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The Relationship between Body Mass Index and Thyroid Cancer Pathology Characteristics and Outcomes

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Abstract: Differentiated thyroid cancer (DTC), especially of the papillary carcinoma (PTC) type accounts for the most common endocrine cancer worldwide with an escalating trend for several decades. This might be partially due to improvement in modern diagnostic imaging and biopsies along with the shift in genetic and environmental factors like ionizing radiation, iodine consumption, and lifestyle modifications. Obesity prevails as one such crucial factor that is long known to be controversially involved in the emergence of thyroid cancer with no clear understanding of the precise mechanism. Our study wanted to determine the relationship between body mass index (BMI) and clinicopathological characteristics of differentiated thyroid cancer (DTC). **Methods:** Data were retrospectively traced from the medical records of 124 patients in total, (19.4% male and 80.6% female) DTC patients who were operated on for the last 16 years in this study. Their TSH levels, weights and heights were recorded before operation. The BMI was calculated and correlated with the histopathological findings. One year postoperatively the DTC outcome was determined based on 2015 ATA DTC guidelines. **Result:** The results thereby demonstrated no positive associations between BMI and diagnostic stage of the tumour (T, N, or M stage), vascular invasion, capsule invasion and Extra thyroid extension (ETE) concerning BMI quartiles. Upon univariate and multivariate analyses, an unexpected inverse association was identified between BMI and nodal metastasis and tumour invasion. This is suggestive of the statement that less aggressive tumour features may be associated with obesity. **Conclusion:** The results lay out the relationship that aggressive features of thyroid cancer may not be indicated by obesity. However further analysis is required to critically estimate the underlying mechanism between the risk of thyroid cancer and obesity.

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Introduction

Differentiated thyroid cancer (DTC) serves as the most prevalent type of endocrine cancer globally. For several decades, the trend of DTC, especially the papillary carcinoma (PTC) type has been escalating. This rise in cancer cases might be partially due to advancements in modern diagnostic imaging and biopsies. However, the amplified incidence of DTC cannot be justified simply by the improvements in the quality of imaging studies. Other components like increased exposure to ionizing radiation, iodine consumption, and lifestyle modifications that occur due to the shift in genetic and environmental factors may increase the incidence of cancer (Matrone et al., 2020a). Moreover, a shorter glimpse of this increasing thyroid cancer incidence was evident even before the adoption of diagnostic imaging tools like ultrasound in general practice. Accretion in the incidence of large papillary thyroid cancers (>5 cm) has also been described in the Surveillance, Epidemiology, and End Results data from 1980 to 2005. These data raise the likelihood that there might be also other contributing factors to the increasing trend of differentiated thyroid cancer (Enewold et al., 2009). Although this drastic shift towards improved diagnostic techniques intends to overcome the risk of disease recurrence or disease-specific mortality, some studies propose an accelerating proportion of patients being treated aggressively with thyroidectomy along with radioactive iodine (RAI) ablation or RAI therapy that further impacts their clinical outcome (Kitahara & Sosa, 2020).

With the exponential trend of thyroid cancer and its modalities, one of the potential factors in cancer development has been stated as obesity. The increasing rate of obesity has been witnessed in both developed and developing countries for the last 20 years. It not only contributes to cardiovascular diseases but also has strong implications in the risk

for cancer. There are also several studies to establish this relationship. For instance, a meta-analysis study had very well explored this strong relationship between body mass index (BMI) and cancer (Renehan et al., 2008). Obesity or a higher BMI not only raises the risk of cancer but is also associated with aggressive pathological features of PTC along with an increased risk of progression and poor outcomes (Li et al., 2020). Other factors like age, sex, and pathological features like tumour size, nodal metastasis, extrathyroidal extension, and distant metastasis also influence the risk of cancer recurrence and mortality (Wu et al., 2020). Gender-specific accretion in the risk for thyroid cancer has also been documented in several epidemiological studies. Higher body mass index was most potentially associated with a moderately increased risk of thyroid cancer in females whereas contrary studies also reveal a similar relationship in men. Epidemiological data report that an increase of 5 kg/m2 in weight raises the risk of thyroid cancer in both men and women (Almotawa et al., 2021). The characteristics of thyroid tumours such as their aggressiveness are also worsened among populations with higher BMI (Tresallet et al., 2014). Supporting studies also demonstrated that a higher frequency of PTC nodules of ≥1 cm, extrathyroid invasion, and a more advanced tumour stage was associated with increased BMI. But no differences in recurrence rates were found concerning BMI range after a mean follow-up of 84 months (Kim et al., 2013). With these emerging pieces of evidence, it is thereby shown that obesity prevails as one of the crucial factors that are long known to be controversially involved in the emergence of thyroid cancer. Studies report that interactions between adipokines and cancer cells remain as one of the reasons that drive this risk factor (Vona-Davis & Rose, 2007).

The tumour genesis is also influenced by the excess body weight, which is known to be mediated through the different hormones, insulin, and inflammatory factors like cytokines, interleukins, and tumour necrosis factor-alpha. These factors can also contribute to the increased aggressiveness/malignancy of the tumours (Matrone et al., 2020b). Thus the progression of thyroid tumours and cancer-related mortality depends upon the higher body mass index (Calle et al., 2003). Although various mechanisms have been speculated, the clear understanding of the precise pathway behind the relationship of higher BMI and risk & clinical outcome of differentiated thyroid cancer remains unclear (Matrone et al., 2020b). Various studies reflect obesity to be affiliated with a worse prognosis in malignant thyroid tumours. The studies also confirm the high incidence of various solid tumours, like DTC with obesity (Ma et al., 2015; Almotawa et al., 2021). But, a study on Caucasian subjects, demonstrated no association between BMI and aggressiveness of DTC even during post-surgical follow up, thereby suggesting that the incidence of progressed aggressiveness of DTC is not based on the body mass index of an individual (Matrone et al., 2020a). However, to our knowledge, there is no solid evidence on whether the severity of thyroid cancer pathology is associated with BMI or not. Therefore, the present study was conducted to explore the link between higher BMI and characteristics of thyroid cancer i.e., type of pathology, stage of cancer, size of the tumour, vascular invasion, multifocality, extrathyroidal extension, LN metastasis, and its clinical outcomes.

Patients and Methods

Design and data sources

After obtaining ethical approval from the biomedical ethics research committee, King Abdulaziz University, this retrospective review study obtained its data from the medical records of all the Differentiated thyroid cancer (DTC) patients (n = 124) whose weight and height were measured before surgery i.e., at the time of admission for surgery. Patients who did not have their body measurements documented before the surgery were excluded from the study. Hence a total of 124 patients (19.4% male (n = 24) and 80.6 % female (n = 100)) operated on for the last 16 years at King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia were included. The mean age was 55 years, among which, 60% were below the age of 55 years and 40% were above the age of 55 years.

BMI calculations

Their TSH levels along with their weights and heights were recorded before operation. The body mass index (BMI) was later calculated based on the World Health Organization standardization that includes underweight, normal, and overweight (25–29.99 kg/m2) for further correlation. The obesity group was divided into three BMI grades: Grade 1 (30-34.9 kg/m2), Grade 2 (35-39.9 kg/m2), and Grade 3 (>=40 kg/m2). The mean Pre-OP TSH range was also calculated. The TSH values of patients were not suppressed or elevated but by treatment became euthyroid.

Primary end points

Histopathological analysis was performed to assess the tumour stage, size, and type of DTC using the T-N-M 8th American Joint Committee on Cancer (AJCC) tumor node metastasis staging system. The pathological traits incorporated were papillary,

follicular, poorly differentiated, Hurthle cell cancer, and NIFTP. Additional parameters like Vascular invasion (VI), Extrathyroid extension (ETE – none, minimal, and extensive), Capsule invasion, Margin involvement, Multifocality, extranodal extension (ENE) and Variant were considered for the aggressiveness of thyroid carcinoma at initial diagnosis. In the case of cancer pathology having multiple characteristics, the dominant or more aggressive one was counted. The types of surgeries patients underwent were lobectomy/hemithyroidectomy and total thyroidectomy/ subtotal thyroidectomy of LN dissection (central LN dissection or lateral LN dissection). One year postoperatively the DTC outcome was determined based on 2015 ATA DTC guidelines.

Statistical analysis

The study was statistically verified by multiple logistic regression analysis (univariate and multivariate) to explore the relationships between obesity and thyroid cancer stage & behaviour along with obesity and Post-Op / RAI DTC outcome. The four categories (quartiles) of BMI analysis was also performed as per the World Health Organization (WHO) guidelines.

Results

Of the total 124 patients, 24 (19.4%) were male and 100 (80.6%) female was enrolled in the study. 109 (87.9%) patients were below 55 years and 15 (12.1%) above 55 years. Only 2 (2.3%) patients were under weight and 40 (46.5%) had normal BMI and 44 patients (51.2%) who were overweight as per their BMI, 29 (76.3%) had grade 1 BMI obesity, 4 (10.5%) had grade 2 and 5 (13.2%) belonged to grade 3 BMI obesity. The mean Pre-OP-TSH was 1.91 (8.07-0.00). The TNM Staging of the cancer diagnosis revealed Carcinoma in Situ in 2 (1.6%) patients. Stage 1 (Localized cancer. T1-T4, N0, M0) was seen in 116 (93.5%) and stage 2 (Localized advanced cancer, early stages, T2-T4, N0, M0) in 6 (4.8%) patients. Vascular invasion was seen only among 5 (12.5%) normal BMI group patients, 7 (15.9%) overweight patients and 3 (10.3%) grade 1 obesity patients. None in the grade 2 & 3 obesity group had a vascular invasion. Capsule invasion was seen in 20 (16.3%) patients – 7 (16.3%) overweight group and among patients with obesity, 3 (10.3%) in group 1, 1 (25.0%) in group 2 and 2 (40.0%) in group 3 had capsular invasion when compared to 7 (17.5%) in normal group patients. Among the obese patients, 5 (17.2%) had margin involvement with 3 (10.3%) having minimal invasive ETE (extra thyroid extension) documented histologically but not grossly, and 1 (3.4%) having extensive invasion in group 1. Margin involvement was not seen in group 2 patients but 1 among them (25.0%) had minimal invasive ETE (extra thyroid extension). Group 3 had only 1 (20.0%) patient with margin involvement and 1 (20.0%) with minimal invasive ETE. The pathological variants observed were Classical in 40 (32.3%) patients – 11 (25.0%) overweight, 15 (51.7 %) in obese group 1, 1 (25.0%) in obese group 2 and 1 (20.0%) in obese group 3; Follicular variant in 25 (20.2%) patients – 9 (20.5%) overweight, 5 (17.2%) in obese group 1, 1 (25.0%) in obese group 2 and none in obese group 3; Papillary microcarcinoma in 39 (31.5%) patients – 17 (38.6%) overweight, 6 (20.7%) in obese group 1, 1 (25.0%) in obese group 2 and 3 (60.0%) in obese group 3. Oncocytic was seen in only 1 (2.5%) normal BMI patient. Multifocality was present in 58 (46.8%) patients. The extra nodal extension (ENE) was seen in only 10 (8.1%) patients – 5 (11.4%) overweight individuals and 3 (10.3%) in obese group 1 patient. None in group 2 & 3 obesity had an extra nodal extension. ENE was not assessed in 79 (63.7%) patients among 86 (69.4%) patients who had no LN resected. Central LN dissection was done in 21 (16.9%) patients and both central and lateral LN dissection regardless of the site or being uni- or bilateral was performed in 17 (13.7%) patients. TGAb was positive in 29 (23.4%) and negative in 95 (76.6%) patients. RAI at least one dose, 30 mCi or more was given in 75 (60.5%) patients. The outcome was assessed among all the groups that revealed excellent response in 66 (53.2%) followed by indetermined response in 24 (19.4%), 11 (8.9%) having biochemically incomplete and 5 (4.0%) having structurally incomplete response (Table 1).

The association between margin involvement and BMI groups – majority 4 (80.0%) with Grade 3 are with no marginal involvement, 31 (77.5%) with normal BMI with no marginal involvement are found to be significant p=0.048<0.05. (Table 2).

The results demonstrated no positive associations between BMI and diagnostic stage of tumour (T, N, or M stage), vascular invasion, capsule invasion and Extra thyroid extension (ETE) concerning BMI quartiles. Upon univariate and multivariate analyses, an unexpected inverse association was identified between BMI and nodal metastasis and tumour invasion. This is suggestive of the statement that less aggressive tumour features may be associated with obesity. However, these findings require further confirmatory studies to verify the results (Table 3).

Table 1: Characteristic of DTC patients

	N (%)
Gender	
Male	24 (19.4)
Female	100 (80.6)
Age at Diagnosis, mean±sd, range (max-min)	41.1±11.8, (75-15)
Age group	
< 55 years	109 (87.9)
>= 55 years	15 (12.1)
Mean BMI (Range)	
BMI group	27.5±5.4 (42.3-16.2)
Underweight	2 (2.3)
Normal	40 (46.5)
Overweight	44 (51.2)
BMI Obesity group	
Grade 1 (30-34.9)	29 (76.3)
Grade 2 (35-39.9)	4 (10.5)
Grade 3 (>=40)	5 (13.2)
Mean Pre-OP-TSH (Range)	1.91 (8.07-0.00)
TNM Staging	
0 (Carcinoma in Situ)	2 (1.6)
1 (Localized cancer. T1-T4, N0, M0)	116 (93.5)
2 (Localized advanced cancer, early stages. T2-T4, N0, M0)	6 (4.8)
Multifocal Tumour	
TX	2 (1.6)
T1a	45 (36.3)
T1b	29 (23.4)
T2	32 (25.8)
T3a	14 (11.3)
T3b	1 (0.8)
T4a	1 (0.8)
Both Central and Lateral LN	
NX	19 (15.3)
N0a	33 (26.6)
N0b	39 (31.5)
N1a	16 (12.9)
N1b	17 (13.7)
Vascular invasion	
None	105 (84.7)
Present	15 (12.1)
encapsulated angioinvasive FTCs, (i.e≤4 VI foci)	2 (1.6)
Widely invasive FTCs	2 (1.6)
Capsule invasion	
No	68 (55.3)
Yes	20 (16.3)
Unknown	35 (28.5)
Margin involvement	
No	96 (77.4)
Yes	21 (16.9)
Unknown	7 (5.6)
ETE (extra thyroid extension)	
None	106 (85.5)
Minimal invasive documented histologically but not grossly	16 (12.9)

Extensive invasion	2 (1.6)
Variant	
None	19 (15.3)
Classical	40 (32.3)
Follicular	25 (20.2)
papillary microcarcinoma	39 (31.5)
oncolytic	1 (0.8)
Multifocality	
Absent/Unifocal	65 (52.4)
Present	58 (46.8)
Unknown	1 (0.8)
ENE (extra nodal extension)	
None or all LN are negative	35 (28.2)
Present	10 (8.1)
Can't be assessed as no LN resected	79 (63.7)
LN dissection	
None	86 (69.4)
central LN dissection	21 (16.9)
central and lateral LN dissection regardless of the site or being uni- or bilateral	17 (13.7)
TGAb	
No	95 (76.6)
Yes	29 (23.4)
RAI	
None	49 (39.5)
Given at least one dose ,30 mCi or more	75 (60.5)
Outcome	
None	18 (14.5)
Excellent response	66 (53.2)
In determined response	24 (19.4)
Biochemically incomplete	11 (8.9)
Structurally incomplete	5 (4.0)

Table 2: Clinicopathologic characteristics according to the six BMI groups

	Under weight	Normal	Over weight	Grade 1	Grade 2	Grade 3	P value
Gender							
Male	0 (0.0)	7 (17.5)	10 (22.7)	7 (24.1)	0 (0.0)	0 (0.0)	0.657
Female	2 (100.0)	33 (82.5)	34 (77.3)	22 (75.9)	4 (100.0)	5 (100.0)	
Age group							
< 55 years	2 (100.0)	39 (97.5)	35 (79.5)	24 (82.8)	4 (100.0)	5 (100.0)	0.127
>= 55 years	0 (0.0)	1 (2.5)	9 (20.5)	5 (17.2)	0 (0.0)	0 (0.0)	
Stage at diagnosis							
0	0 (0.0)	1 (2.5)	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	0.781
1	2 (100.0)	39 (97.5)	40 (90.9)	27 (93.1)	4 (100.0)	4 (80.0)	
2	0 (0.0)	0 (0.0)	3 (6.8)	2 (6.9)	0 (0.0)	1 (20.0)	
Vascular invasion							
None	2 (100.0)	33 (82.5)	36 (81.8)	26 (89.7)	4 (100.0)	4 (80.0)	0.439
Present	0 (0.0)	5 (12.5)	7 (15.9)	3 (10.3)	0 (0.0)	0 (0.0)	
encapsulated angioinvasive FTCs,	0 (0.0)	1 (2.5)	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	
Widely invasive FTCs	0 (0.0)	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.0)	
Capsule invasion							

No	1 (50.0)	24 (60.0)	23 (53.5)	17 (58.6)	1 (25.0)	2 (40.0)	0.835
Yes	0 (0.0)	7 (17.5)	7 (16.3)	3 (10.3)	1 (25.0)	2 (40.0)	
Unknown	1 (50.0)	9 (22.5)	13 (30.2)	9 (31.0)	2 (50.0)	1 (20.0)	
Margin involvement							
No	2 (100.0)	31 (77.5)	33 (75.0)	24 (82.8)	2 (50.0)	4 (80.0)	0.048*
Yes	0 (0.0)	6 (15.0)	9 (20.5)	5 (17.2)	0 (0.0)	1 (20.0)	
Unknown	0 (0.0)	3 (7.5)	2 (4.5)	0 (0.0)	2 (50.0)	0 (0.0)	
ETE (extra thyroid extension)							
None	2 (100.0)	35 (87.5)	37 (84.1)	25 (86.2)	3 (75.0)	4 (80.0)	0.968
Minimal invasive documented histologically but not grossly	0 (0.0)	4 (10.0)	7 (15.9)	3 (10.3)	1 (25.0)	1 (20.0)	
Extensive invasion	0 (0.0)	1 (2.5)	0 (0.0)	1 (3.4)	0 (0.0)	0 (0.0)	
Variant							
None	0 (0.0)	7 (17.5)	7 (15.9)	3 (10.3)	1 (25.0)	1 (20.0)	0.647
Classical	2 (100.0)	10 (25.0)	11 (25.0)	15 (51.7)	1 (25.0)	1 (20.0)	
Follicular	0 (0.0)	10 (25.0)	9 (20.5)	5 (17.2)	1 (25.0)	0 (0.0)	
papillary microcarcinoma	0 (0.0)	12 (30.0)	17 (38.6)	6 (20.7)	1 (25.0)	3 (60.0)	
oncocytic	0 (0.0)	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
ENE (extra nodal extension)							
None or all LN are negative	1 (50.0)	9 (22.5)	13 (29.5)	10 (34.5)	2 (50.0)	0 (0.0)	0.100
Present	0 (0.0)	0 (0.0)	5 (11.4)	3 (10.3)	0 (0.0)	2 (40.0)	
Can't be assessed as no LN resected	1 (50.0)	31 (77.5)	26 (59.1)	16 (55.2)	2 (50.0)	3 (60.0)	
Outcome							
None	0 (0.0)	5 (12.5)	7 (15.9)	6 (20.7)	0 (0.0)	0 (0.0)	0.644
Excellent response	1 (50.0)	20 (50.0)	26 (59.1)	14 (48.3)	4 (100.0)	1 (20.0)	
In determined response	1 (50.0)	11 (27.5)	6 (13.6)	4 (13.8)	0 (0.0)	2 (40.0)	
Biochemically incomplete	0 (0.0)	3 (7.5)	3 (6.8)	4 (13.8)	0 (0.0)	1 (20.0)	
Structurally incomplete	0 (0.0)	1 (2.5)	2 (4.5)	1 (3.4)	0 (0.0)	1 (20.0)	

*p<0.05

Table 3: Predictive factors for vascular invasion, extra nodal extension, LN dissection and outcome on BMI as defined by univariate logistic regression analysis
Dependent variable: BMI

	Beta	**S.E**	**OR 95% C.I (U.L-L.L)**	**P value**
Vascular invasion (Yes)	0.585	0.600	1.796 (0.554-5.822)	0.329
Capsule invasion				0.876
Capsule invasion (Yes)	-0.225	0.445	0.799 (0.334-1.909)	0.613
Capsule invasion (Unknown)	-0.197	0.604	0.821 (0.251-2.684)	0.745
ENE (extra nodal extension)				
ENE (extra nodal extension) (Present)	0.365	0.438	1.441 (0.611-3.399)	0.404
ENE (extra nodal extension (can't be assessed as no LN resected)	1.016	0.682	2.762 (0.726-10.509)	0.136
LN dissection				
LN dissection (Central LN dissection)	-0.950	0.545	0.387 (0.133-1.126)	0.081
LN dissection (Lateral Ln dissection)	-0.368	0.662	0.692 (0.189-2.533)	0.578
Outcome				
Outcome (excellent response)	-0.288	1.041	0.750 (0.098-5.768)	0.782
Outcome (in determined response)	-0.500	0.952	0.606 (0.094-3.922)	0.599
Outcome (biochemically incomplete)	-0.693	1.027	0.500 (0.067-3.745)	0.500
Outcome (structurally incomplete)	0.223	1.095	1.250 (0.146-10.699)	0.839

Discussion

The growing body of evidence suggests that increased BMI and obesity stand as a cause and poor pathological prognostic factor of several malignancies including thyroid cancer (Kitahara et al., 2016). Investigative techniques like fine-needle aspiration biopsies and preventive screening for cancer displayed no link between obesity, that is, increased BMI groups (Grade 1-3 obesity) and cancer risk (Rotondi et al., 2016; Farfel et al., 2014). The discrepancies in clinicopathological features are established to be prognostic factors for DTC. Since various studies correlate the aggressiveness of thyroid cancer with obesity (Kim et al., 2013, 2015; Wu et al., 2017), our study traverses the relationships between body mass index and histopathological features of the different stages of thyroid cancer to further verify the postoperative outcome of DTC.

Interestingly, the relationship between obesity and histological features of cancer was detected to be inversely associated via the statistical analysis. It is reported that increased expression of locally produced adipokines such as leptin (an important autocrine or paracrine factor) and/or its receptor is found to influence thyroid cancer (Cheng et al., 2010). However, the exact mechanism behind this association remains uncertain. Hence the increased BMI of the patients (obesity) did not associate with the T, N, M staging of cancer diagnosis and the aggressiveness of histological features of the tumor. The results are comparable to other studies where median BMI was 27.5±5.4 (42.3-16.2) and the clinicopathological features of thyroid cancer did not positively correlate with the increasing BMI (Paes et al., 2010; Kim et al., 2011; Grani et al., 2019). The post-op outcome assessment showed statistical significance for indetermined and biochemically incomplete responses among the patients. This might be explained by the impact of cancer-adipocyte interactions on tumour behaviour in a different way.

Certain limitations of our study include the non-availability of other prognostic factors of tumour-like comorbidities such as diabetes, hypercholesterolemia, lifestyle factors like nutrition, smoking, alcohol consumption, & physical activity, duration of obesity and thyroid cancer. Second, although several studies have cited BMI determinations to establish the cancer aggressiveness, factors like waist-to-hip ratio, body fat percentage, skinfold thickness, and abdominal fat evaluation may provide better measures of obesity. As this was a retrospective study, data were not available on were for the described analysis. However, the wide exploration of the BMIs stages in the study may contribute to only slight chances of inaccuracies in results. BMI was utilized as the only tool to define obesity in various similar studies (Kim et al., 2013, 2015; Paes et al., 2010; Grani et al., 2019; G sior-Perczak et al., 2018).

Since the neck examinations of obese patients may increase the difficulties in identifying thyroid nodules, the chance for delayed diagnosis of the DTC might be present. The other limitation to be considered is the inability to assess the impact of the initial diagnostic method on the thyroid nodule or cancer in this retrospective analysis. The differences contributed by the different modes of physical examination utilized for diagnosis and the incidental finding on the radiographic test may take place among patients with varying levels of BMI. However, as the higher tumour frequency is absent in obese patients, the result is less likely to be impacted by the initial diagnosis.

Also the shorter follow-up duration of only one year post-op in the present study contributes to another limitation. Hence the recurrence or persistence of the tumour was focussed as the outcome measure rather than tumour-specific survival rate. The pre-op TSH levels did not reveal any significant correlation with the tumour aggressiveness. As this was a single-centre based study, other impacting factors like race, ethnicity and socioeconomic status may add to mild differences in the result. Thus larger multicenter studies may address these differences to establish a relationship between the tumour and race ethnicity or socioeconomic status of patients.

Conclusion

In conclusion, our initial hypothesis of the study that aggressive pathological features of the tumour are associated with obesity was not valid. The report rather speculates that less aggressive tumour features correlate positively with obesity. Hence obesity was neither a risk factor nor a prognostic factor for aggressive clinicopathological features of thyroid cancer and worse clinical outcome in DTC patients respectively. This data thereby seeks further research to establish the exact mechanism behind the incidence of obesity and thyroid cancer.

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