Original research

Obesity prevalence in thyroid dysfunction: A cross sectional study

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Received date: 20June, 2023 Acceptance date: 24 July, 2023

Abstract
Background: The obesity epidemic is a major threat to health in most countries. The international focus on obesity has led to a steep increase in the number of studies dealing with possible interactions between obesity and other diseases as well as the relation betweenobesity and physiology and pathophysiology of the various organs and tissues of the body.The interaction between obesity and thyroid dysfunction has been the topic of clinical importance and hence many studies had tried to explore this potential link.
Aim & objective: The objective of this study was to investigate the prevalence of obesity in subjects with thyroid dysfunction.
Study design: Observational cross sectional study.
Methodology: In total 270subjects who were newly diagnosedwith thyroid dysfunctionin special investigation biochemistry laboratory of GMC Aurangabadwere duly informed about this study before enrollingthem in this research study. These study subjects were categorized on the basis of their values of thyroid hormones(FT3, FT4 &TSH) into four groups of overt hypothyroidism,subclinical hypothyroidism, overt hyperthyroidism and subclinical hyperthyroidism.Secondly these 270 study participants were again categorized on basis of theirrespective body mass indices(BMI) into three groups as normal weight, overweight and obese subjects. The BMIof the participants were compared with their respective thyroid dysfunction and the resulted data was subjected for statistical analysis.
Method of sample analysis: Serum free T3, free T4, TSH were estimated in the central clinical laboratory on cobas e411 biochemistry immunoassay analyser which used the principle of electrochemiluminiscence for estimating these hormones.
Method of statistical analysis: The statistical data was systematically analyzed by using chi square test to compare the statistical significance of prevalence rates between two study groups.
Result: The prevalence rates of obesity and overweight BMIin both the hypothyroid groups (overt & subclinical) was found to be significantly higher(p= 0.019) as compared to its prevalence in overt as well as subclinical hyperthyroidism**.** Secondlythe prevalence rates of obesity and overweight BMIwas significantly higher statistically(p= 0.024) in both the hypothyroid groups (overt & subclinical) as compared to the prevalence of normal weight BMI in subjects with overt as well as subclinical hypothyroidism.
Conclusion: This study conclude that as obesity is significantly prevalent in hypothyroidism, all individuals with obesity must be screened for thyroid dysfunctions.
Key words: thyroid dysfunction, prevalence, overweight & obese.

Introduction

The obesity epidemic is a major threat to health in most countries.[1]The global prevalence of obesity in adults was estimated to be 12%,with a higher prevalence rate in women than men.[2] in a recent ICMR-Indiastudy, conducted among adults aged 20 years and older, it was estimated that the overall weighted prevalence of generalized obesity (BMI of 25 kg/m^2) in Indian males and females was reported to be to be 28.6% and 39.5% respectively.[3]In a 2000 consensus, a who expert group proposed the BMIcriterion for overweight as 23–24.9 kg/m^2 and obesity as ≥25 kg/m^2 for individuals in the Asia-pacific region.[4]In 2009, more than 100 Indian medical experts brain-stormed and published consensus guidelines defining overweight as those with a BMI between 23.0 and 24.9 kg/m^2 and obesity as those having a BMI ≥25 kg/m^2. [5]Thyroid dysfunctions, after diabetes, are the second most prevalent metabolic disorders in the world.[6] The most burning scientific and practical clinical question in the thyroid and obesity field is the potential association between thyroid function and weight, and the same issue had been addressed in many studies.[7] In the same context a

research study was conducted by AbhyudayVerma etal which explored a very interesting cause or effect relationship between obesity andthyroid dysfunction.[8]Body mass index(BMI) is one of the most consistent measurable parameter of obesity and there had been several studies which had reported either positive,[9]negative[10] and even no correlation between Ft4 &BMI.[11] As previous research studies[6]have stated that both thyroid dysfunction and obesity can independently have deleterious effects on health so the coexistence of both these conditions will certainly be a complete health hazard. This makes it even more crucial to study the prevalence of obesity in thyroid dysfunction.

Aim & objective

The objective of this study was to investigate the prevalence of obesity in subjects with thyroid dysfunction.

Material & methods

Study design: This study was an observational cross sectional study conducted over a period of 6 months from May 2022 to October 2022.

Study subjects: In total 270 participants were enrolled in this study. Of these 108 were males and 162 were female subjects. These subjects were newly diagnosedwith thyroid dysfunctionin special investigation biochemistry laboratory of GMC Aurangabad. All these individuals were duly informed about this study before enrolling them as study subjects. These 270 subjects with thyroid dysfunction were categorized on the basis of their mean values of thyroid hormones(FT3, FT4 & TSH) into 4 groups those having overt or subclinical hypothyroidism and those having overt or subclinical hyperthyroidism.Secondly these 270 study participants were again categorized on basis of theirrespective body mass indices(BMI) into four groups as underweight,normal weight, overweight and obese subjects. The BMI of the participants with thyroid dysfunction was subjected for statistical analysis. The subjects that were excluded from this study were those having a history of thyroid cancer, a history of thyroid surgery,current pregnancy and corticosteroid usage. Written consent was taken of all the 270 study participants and then they were subjected to accurate anthropometric measurements of weight in kgs and height in cm. BMI was calculated by using the given formula:

$$\text{BMI}=\frac{WeightInKilograms\ (kg)}{HeightInMetersSquare}=\frac{Kg}{m^2}$$

In this study the obesity and overweight variables were defined on the basis of criteria published by the Indian consensus group in 2009. Accordingly Indian consensus group studied all available evidence and defined 23–24.9 kg/m^2 for overweight and ≥25 kg/m^2 for obesity.[5]

Table 1: Indian consensus group BMIcriterias 2009

Bmi in kg/m^2	Normal	Overweight	Obese
	< 23 kg/m^2	23–24.9 kg/m^2	≥25 kg/m^2

Laboratory assessment: After written consent of the study subjects fasting blood samples were taken and were analysed for serum free T3, free T4, and TSH. Serum free T3, free T4 & TSH were estimated in the central clinical laboratory of Biochemistry Department in GMC Aurangabad on Cobase411 biochemistry immunoassay analyser which used the principle of electro-chemiluminiscence for estimating these hormones.The following serum thyroid hormone values were considered as normal according to the thyroid hormone kit insert information sheet:the followingfreet3, freet4 & TSH cut off values as per Indian consensus study by Misraetal[5] thyroid dysfunction were used as basis to categorize thyroid dysfunction.

Table 2: Thyroid dysfunction

Thyroid hormones	Reference values.[10]	Overt hypothyroidism	Subclinical hypothyroidism	Overt hyperthyroidism	Subclinical hyperthyroidism
Free t3 (ft3)	1.4-4.2 pg/ml	<1.4 pg/ml	1.4–4.2 pg/ml	> 4.4 pg/ml	1.4–4.2 pg/ml
Free t4 (ft4)	0.7-1.4 ng/dl	<0.7 ng/dl	0.7–1.4 ng/dl	> 1.8 ng/dl	0.7–1.4 ng/dl
Tsh	0.34-4.25 μiu/ml	>4.50μiu/ml	> 4.50 Miu/ml	< 0.30 μiu/ml	< 0.30 μiu/ml

Method of statistical analysis:the statistical analysis was performed using SPSS software. The statistical data was systematically analysed by using chi square test to compare the statistical significance of prevalence rates of obesity and overweight BMI in subjects with thyroid dysfunction. The p-value was calculated and if it was less than 0.05 it was considered as statistically significant.

Results

270 participants were classified according to their respective BMI values as tabularised below

Table 3: Number of study subjects in 3 groups as per BMI

BMI≥25 kg/m^2 (obese group)	23–24.9 kg/m^2 (overweight group)	BMI<23 kg/m^2 (normal weight)	BMI≤18.5 kg/m^2 Under weight
83	130	46	11

The mean BMIof obese study subjects was found to be26±2.7 SD, mean BMIin overweight study subjects was reported as 24±1.9 SD while mean BMIin normal weight study subjects was found to be 22±0.4 sd.

Table 4: Mean BMI of study subjects in 3 groups

Obese	Overweight	Normal weight	Under weight
26±2.7 SD	24±1.9 SD	22±0.4 SD	17.9±0.6 SD

Out of 270 study participants with thyroid dysfunction 228 subjects were diagnosed with hypothyroidism whereas hyperthyroidism was reported only in 42 study subjects.

Table 5: Study subjects groups of thyroid dysfunction

270 subjectst hyroid dys-function	**Hypothyroidism**		**Hypothyroidism**		**Hyperthyroidism**		**Hyperthyroidism**	
	Overt	**Mean**	**Sub Clinical**	**Mean**	**Overt**	**Mean**	**Sub clinical**	**Mean**
	104	Ft3=1.2	124	Ft3=2.2	19	Ft3=5.1	23	Ft3=5.1
		Ft4=0.5		Ft4=1.3		Ft4=2.2		Ft4=2.2
		TSH=5.74		TSH=4.94		TSH=0.17		TSH=0.29

The number of hypothyroid study subjects and their bmi findings are tabularised below:

Table 6: Hypothyroidism groups &BMI group with prevalence rates

Hypothyroidism groups	BMIgroup with prevalence rates			
	Obese	**Overweight**	**Normal weight**	**Under wt**
Overt Hypothyroidism	26.7 %	41.7 %	1.3%	0
Subclinical hypothyroidism	9.0 %	10.6 %	10.7%	0

The number of hyperthyroid study subjects and their BMI findings are tabularised below:

Table 7: Hyperthyroidism groups &BMI group with prevalence rates

Hyperthyroidism groups	BMI group with prevalence rates			
	Obese	**Overweight**	**Normal weight**	**Under wt**
Overt Hyperthyroidism	1.5%	2.3 %	31.3%	19.6%
Subclinical hyperthyroidism	3.1%	25.2 %	17.4%	07.3%

The BMIvalues of study subjects with thyroid dysfunction were compared by chi square test and was found to be statistically significant.

Table 8:Comparison between the BMI values of subjects with thyroid dysfunction

BMI	Hypothyroidism	Hyperthyroidism
Underweight	00 (0%)	11 (26.91%)
Normal	29 (12.71)	17 (40.47)
Overweight	118 (51.75%)	12 (28.57)
Obese	81 (35.52%)	2 (4.76)
Total	228	42
Chi square value = 90.63 Degree of freedom = 3 P < 0.0001 (statistically significant)		

In table number 9 we compared the prevalence rates of obesity in both the hypothyroid groups (overt & subclinical) with its prevalence rates in overt as well as subclinical hyperthyroid subjects. We also compared prevalence rates of obesity with normal BMIin same hypothyroid groups. The study found that the obesity prevalence was significantly higher(p = 0.019) as compared to its prevalence of 5.1% in respectivehyperthyroid subjects**.** Secondlythe prevalence rates of obesity (34.64%) was significantly higher statistically(p = 0.024) in

both the hypothyroid groups as compared to the prevalence of normal weight bmi (12.7%) in the same group of hypothyroid subjects.

Table: 9

Statistical comparison					
Obesity prevalence in hypothyroid subjects with its prevalence in hyperthyroid subjects			**Obesity prevalence in hypothyroid subjects with prevalence of normal BMI in hypothyroid subjects**		
Obesity prevalence in hypothyroid	Obesity prevalence in hyperthyroid	*P* Value	Obesity prevalence in hypothyroid	Normal BMI prevalence in hypo thyroid	*P* Value
34.6%	5.1%	0.009*	34.6%	12.7%	0.024*

* p value < 0.05 was considered as statistically significant.

In table number 10 we also compared the prevalence rates of overweight BMIin overt as well as subclinical hypothyroid subjects with its prevalence in both the groups of hyperthyroid subjects and it was found that the prevalence of overweight BMI was significantly higher (p = 0.04) as compared to its prevalence of 12.3% in overt as well as subclinical hyperthyroidism**.** Similarlyprevalence rates of overweight BMIin overt as well as subclinical hypothyroid subjects (50.7%)was significantly higher statistically(p = 0.011) as compared to the prevalence of normal weight BMI (12.7%) in the same group of hypothyroid subjects.

Table: 10

Statistical comparison					
Overweight BMI prevalence in hypothyroid subjects with its prevalence in hyperthyroid subjects			**Overweight BMI in hypothyroid subjects with prevalence of normal BMI in hypothyroid subjects**		
Overweight BMI prevalence in hypothyroid	Overweight BMI prevalence in hyperthyroid	*P* Value	Overweight BMI prevalence in hypothyroid	Normal BMI prevalence in hypo thyroid	*P* Value
50.7%	5.1%	0.019*	50.7%	12.7%	0.011*

* p value < 0.05 was considered as statistically significant.

When the prevalence rates of obesity and overweight BMIin hyperthyroid subjects were compared statistically it was found to be non significant.(p>0.05).

Discussion

This study reported statistically higher prevalence of obesity and overweight BMIin both overt and subclinical groups of hypothyroidism. Our findings were consistent with the findings of other studies such as by Rahmani A et al[12] and Tabrizi JS et al.[13]A recentmeta-analysis performed by song et al. Using 22 studies found a positive association between obesity and risk of hypothyroidism (or: 1.86; 95% ci: 1.63–2.11, p < 0.001);moreover, an increased odds of overt (or: 3.21, 95% CI: 2.12–4.86, p < 0.001) and subclinical (or: 1.70, 95% CI: 1.42–2.03, p < 0.001) hypothyroidism was observed in obese individuals. However, no association was found between obesity and hyperthyroidism.[14]A cross-sectional studyconducted on 27,097 Norwegian individuals above 40 years found that obesity was positively associated with odds of subclinical and overt hypothyroidism. Furthermore, a positive correlation between BMI and TSH in both smoker &non smoker participants was observed.[15] "The blue mountains eye" cohort study conducted by Gopinath et al. On 1768 Australian individuals above 55 years old found a positive association between obesityand overt hypothyroidism; however, similar to our study, no significant association between obesity and prevalence of subclinical hypothyroidism was observed.[16]Other studies have justified their findings in the direction of frequent coexistence of obesity and hypothyroidism by reporting that overthypothyroidismleadstoincreasedbodyweightbyin creasingmucindepositsinskinandother organs and by salt and water retention.[17]In the same context Al Adsani H et al[18] and Nicolas P et al[19] have stated in their respective research studies that subtleelevation of thyroid stimulating hormone (TSH) is associated with decrease in resting energy expenditure and increase in body weight. They also mentioned that its the obesity gene tub which is regulated by thyroid hormone and thus any mutation in this gene tub leads to many adverse effects such as insulin resistance and obesity. Many mechanisms have been proposed to explain the observed association between obesity and thyroid

Dysfunction.several studies have found a positive correlation between increased serum leptin and TSH levels in obese individuals.[20]Leptin promotes trh expression and synthesis in the paraventricular hypothalamic and arcuate nucleus, which, in turn, can cause an increasein serum TSH levels.[21]Leptincould also increase the conversion of T4 to T3 in peripheral

tissues resulting in decreased levels of T4 that is observed in many studies. Moreover, this can lead to compensatory activation of the hypothalamus-pituitary-thyroid axis in an attempt to maintain serum thyroid hormone levels within the euthyroid range.[22,23] adipocytes of obese individuals generate a state of peripheral resistance to thyroid hormones due to their lower-than-normal expression of TSH receptors, leading to increased plasma TSH levels as a compensatory mechanism.[24]As the most common cause of thyroid dysfunction has been attributed to autoimmune etiologies several studies have tested the correlation between TPOAb(anti–thyroid peroxidase antibody) and obesity. Of these many studies have found a positive association between obesity and tpoab,[25,26]In the same context a study done byGarcía et al[27] have defended their finding by stating that adipokines& inflammatory cytokines released by the adipose tissue in obese individuals might play a rolein altering the thyroid function by inducing chronic lowgrade inflammation in the thyroid tissue of obese individuals. Moreover, several studies have shown that leptin can decrease the function of regulatory T (TREG) cells and increase the percentage of T helper 1 (Th1) cells; these events can, to some extent, explain the reported positive correlation between obesity and TPOAb positivity by stating that as a result of altered immune function, obese individuals are more prone to autoimmune and inflammatory processes in the thyroid gland.[28,29]Although some of these above mentioned research studies have found positive correlation between TPOAband obesity but there have been some studies who have reported otherwise with no association between these two variable of interest.[30,31]Hence, more studies are needed to illuminate the relationship between TPOAband obesity. This study also reported the significant association between overweight BMIand hypothyroidism which was consistent with the results of some other studies as done by Saltevo J[32]but in some studies it must be noted that in other studies after adjusting for confounding factors, such as sex andage this association was found to be no longer significant.[33]The findings of this study should be seen in the light of some limitations. While the cross-sectional study design is suitable for establishing prevalence, determination of the observed associations' causality and temporality were not possible and must be subjected to more appropriate study design such as randomized control trial for exploringthe cause and effect relationship.

Conclusion

This study conclude that as obesity is significantly prevalent in hypothyroidism, all individuals with obesity must be screened forthyroiddysfunctionsandoptimumcontrolofhypothyroidismshouldbeconsideredanintegralpartof obesity management.

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