by Enzyme Linked Immunosorbent Assay (ELISA).

STATISTICAL ANALYSIS

The statistical analysis employed by using statistical software SPSS version 22. Significant results are those with a p-value<0.05 derived at a 95% level of reliability. A highly significant p-value <0.01.

RESULTS

Among the 100 healthy young females, subjects were categorised on the basis of normal fat with FMI<9 kg/m^2 and overfat/obese subjects with FMI≥9 kg/m^2, out of which 34 subjects were found to be in the over fat/obese group (6). The mean age of the study subjects was 21.87±1.83 years.

Table 1: The Serum TSH & FMI of the female subjects in terms of Mean±S.D of both study groups.

Parameter	Normal Fat (n=66) (FMI<9 kg/m^2)	Over Fat/Obese (n=34) (FMI≥9 kg/m^2)	t-value	p-value
Serum TSH	2.58±1.57 µIU/L	3.73±1.62 µIU/L	3.432	<0.001**
Fat Mass Index (FMI)	6.31±1.34 kg/m^2	11.12±0.95 kg/m^2	18.636	<0.001**

****Highly Significant <0.01 *Significant <0.05 Non-Significant >0.05**

The mean of serum TSH & FMI was calculated and one sample t-test was implemented to compare the means of the parameters of both the groups with Normal fat and Over fat/Obese group. A highly significant association (p<0.001) was observed for both the parameters in the study groups.

Table 2: Relationship between Serum TSH and FMI in subjects with Normal fat (FMI<9 kg/m^2).

Serum TSH	**Subjects with Normal Fat (n=66) (FMI<9 kg/m^2)**	
	Pearson Correlation (r-value)	0.140
	Sig. (2-tailed)	0.361

****Highly Significant <0.01 *Significant <0.05 Non-Significant >0.05**

The mean of Serum TSH was 2.58±1.57 µIU/L and FMI was 6.31±1.34 kg/m^2 in subjects with Normal fat. No significant correlation was found between Serum TSH & FMI in subjects with normal fat.

Table 3: Relationship between Serum TSH and FMI in subjects with high fat (FMI≥9 kg/m^2).

Serum TSH	**Subjects with Over Fat & Obese (n=34) (FMI≥9 kg/m^2)**	
	Pearson Correlation (r-value)	0.236*
	Sig. (2-tailed)	0.036

****Highly Significant <0.01 *Significant <0.05 Non-Significant >0.05**

The mean of Serum TSH was 3.73±1.62 μIU/L and FMI was 11.12±0.95 kg/m^2 in subjects with FMI≥9 kg/m^2. A positively significant correlation ($p<0.05$) was found between Serum TSH & FMI, in subjects with overweight fat/obese group.

DISCUSSION

Obesity can be described as a chronic condition marked by an excess of fat within the body that results mostly from a caloric energy imbalance (17). Obesity puts a serious impact to health care system of India and encroaching in younger generation also (18). This study targeted healthy females between the ages of 18-24 years, since the shift from adolescence to adulthood is accompanied by considerable physiological, sexual, emotional and social changes. They could be at risk for harm from this alteration to their health and wellbeing (19). FMI which is a sole indicator of body fat mass and considered a more trustworthy index than BMI. The author of the current study discovered that serum TSH despite being in the normal range, is positively correlated with FMI ($p<0.05$) in the overweight & obese subjects with FMI>9 kg/m^2, however no association ($p>0.05$) was found in subjects with normal body fat with FMI<9kg/m^2 (Table 2 & 3). Gazarova M. et al. in 2022, suggest that FMI excellently correlate with fat mass and visceral fat (20).

Alpizar M et al. in 2020, suggested that FMI is considered as accurate tool in subjects with overweight and obese (8). According to Liu P. et al. in 2013, high FMI may be an accurate measurement approach for the assessment of MetS in clinical practice because they appear to be independently related with MetS (21). De Oliveira et al in 2016, suggested that FMI has been correlated in subjects with elevated Waist Circumference (20, 22). Abdominal Obesity (AO) is a form of obesity which is characterised as excessive fat accumulation in the abdominal area and defined by WC measured by using a non-stretch resistant tape by standard WHO criteria (23). In a study by Singh S. et al in 2023, rise in WC in AO in women increases the level of serum TSH & TNF-α, presenting a risk of hypothyroidism (24). Previous studies did propose that the aetiopathogenesis of AO is based on low grade inflammation and deposition of White Adipose Tissue (WAT) which is responsible for secreting adipokines and energy homeostasis (25-27). Singh S. et al, draw a cut-off value of WC>85 cms for the risk of SCH in healthy females of 18-24 years of age and suggested a thorough biochemical & medical intervention (24).

Fat Mass Index measured by using BIA can be useful in accurately measuring body fat to screen obesity and its associated risk factors. Previous reports suggested than FMI is an indicator of true obesity and can relate with morbidity & mortality. However, a large number of subjects will be required to establish accuracy of this hypothesis of using FMI as an index for thyroid disorder.

CONCLUSION

Fat Mass Index (FMI) may be a better indicator of fat mass as it reflects true body fatness. Increase in FMI in women increases the level of serum TSH in overweight/obese subjects, presenting a risk of hypothyroidism. Assessment of body fat by Bioelectrical Impedance (BIA) method a non- invasive procedure, would be advisable to incorporate these examinations into screening, preventive and clinical practice for the purpose of a comprehensive evaluation of the health condition in females of child bearing age.

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Reference

1) Das S. Nearly one-fourth of all men and women in India are now obese: NFHS. Business Standard, 2022.

2) Mili N., Paschou S.A., Goulis D.G., Dimopoulos M.A., Lambrinoudaki I., Psaltopoulou T. Obesity, metabolic syndrome, and cancer: Pathophysiological and therapeutic associations. Endocrine. 2021;74:479-97.

3) Chlabicz M., Dubatówka M., Jamiołkowski J., Sowa P., Łapińska M., Raczkowski A., Łaguna W., Moniuszko-Malinowska A.M., Waszkiewicz N., Kowalska I., et al. Subjective well-being in non-obese individuals depends strongly on body composition. Sci. Rep. 2021;11:21797.

4) Krakauer NY, Krakauer JC. A New Body Shape Index Predicts Mortality Hazard Independently of Body Mass Index. PLoS ONE. 2012;7(7): e39504.

5) Elagizi A, Kachur S, Lavie CJ, Carbone S, Pandey A, Ortega FB, et al. An Overview and Update on Obesity and the Obesity Paradox in Cardiovascular Diseases. Prog Cardiovasc Dis. 2018;61(2):142–50.

6) Kelly T.L., Wilson K.E., Heymsfield S.B. Dual energy X-Ray absorptiometry body composition reference values from NHANES. *PLoS ONE.* 2009;4:e7038.

7) Petak S, Barbu CG, Yu EW, Fielding R, Mulligan K, Sabowitz B, et al. The Official Positions of the International Society for Clinical Densitometry: body composition analysis reporting. J Clin Densitom. 2013;16(4):508-19.

8) Alpízar M, Frydman TD, Reséndiz-Rojas JdJ, Trejo-Rangel MA, Aldecoa-Castillo JMD. Fat Mass Index (FMI) as a Trustworthy Overweight and Obesity Marker in Mexican Pediatric Population. *Children*. 2020; 7(3):19.

9) Bonikowske AR, Barillas Lara MI, Koepp KE, Medina Inojosa JR, Squires RW, Lopez-Jimenez F, Olson TP. Fat Mass Index Better Identifies Metabolic Syndrome: Insights from Patients in Early Outpatient Cardiac Rehabilitation. J Clin Med. 2019;8(12):2147.

10) Hoermann R, Midgley JE, Larisch R, Dietrich JW. Recent advances in thyroid hormone regulation: toward a new paradigm for optimal diagnosis and treatment. Frontiers in endocrinology. 2017;8:364.

11) Shailza Verma, Rajesh Kumar Thakur, Aisha Beg, Subhra Sucharita Sahoo, Jyoti Mishra, Monal Trishal. Vıtamın B12 Defıcıency In Subclınıcal Hypothyroıd: A Pılot Study. Journal of Pharmaceutical Negative Results, 2022;2427-33.

12) Abdulsalam A.A.Al-Azazi T, Verma S, Kr Thakur R, Kumar Nandkeoliar M, Punia VPS, et al. A study of the levels of serum magnesium and serum zinc in patients of subclinical Hypothyroidism. Int J Adv Res (Indore). 2022;10(05):297-302.

13) Fox CS, Pencina MJ, D'Agostino RB, Murabito JM, Seely EW, et al. Relations of thyroid function to body weight: cross-sectional and longitudinal observations in a community-based sample. Archives of internal medicine. 2008;168(6):587-92.

14) Kawai T, Autieri MV, Scalia R. Adipose tissue inflammation and metabolic dysfunction in obesity. Am J Physiol Cell Physiol. 2021;320(3):C375-91.

15) Priya R, Nanda R, Mohapatra E, Patel S, Dubey SS. Association of thyroid function with body mass index in adolescent girls. Ind J Med Biochem. 2021;24(2):55-8.

16) Solanki A, Bansal S, Jindal S. Relationship of serum thyroid stimulating hormone with body mass index in healthy adults. Indian J Endocrinol Metab. 2013;17(1):S167-9.

17) Frydman, T.D.; De Aldecoa, J.M.; Alpizar, M. What are you Feeding your kids? Biomed. J. Sci. Tech. Res. 2019, 19, 14448-9.

18) Feng RN, Zhao C, Wang C, Niu YC, Li K, Guo FC, et al. BMI is strongly associated with hypertension and waist circumference is strongly associated with type 2 diabetes and dyslipidemia, in northern Chinese adults. J Epidemiol. 2012;22(4):317-23.

19) Adolescent health. Who.int. [cited 2023 May 31].

ISSN 1462 2815

20) Gažarová M, Bihari M, Lorková M, Lenártová P, Habánová M. The Use of Different Anthropometric Indices to Assess the Body Composition of Young Women in Relation to the Incidence of Obesity, Sarcopenia and the Premature Mortality Risk. Int J Environ Res Public Health. 2022;19(19):12449.

21) Liu P, Ma F, Lou H, Liu Y. The utility of fat mass index vs. body mass index and percentage of body fat in the screening of metabolic syndrome. BMC Public Health. 2013;13:629.

22) De Oliveira, P.M.; Almeida, F.; Maria, R.; Oliveira, S.; Mendes, L.L.; Netto, M.P.; Cândido, A.P.C. Association between fat mass index and fat-free mass index values and cardiovascular risk in adolescents. Rev. Paul. Pediatr. (Engl. Ed.) 2016:34;30-7.

23) WHO, "Waist Circumference and Waist-Hip Ratio, Report of a WHO Expert Consultation". World Health Organization. 2008.

24) Singh S, Thakur R K, Nandkeoliar M K, Sahoo S S, Kabi B C, Al-Azazi A A A T, et al. Influence of Waist Circumference (WC) on Thyroid Stimulating Hormone (TSH) and Tumor Necrosis Factor-Alpha (TNF-α) in young healthy females from Western Uttar Pradesh, India. 2023:20(7); 112-9.

25) Choe, S.S.; Huh, J.Y.; Hwang, I.J.; Kim, J.I.; Kim, J.B. Adipose tissue remodeling: Its role in energy metabolism and metabolic disorders. *Front. Endocrinol.* 2016, *7*, 1-16.

26) Nagai M, Komiya H, Mori Y, Ohta T, Kasahara Y, Ikeda Y. Estimating visceral fat area by multifrequency bioelectrical impedance. Diabetes Care. 2010;33(5):1077-9.

27) Tsigos C, Kyrou I, Chala E, Tsapogas P, Stavridis JC, Raptis SA, et al. Circulating tumor necrosis factor alpha concentrations are higher in abdominal versus peripheral obesity. Metabolism. 1999;48(10):1332-5.