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Research Paper

Study on changes in basal metabolic rate, body weight and fat mass per cent in hypothyroidism

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■ **ABSTRACT :** Thyroid is an endocrine gland located below the larynx. The principal thyroid hormones are thyroxin (T_4) and tri-iodothyroxine (T_3). The current study was carried out to investigate the changes in body weight, basal metabolic rate, total fat per cent and prevalence of obesity in hypothyroid subjects. The obesity epidemic has reached alarming numbers, the problem is multi-faceted and requires the understanding of different areas in order to effectively address the growing obese population and begin to reverse the current trends. The present study is cross-sectional in design and aimed at understanding the association between thyroid function and obesity in individuals with normal and underactive thyroid function. It was observed that fat mass per cent, body weight and BMI of hypothyroid subjects were significantly higher than the normal subjects while significant low basal metabolic rate was observed among hypothyroid subjects.

■ **KEY WORDS:** BMI, Obesity, Fat per cent, Basal metabolic rate, Underactive thyroid

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The thyroid gland is a butterfly-shaped endocrine gland that is normally located in the lower front of the neck. Thyroid hormone helps the body use energy, stay warm and keep the brain, heart, muscles, and other organs working as they should. Thyroid hormone regulates metabolism in both animals and humans. Metabolism is determined by measuring the amount of oxygen used by the body over a specific amount of time. If the measurement is made at rest, it is known as the basal metabolic rate (BMR). Indeed, measurement of the BMR was one of the earliest tests used to assess a patient's thyroid status. Patients whose thyroid glands were not working were found to have low BMRs, and those with overactive thyroid glands had high BMRs. Changes in thyroid hormone levels, which lead to changes in BMR also cause changes in energy balance and similar changes in body weight. Thyroid disorders are amongst the most common endocrine diseases in India. The prevalence and pattern of thyroid disorders depends on sex, age, ethnic and geographical factors and especially on iodine intake (Paoletti, 2008). Thyroid disease is one of the chronic non-communicable disease affecting women more than the male population. Thyroid is the one of the most important and sensitive endocrine gland as it easily responds to stress and stimuli and plays a pivotal role in tissue metabolism and development. The low and high secretion of hormone cause thyroid disorder, include hypothyroidism. Throughout the life-cycle an

individual's ability to alter synthesis, secretion or turnover of thyroid hormones in response to changes in nutrient intake and/or ambient temperature has a large impact on heat production and body composition. Hypothyroidism is defined as a deficiency of both T_3 and T_4 hormones resulting in decreased thyroid activity. Iodine is an essential micronutrient which is required for the synthesis of the thyroid hormones, thyroxin (T_4) and triiodothyronine (T_3), regulate cellular oxidation and hence, affect calorigenesis, thermoregulation and intermediary metabolism. Obesity increases the risk for cardio-vascular disease, diabetes, cancers and metabolic syndrome, to name a few. It reduces the quality of life as well as overall life expectancy. It is important to understand all the risk factors that contribute to obesity, as well as understand all the co-morbidities that arise with being overweight and obese since the majority of the population suffers from the disease. Triiodothyronine (T_3) and thyroxine (T_4) deiodinized to T_3 are both used by cells to increase the metabolic rate known as adaptive thermogenesis. Thyroid hormones are potent modulators of adaptive thermogenesis. Overt hypothyroidism leads to increased body weight by increasing mucin deposits and by salt and water retention. Extreme obesity also leads to increased thyroid stimulating hormone (TSH) due to hypothalamic-pituitary thyroid axis abnormality. Leptin hormone produced by adipocytes directly stimulates thyrotropin releasing hormone (TRH) neuron in the paraventricular nucleus, thus increasing TSH (Pinkeney *et al.*, 2008). Thyroid function tests form an important component of the clinical studies on the relationship between thyroid function and obesity. Few studies found that weight gain increases serum thyroid stimulating hormone, yet others showed no relation between TSH and body weight. Therefore, we planned to analyze the frequency of obesity, changes in fat mass per cent and basal metabolic rate in patients with hypothyroidism.

■ RESEARCH METHODS

The study selected 200 subjects of age between 20 to 65 years of both sex by purposive sampling from Haldwani city, Nanital district (Uttarakhand). The study was carried out from the month of June to November 2013. The subjects mainly belonged to middle income group. To confirm the subjects thyroid status venous blood samples of the subjects were collected from their localities by the lab technician and were evaluated for thyroid hormone profile. A professional from "Thyrocare" (Rudrapur, U.S.Nagar centre) was administered to collect the blood samples. About 4 ml blood was collected from each subject and the samples were sent for examination to the "Thyrocare Laboratory Mumbai". Total triiodothyronine and Total Thyroxin levels were examined via "Competitive Chemi Luminescent Immuno Assay" and Thyroid Stimulating Hormone (TSH) via 'Ultra Sensitive Sandwich Chemi Luminescent Immuno Assay'. Assessment of total body fat and basal metabolic rate of the normal and hypothyroid subjects were done with the help of four terminal portable impedance device, Maltron Bioscan Analyzer which works on the principle of bioelectrical impedance, measurements were made while the subjects lay comfortably on a bed with the limbs abducted from the body. Four electrodes: two current injector I and two voltage sensors V, were dorsally placed on the right hand in the third metacarp-phalangeal articulation and in the carpus, respectively, 5 cm apart. The pair on the foot was located in the third metatarso-phalangeal and in the articulation, six cm apart. BMI, according to the International classification of adult underweight, overweight and obese given by WHO (2004) was used for categorisation of subjects.

■ RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Body weight :

There was a significant difference between the weights of both normal and hypothyroid male and female subjects with means weight of 68.49 and 86.75 kg of normal and hypothyroid male subjects, respectively and 57.38 and 73.64 kg of normal and hypothyroid female subjects, respectively (Fig. 1). In a study conducted by

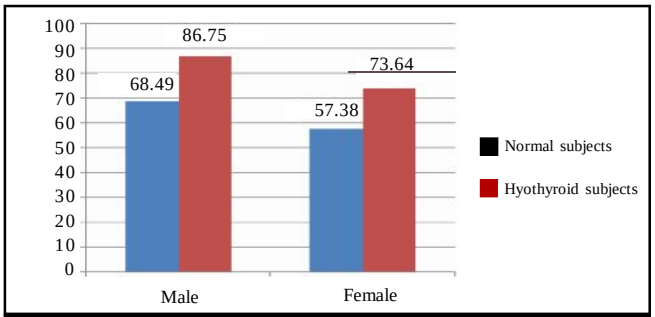

Fig. 1 : Mean value of weight (kg) of normal and hypothyroid subjects

Bjekic Macut and Trbojevic (2008) mean weight of the female patients suffering from hypothyroidism was 79.2 ± 2.6 kg which is more than the weights of the hypothyroid patients in the present study.

Mean values of body weight of hypothyroid subjects was found to be significantly higher than normal subjects. The condition of increasing body weight was found to be significantly positively associated with hypothyroidism disease ($p<0.01$) (Table 1).

Fat mass per cent :

The fat mass per cent was found to be significantly higher in hypothyroid subjects than the normal subjects in both male and female groups. The mean values of fat per cent for normal and hypothyroid male subjects were 22.18 and 34.58 per cent, respectively for male subjects and 29.76 and 41.87 per cent, for normal and hypothyroid female subjects, respectively. Sanchez *et al.* (2004) reported that the mean fat percentage of hypothyroid patients was 45.2 ± 9.2 per cent which was more than the fat mass per cent among hypothyroid patients in the present study. Thyroid hormones stimulate fat mobilization, leading to increased concentration of fatty acids in plasma. In case of hypothyroidism lipid metabolism is impaired which might be the reason for the increased fat mass per cent in the body of hypothyroid patients.

BMI :

Among normal female subjects (n=105), 24.76 per cent subjects were underweight, 38.09 per cent were normal, 20 per cent subjects were overweight and 17.14 per cent were obese. While among hypothyroid female subjects (n=28), none was underweight, 9.37 per cent were normal, 17.85 per cent were overweight and 71.42 per cent were obese (Fig. 2). In case of normal male subjects (n=63), 3.17 per cent were underweight, 46.03 per cent were normal, 31.74 per cent were overweight and 19.04 per cent were obese while all the hypothyroid male subjects (n=4) were obese (100 %) on the basis of fat mass per cent (Fig. 3).

There was significant positive correlation between hypothyroidism and fat mass ($p<0.01$) *i.e.* with increase in fat mass the chances of occurrence of hypothyroidism also increased (Table 1). Therefore, increased fat mass per cent may be used as an indicator that the person might be suffering from hypothyroidism.

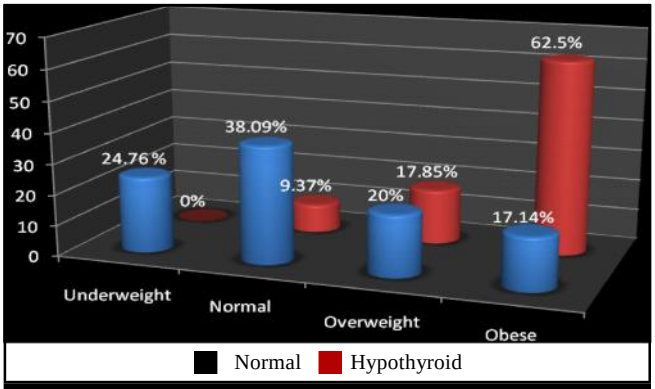

Fig. 2 : Percentage of overweight and obese among normal and hypothyroid female subjects based on body fat mass

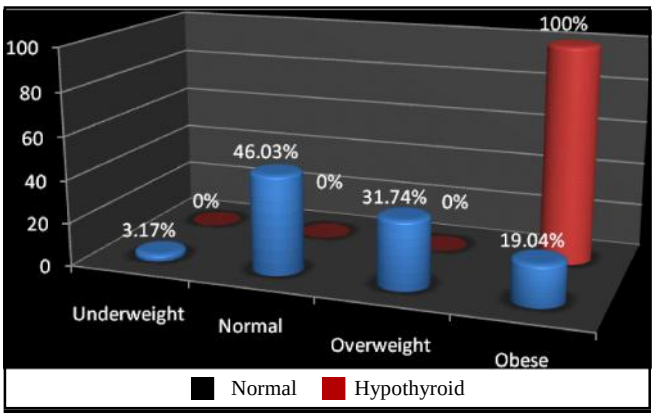

Fig. 3 : Percentage of overweight and obese among normal and hypothyroid male subjects based on body fat mass

BMI classification :

The BMI data showed that out of 133 female subjects nine (6.76 %) were underweight (BMI<18.50), fifty three (39.84 %) were having normal BMI between 18.50-24.99, forty two (31.5 %) were overweight having BMI between 25-29.99, twenty four (18.04 %) were obese grade 1 (BMI> 30-35), four (3 %) were obese grade-2 (BMI>35-40) and one (0.75 %) were obese grade-3

Table 1 : Correlation between hypothyroidism disease and various parameters of the population group (n= 200)

	Weight (kg) (r)	BMI (kg/m^2) (r)	Fat mass % (r)	Basal meta- bolic rate (r)	Correlation comparison (*p*)
Hypothyroidism	0.349**	0.496**	0.467**	-0.157*	**p<0.01 * p<0.05

* and ** indicate significance of values at P=0.05 and 0.01, respectively

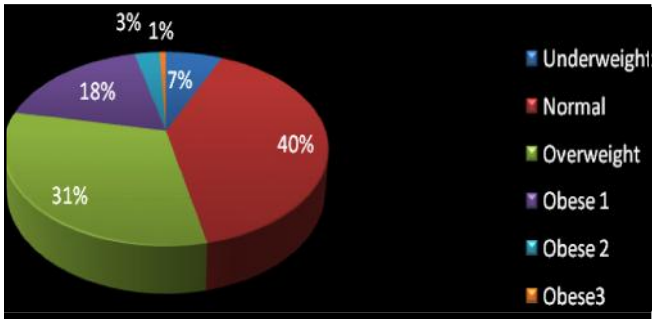

Fig. 4 : Nutritional status of the female subjects (n=133) on the basis of BMI

(BMI> 40) (Fig. 4).

Out of fifty three female subjects with normal BMI, three (5.66 %) were suffering from hypothyroidism. Similarly, out of forty two subjects who were overweight, six (14.28 %) and out of twenty four subjects who were obese grade 1, fifteen (62.5 %) were suffering from hypothyroidism. Similarly, out of four subjects who were obese grade 2, three (75 %) and out of one subject who were obese grade 3, one (100 %) were suffering from hypothyroidism. None of the underweight subjects were suffering from hypothyroidism. Results showed that the prevalence of hypothyroidism was more among obese and overweight female subjects (Fig. 5).

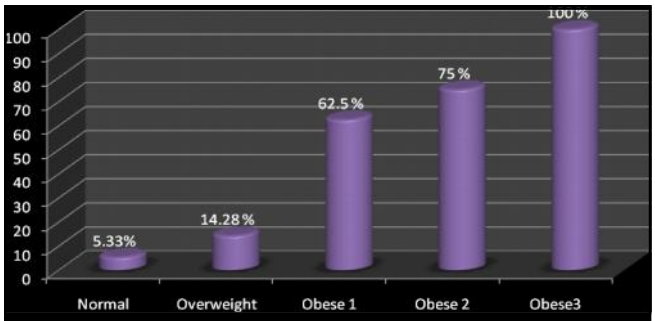

Fig. 5 : Prevalence of hypothyroidism among normal, overweight and obese female subjects

Among male subjects, out of total 67 male respondents, four (5.97 %) were underweight (BMI<18.50), thirty three (49.2 %) had BMI between 18.50-24.99, twenty four (35.82 %) were overweight having BMI between 25-29.99, four (5.97 %) were obese grade 1 (BMI> 30-35) and two (2.9 %) were obese grade 2 (BMI >35- 40) while none of the male subjects belonged to obese grade 3 (BMI> 40) (Fig. 6). Out of twenty four overweight male subjects, two (8.33 %) were suffering from hypothyroid. Similarly, one (75 %) was hypothyroid out of four subjects in obese grade 1 class and out of two male subjects in obese grade 2 class one (50 %) was suffering from hypothyroidism. Among male subjects none of the hypothyroid subjects were found in underweight and normal category while prevalence of hypothyroidism was more among overweight and obese male subjects (Fig. 7).

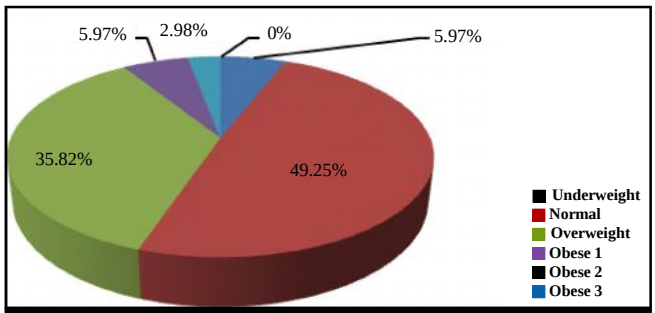

Fig. 6 : Nutritional status of the male subjects (n=67) on the basis of BMI

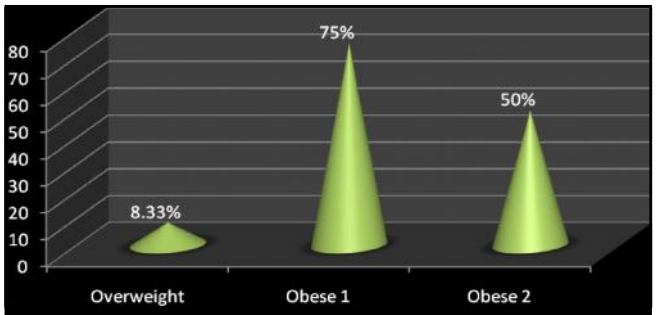

Fig. 7 : Prevalence of hypothyroidism among overweight and obese male subjects

There was a significant difference between the BMI of normal and hypothyroid female subjects with the mean values of 24.15 and 31.10 kg/m^2, respectively while among normal and hypothyroid male subjects mean values of BMI were 26.61 and 32.09 kg/m^2, respectively. (Dipankar *et al.*, 2012) reported significant ($p<0.05$) increase in the values of BMI (31.2 kg/m^2) in hypothyroid patients as compared with normal people (23 kg/m^2). There was a significant positive correlation between BMI and age *i.e.* BMI increased significantly ($p<0.05$, $p<0.01$) with advancing age in case of normal subjects (Table 1).

Kaur *et al*. (2012) also reported an increase in BMI with an advancement of age. There was a significant positive correlation ($p<0.01$) between BMI and hypothyroidism *i.e.* with increase in BMI the chances of occurrence of hypothyroidism also increased (Table 1). Therefore, increased BMI (obesity) may be used as an indicator that the person might be suffering from hypothyroidism. Morbid obesity (BMI > 40 kg/m^2) is

associated with thyroid function disturbances, with a high rate of hypothyroidism being the most consistently reported (Rotondi *et al.*, 2008). In a cross sectional, population based study of 27,097 individuals above 40 year of age with body mass index (BMI) of at least 30.0 kg/m^2, sub-clinical and overt hypothyroidism correlated with a higher BMI and a higher prevalence of obesity in both smokers and non-smokers (Asvold *et al.*, 2009).

Basal metabolic rate (BMR) :

Significant difference in mean values of basal metabolic rate in case of both male and female normal and hypothyroid groups was observed. The mean values of BMR of normal and hypothyroid male subjects were 1514 and 1262 kilocalorie/day, respectively and among normal and hypothyroid female respondents were 1260 and 1208 kilocalorie/day, respectively. Postive correlations of BMR with fat free mass, protein, mineral, muscle was observed while negative correlations of basal metabolic rate with fat per cent was observed ($p<0.01$) (Fig. 8). The significant positive correlation of basal metabolic rate with hypothyroid was found ($p<0.01$), thus, decrease in basal metabolic rate along with presence of other clinical signs can be used as marker for hypothyroidism (Table 1).

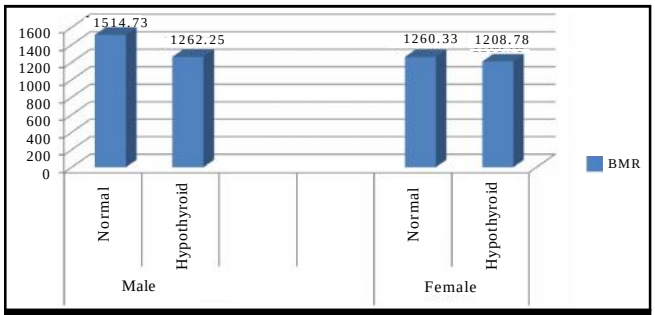

Fig. 8 : Mean values of basal metabolic rate (kilocalorie/day) of normal and hypothyroid male and female subjects

Conclusion :

It was concluded that hypothyroidism leads to alteration in the body fat by increasing the total body fat content and body weight. Basal metabolism also gets decreased in hypothyroidism which further aids in weight gain. Obesity is a growing problem that needs to be well understood in order to control it and stop the epidemic. It is important to have enough information and knowledge about all the aspects that affect weight. Hormones control bodily functions such as metabolism and cell growth and development, which directly affect how the body uses energy. Study on thyroid hormones a very important aspect of weight management.

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