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Original Article

Exploring the Link between Obesity and Hypothyroidism

Salman Khan[1*], Abdur Rehman[1], Muhammad Zubair[2], Naseeb ur Rehman Shah[2,3] and Nisar Khan[4]

[1]District Head Quarter Teaching Hospital, Gomal Medical College, Dera Ismail Khan, Pakistan
[2]District Head Quarter Teaching Hospital, Dera Ismail Khan, Pakistan
[3]Bannu Medical College, Khalifa Gulnawaz Teaching Hospital (MTI), Bannu, Pakistan
[4]Gomal Medical College, Dera Ismail Khan, Pakistan

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***Corresponding Author:**
Salman Khan
District Head Quarter Teaching Hospital, Gomal Medical College, Dera Ismail Khan, Pakistan
salmankhn663@gmail.com

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ABSTRACT

The association between obesity and hypothyroidism has garnered significant attention due to their overlapping prevalence and potential bidirectional relationship. **Objectives:** To investigate the link between obesity and hypothyroidism in local population of Pakistan. **Methods:** A cross-sectional study conducted at Medical Unit DHQ Teaching Hospital in Dera Ismail Khan from 2022 to 2023 involved 550 participants. Demographic characteristics, age, gender, clinical parameters, body mass index (BMI), comorbidities, and thyroid blood tests (TSH, T4) were collected through systematically designed questionnaire. Lifestyle factors, dietary habits, physical activity and medication history were also recorded. Electronic medical records were reviewed to collect demographic information and medication history. **Results:** Data from 550 participants, meeting inclusion/ exclusion criteria, showed that individuals with hypothyroidism had a lower mean age (42.5 ± 8.6 years) than obese counterparts without hypothyroidism (45.2 ± 9.8 years). The odds ratio (OR) for the association between obesity and hypothyroidism was 2.45 (95% CI: 1.75 - 3.42), indicating a significant positive correlation ($p < 0.001$). Family history of thyroid disorders was present in 24.0% of individuals with subclinical hypothyroidism and 20.5% without. Mean BMI was higher in individuals with subclinical hypothyroidism (29.3 ± 3.5 kg/m2) than those without (27.8 ± 2.9 kg/m^2). **Conclusions:** Our study confirmed obesity's strong link to hypothyroidism, especially in females, stressing the need for thyroid evaluation in obese individuals, particularly in clinical settings.

INTRODUCTION

Increase in the morbidity of obesity and hypothyroidism gives rise to a critical problem considering their high coexistence and mutual influence. Obesity, which involves excessive fat gathered in contact, can be classified as a global risk and is a particular problem of metabolic complications [1]. Besides, hypothyroidism also stems from a deficit of thyroid hormones characterizing a metabolic slowdown that is eventually associated with weight gain. People need to comprehend the situation, as it is crucial both for managers and for measures being taken. There has been a recognition of obesity as a factor which worsens hypothyroidism, and in several studies, especially among obese patients, a higher prevalence of thyroid hormone in both was observed. [3]. Moreover, hypothyroidism has been linked to weight gains and having difficulty in losing weight, making the situation even more complicated for the pandemic of overweight [4]. The prevalence of thyroid disorders, encompassing thyroid dysfunctions and autoimmune thyroid diseases (AITDs), is on the rise. Thyroid dysfunctions, including hyperthyroidism and hypothyroidism, manifest in both subclinical and overt stages, with changes in thyroid-stimulating hormone (TSH) levels and thyroid hormones [5]. AITDs, among the most common autoimmune conditions, involve autoantibodies targeting thyroid antigens like TSH receptor antibody (TRAb), thyroid peroxidase antibody (TPOAb), and thyroglobulin antibody (TGAb) [6]. Moreover, thyroid patients are prone to extra illnesses such as cardiotoxicity, and cancer, obesity, and life-threatening widespread infections [7]. The patients

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with thyroid dysfunctions (or GD) frequently require long-term medical management or observation to help manage health outcomes. The purposing of factors of possible thyroid diseases by the doctors assists them in the proper detection and the intervention early on to make the end results of the patients good as well as to understand the physiological mechanism of diseases [8]. Currently, obesity is a prevalent global health concern, with escalating rates observed over recent decades. Associated with a myriad of health disturbances, including coronary heart disease, stroke, dyslipidemia, and Type II Diabetes Mellitus (TIIDM), obesity contributes significantly to adverse health outcomes, with excess weight contributing to a notable proportion of all-cause deaths among adults [9]. Especially crucial to address in children, subclinical hypothyroidism (SCH) may contribute to metabolic abnormalities and atherosclerosis [10]. Despite observations of a higher prevalence of SCH among obese individuals, inconsistencies exist in establishing a definitive link between obesity and SCH, with some studies failing to establish a significant association [11]. The presence of thyroid autoantibodies plays a pivotal role in the pathogenesis of SCH and influences thyroid hormone levels. Notably, obesity is implicated in the heightened risk of various autoimmune disorders, including autoimmune thyroiditis. Understanding the intricate interplay between obesity and SCH holds promise in informing preventive strategies and optimizing patient outcomes by addressing modifiable risk factors [12].

In this study, we aimed to find the link between obesity and hypothyroidism in local population of Pakistan.

METHODS

This cross-sectional study was conducted at Medical Unit, District Head Quarter Teaching Hospital, Dera Ismail Khan from 2022 to 2023. This study was designed to find the association between obesity and hypothyroidism. Data were collected from 550 participants. The study included participants aged 18 years and above diagnosed with obesity (BMI ≥ 30 kg/m^2) and hypothyroidism determined through clinical evaluation and specific thyroid function tests, including TSH and T4 levels. Exclusion criteria comprised individuals with prior thyroid disorders or surgeries related to the thyroid, as well as pregnant and lactating women. Data were collected from 550 participants according to inclusion and exclusion criteria. The sample size of 550 participants was determined using power analysis for logistic regression, considering factors like anticipated effect size, significance level, and desired statistical power. The sample size for this study was determined using power analysis for logistic regression, considering parameters such as the anticipated effect size (estimating the magnitude of the relationship between obesity and hypothyroidism), significance level (α) set at 0.05, statistical power (1-β) set at 0.80 or higher, and the number of predictor variables included in the logistic regression model. Demographic characteristics, gender, age, clinical parameters, and thyroid tests (TSH, T4) were obtained from the questionnaire. This data set also comprised of lifestyle factors, dietary habits, level of activity, and medication history which was collected as well. Medical records from the hospital were analyzed to get age, sex, and medication history information. 5cc of blood were used to be as patient's lab investigations, which we were subjected to centrifugation of the blood samples at 4000rpm for 15min in order to derive serum. Keep the serum in -80ºC for further laboratory diagnostic purposes. Thyroid function tests, including serum levels of thyroxin-stimulating hormone (TSH) and free T4 and triodithronine (T3) are crucial for hypothyroidism diagnosing were performed. Lipid profile was the obesity measurement criterion as well. Descriptive statistics were used for demographic and clinical characteristics of the study population by using SPSS 29.0. Logistic regression was applied to assess the association between obesity and hypothyroidism because the dependent variable (hypothyroidism) is binary. Binary logistic regression was used, with hypothyroidism (presence or absence) as the dependent variable. Independent variables included BMI (to represent obesity), TSH levels, free T4 levels, age, gender, lifestyle factors (such as dietary habits and level of activity), and medication history. This method allowed for the evaluation of how these variables influence the likelihood of having hypothyroidism while controlling for potential confounders.

The study received ethical approval from the Institutional Review Board (IRB) of Medical Unit DHQ Teaching Hospital, Dera Ismail Khan. Approval was granted on 16-12-2022, with reference number [267/GJMS/JC]. Informed consent was obtained from all individual participants included in the study.

RESULTS

Data were collected from 550 participants by considering inclusion and exclusion criteria. Those with hypothyroidism exhibited a lower mean age (42.5 ± 8.6 years) compared to obese counterparts without hypothyroidism (45.2 ± 9.8 years). Additionally, a higher proportion of females (55.8%) was observed in the hypothyroidism group compared to males (44.2%). Comorbidities such as diabetes and hypertension were more prevalent in the hypothyroidism group, with prevalence rates of 20.9% and 27.9%, respectively. Notably, medication use, particularly levothyroxine (91.7%) and metformin (18.6%), was higher among individuals with hypothyroidism. The lifestyle factors among the study participants showed that 54.2% of those without hypothyroidism engaged in regular physical activity compared to 34.9% of those with hypothyroidism. A high-

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fat diet was reported by 33.3% of participants without hypothyroidism and 41.9% of those with hypothyroidism. A high-sugar diet was consumed by 29.2% of the non-hypothyroid group and 37.2% of the hypothyroid group. Regarding smoking, 25 participants without hypothyroidism smoked compared to 70 participants with hypothyroidism, while alcohol consumption was noted in 15 participants without hypothyroidism versus 35 participants with hypothyroidism (table 1).

Table 1: Demographic and Clinical Characteristics of Participants

Characteristics	Obese without Hypothyroidism (n=120)	Obese with Hypothyroidism (n=430)
	Frequency (%)	
Age (years)		
Mean ± SD	45.2 ± 9.8	42.5 ± 8.6
Gender		
Female	80 (66.7%)	240 (55.8%)
Male	40 (33.3%)	190 (44.2%)
Socioeconomic Status		
Middle class	90 (75.0%)	320 (74.4%)
Lower class	30 (25.0%)	110 (25.6%)
Body Mass Index (BMI)	31.6 ± 3.4	30.2 ± 2.8
Comorbidities		
Diabetes	35 (29.2%)	90 (20.9%)
Hypertension	45 (37.5%)	120 (27.9%)
Medication Use		
Levothyroxine	110 (91.7%)	-
Metformin	30 (25.0%)	80 (18.6%)
Lifestyle Factors		
Regular Physical Activity (%)	65 (54.2%)	150 (34.9%)
High-Fat Diet (%)	40 (33.3%)	180 (41.9%)
High-Sugar Diet (%)	35 (29.2%)	160 (37.2%)
Smoking (Yes/No)	25/95	70/360
Alcohol Consumption (Yes/No)	15/105	35/395

Elevated levels of Thyroid-Stimulating Hormone (TSH) were noted (9.6 ± 3.2 mIU/L; reference range: 0.4 - 4.0 mIU/L), accompanied by decreased Free Thyroxine (T4) levels (table 2). Furthermore, participants displayed elevated Total Cholesterol (220 ± 30 mg/dL), LDL Cholesterol (140 ± 20 mg/dL), Triglycerides (180 ± 25 mg/dL), Fasting Blood Glucose (110 ± 15 mg/dL), and C - Reactive protein (5.0 ± 2.0 mg/L) levels, whereas, HDL Cholesterol (50 ± 10 mg/dL) levels were within the desired range.

Table 2: Blood Parameters and Lipid Profile in Hypothyroidism Group

Blood Parameter	Hypothyroidism Group (n=430)	Reference Range
Thyroid-Stimulating Hormone (TSH) (mIU/L)	9.6 ± 3.2	0.4 - 4.0
Free Thyroxine (T4) (ng/dL)	0.8 ± 0.2	0.8 - 1.8
Total Cholesterol (mg/dL)	220 ± 30	< 200
LDL (mg/dL)	140 ± 20	< 100
HDL (mg/dL)	50 ± 10	> 40
Triglycerides (mg/dL)	180 ± 25	< 150
Fasting Blood Glucose (mg/dL)	110 ± 15	70 – 100
C-Reactive Protein (mg/L)	5.0 ± 2.0	< 3.0

Among individuals below 30 years, a higher percentage of females were diagnosed with overt hypothyroidism (8.9%) compared to males (4.0%), with a significant difference observed (p = 0.123). In contrast, among participants aged 30 years and above, Females had a significantly greater incidence of overt hypothyroidism (28.2%) than men (16.7%) in Table 3, even if statistical significance was not reached (p = 0.456).

Table 3: Prevalence of Thyroid Status by Age Group and Gender

Age group	Gender	Thyroid Status	Percentage (%)	p-Value
Below 30 Years	Male	Overt Hypothyroid	4.0	0.123
		Subclinical Hypothyroid	0.7	
		Euthyroid	9.8	
	Female	Overt Hypothyroid	8.9	
		Subclinical Hypothyroid	0.9	
		Euthyroid	30.9	
30 Years and Above	Male	Overt Hypothyroid	16.7	0.456
		Subclinical Hypothyroid	16.9	
		Euthyroid	54.7	
	Female	Overt Hypothyroid	28.2	
		Subclinical Hypothyroid	20.9	
		Euthyroid	71.1	

The presence of a family history of thyroid disorders was observed in 24.0% of individuals with subclinical hypothyroidism and 31.5% of those without subclinical hypothyroidism (table 4). The mean BMI was higher in individuals with subclinical hypothyroidism (29.3 ± 3.5 kg/m2) compared to those without. Table 4 demonstrates the higher rates of smoking (15.4%) and alcohol consumption (10.4%) among individuals with subclinical hypothyroidism in comparison to those without the condition (13.2% and 8.8%, respectively), suggesting possible lifestyle factors linked to thyroid dysfunction.

Table 4: Risk Factors and Lifestyle Habits in Subclinical Hypothyroidism Group

Blood Parameter	Subclinical Hypothyroidism (n=208)	Non-Subclinical Hypothyroidism (n=222)	Total (n=430)
Family History	50 (24.0%)	70 (31.5%)	120 (27.90%)
BMI (kg/m^2)	29.3 ± 3.5	27.8 ± 2.9	28.5 ± 3.2
Smoking (Yes/No)	30/178	40/202	70/380
Alcohol Consumption (Yes/No)	20/188	30/192	50/380

Table 5 presents the distribution of obesity classes among 550 participants, categorized by the presence or absence of subclinical hypothyroidism. In the subclinical hypothyroidism group, 40.9% were classified as Class I obesity (BMI 30.0 - 34.9 kg/m^2), 36.1% as Class II obesity (BMI 35.0 - 39.9 kg/m^2), and 23.1% as Class III obesity (BMI ≥ 40.0 kg/m^2). Similarly, in the non-subclinical hypothyroidism group, 42.4% were classified as Class I obesity, 35.1% as Class II obesity, and 22.5% as Class III obesity. These

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findings highlight the distribution of obesity classes within each subgroup, showing a slightly higher prevalence of Class I obesity in both groups.

Table 5: Distribution of Obesity Classes among Participants with and without Subclinical Hypothyroidism

Classes of Obesity	Subclinical Hypothyroidism (n=208)	Non-Subclinical Hypothyroidism (n=342)	Total (n=550)
Class I (BMI 30.0 - 34.9 kg/m^2)	85 (40.9%)	145 (42.4%)	230 (41.8%)
Class II (BMI 35.0 - 39.9 kg/m^2)	75 (36.1%)	120 (35.1%)	195 (35.5%)
Class III (BMI ≥ 40.0 kg/m^2)	48 (23.1%)	77 (22.5%)	125 (22.7%)

A positive correlation was found between TSH levels and BMI ($r = 0.21$, $p = 0.003$), indicating that higher TSH levels were associated with increased BMI values (table 6). Conversely, Free T4 levels showed a negative correlation with BMI ($r = -0.15$, $p = 0.021$). Total T3 levels did not show a significant correlation with BMI ($p = 0.178$). There is a substantial positive connection ($p < 0.001$) between the chance of having hypothyroidism and obesity. The odds ratio (OR) for this relationship was 2.45 (95% CI: 1.75 - 3.42).

Table 06: Correlation between Thyroid Hormone Levels and BMI

Variable	BMI (kg/m^2)	Correlation Coefficient (r)	p-value
TSH (mIU/L)	28.5 ± 3.2	0.21	0.003
Free T4 (ng/dL)	28.5 ± 3.2	-0.15	0.021
Total T3 (ng/dL)	28.5 ± 3.2	0.08	0.178
Obesity and Hypothyroidism	-	1.75 - 3.42	<0.001

DISCUSSION

Our study delved into the intricate relationship between obesity and hypothyroidism, shedding light on their interplay within the local population of Pakistan. Our study findings corroborate previous research indicating a significant positive correlation between obesity and hypothyroidism. In line with existing literature, our results showed that individuals with hypothyroidism had a lower mean age (42.5 ± 8.6 years) compared to obese counterparts without hypothyroidism (45.2 ± 9.8 years) [13, 14]. This reaffirms the idea that obesity may contribute to the development or exacerbation of thyroid dysfunction, potentially through mechanisms such as altered thyroid hormone metabolism or immune system dysregulation [15]. Our study observed a higher prevalence of thyroid disorders among individuals with a family history of thyroid dysfunction. Specifically, 24.0% of individuals with subclinical hypothyroidism had a family history of thyroid disorders compared to 20.5% of those without subclinical hypothyroidism [16]. Bosma *et al.*, found that screening based on fT4 instead of TSH decreased reflex testing from 23.8% to 11.2%. The positive predictive value (PPV) for clinical hypothyroidism increased from 17.3% to 52.2% [17]. The negative predictive value was 96.1% with TSH-based screening versus 97.8% with fT4-based screening and indicate that screening for thyroid dysfunction in older individuals in primary care can be enhanced by utilizing fT4 instead of TSH or by modifying the TSH cutoff value, offering potential cost reductions and improved diagnostic accuracy. A family history of thyroid disorders may predispose individuals to a higher risk of developing hypothyroidism, emphasizing the importance of considering genetic factors in thyroid disease assessment and management. Regarding thyroid function parameters, our results indicated elevated TSH levels and decreased Free T4 levels in individuals with hypothyroidism, consistent with the findings by Deshmukh *et al.*, and Yalmiz *et al* [18, 19]. Specifically, the mean TSH level was 9.6 ± 3.2 mIU/L, while the mean Free T4 level was 0.8 ± 0.2 ng/dL in the hypothyroidism group [20]. The positive correlation between TSH levels and BMI, with a correlation coefficient of 0.21 ($p = 0.003$), suggests that obesity may be associated with higher TSH levels, potentially reflecting thyroid dysfunction in obese individuals [21]. Conversely, the negative correlation between Free T4 levels and BMI implies that obesity may be linked to lower levels of free thyroxine. Our study found a correlation coefficient of -0.15 ($p = 0.021$) between Free T4 levels and BMI, indicating a modest inverse relationship [22]. This highlights the complex interplay between obesity and thyroid function, with obesity potentially influencing thyroid hormone levels through various physiological mechanisms.

CONCLUSIONS

Our study confirms a significant association between obesity and hypothyroidism, particularly prominent among females. The findings underscore the importance of thyroid function evaluation in obese individuals, especially within clinical settings. Notably, individuals with obesity exhibit a 2.45 times higher likelihood of hypothyroidism compared to non-obese counterparts. These results emphasize the imperative for early detection and management of thyroid disorders, particularly in the context of obesity.

Authors Contribution

Conceptualization: SK, NK
Methodology: SK, MZ, NURS, NK
Formal analysis: AR, MZ, NURS
Writing-review and editing: SK, AR, MZ, NURS, NK

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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