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A contemporary analysis of goiters undergoing surgery in the United States☆

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ABSTRACT

Introduction: We identified disparities and at-risk populations among patients with goiters undergoing thyroidectomy.

Materials and methods: The National Inpatient Sample (NIS) database was queried for patients with goiter who underwent thyroidectomy between 2009 and 2013. Multivariable logistic regression was used to determine factors associated with goiters undergoing thyroidectomy.

Results: The study consisted of 103,678 patients with thyroidectomy and a goiter diagnosis, which included: simple goiter (n = 7,692, 7.42%), nodular goiter (n = 73,524, 70.92%), thyrotoxicosis (n = 14,043, 13.54%), thyroiditis (n = 1,248, 1.20%), and thyroid cancer (n = 7,169, 6.92%). Factors associated with operation for simple goiter included age >65 years (AOR 1.43 [1.15–1.79]), black race (AOR 1.35 [1.14–1.58]), and being uninsured (AOR 2.13 [1.52–2.98]). Patients with cancerous goiters undergoing thyroidectomy were less likely to be Black (AOR 0.38 [0.31–0.48]) or uninsured (AOR 0.25 [0.07–0.89]).

Discussion: Understanding disparities within populations undergoing thyroidectomy for goiter may allow for targeted efforts to more effectively treat goiters nationwide.

Introduction

A goiter is an abnormal enlargement of the thyroid gland that can develop from a variety of etiologies. Many goiters require thyroidectomy operations due to size, symptoms, or malignancy.[1] Goiters continue to be a significant issue worldwide. Contemporary studies from several countries have identified disparities in goiter prevalence that vary by socioeconomic and geographical factors, with iodine deficiency continuing to be the most common cause of goiter worldwide.[2–5] In the United States, public health measures to address iodine deficiency nearly a century ago served to effectively eliminate geographic disparities in iodine deficiency-associated goiter and made this cause relatively uncommon. However, these measures were not federally mandated. A review of the contemporary literature demonstrates that while much is published on the current status of goiters internationally, relatively little is known regarding the current status of patients with goiters undergoing thyroidectomy in the U.S.

We hypothesized that distinct factors can be identified for patients with each of the goiter diagnoses undergoing thyroidectomy in the U.S. The aim of this study is to describe demographics, disparities, and associated factors among patients in the U.S. undergoing thyroidectomy with a diagnosis of goiter. We used a national dataset to determine the current distribution of etiologies of patients with goiters undergoing thyroidectomy operations in the U.S. and to identify the populations with goiters most likely to undergo thyroidectomy.

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Materials and Methods

This study was approved by the institutional review boards at Thomas Jefferson University and University of Pennsylvania.

Study dataset

This study utilized the National Inpatient Sample (NIS) datasets of years 2009–2013. The NIS is the largest all-payer inpatient care health care utilization database, and is a part of the family of databases made available by the Health Care and Utilization Project (HCUP).[6] The NIS draws data from around 20% of inpatient hospitalizations in the United States and provides population weights that allow to generate national estimates. It contains patient-level data such as age, sex, race/ethnicity median zip code income, insurance status, discharge disposition, and comorbidities based on diagnosis codes; as well as hospital-level data that include census region (Northeast, Midwest, West, South), location (rural, urban), academic teaching status (teaching, non-teaching), and ownership (public, private not-for-profit, proprietary).

It should be noted that the NIS underwent changes in 2012. In prior years, the NIS was generated from a sample of discharges from approximately 20% of U.S. community hospitals. However, starting with 2012 data, the NIS samples discharges from all community hospitals participating in HCUP, which yields roughly a 20% sample of all discharges from U.S. community hospitals, rather than a sample of hospitals from which all discharges were retained.[8] For years prior to 2012, HCUP provides researchers with revised sample weights and statistical programs that were used in this analysis. These weights account for this change and make estimates comparable to data after 2012, allowing researchers to calculate national estimates of disease, procedures, and outcomes across the entire dataset.

Patient population and data source

The NIS was queried to select patients with a diagnosis code of goiter who underwent complete or partial thyroidectomy from years 2009–2013. Patients were identified using ICD-9 procedure and diagnosis codes. Patients were included who underwent partial or complete thyroidectomy (primary procedure codes 06.2 - unilateral thyroid lobectomy; 06.3 - other partial thyroidectomy; 06.4 - complete thyroidectomy; 06.5 - substernal thyroidectomy) and carried a diagnosis of goiter (diagnosis codes 193 - malignant neoplasm of thyroid gland; 240 - simple and unspecified goiter; 241 - nontoxic nodular goiter; 242 - thyrotoxicosis with or without goiter; and 245 - thyroiditis; Fig. 1).

Outcomes

The primary outcomes of this study were to describe the prevalence of and characteristics associated with goiters treated with thyroidectomy in the U.S. Thyroidectomies with a goiter diagnosis were stratified according to the etiology of the goiter.

Variables

We assessed demographic and facility-related variables including age (categories <45, 45–65, >65 years), sex, race/ethnicity (White, Black, Hispanic, Asian or Pacific Islander, Native American and Other), payer (Medicare, Medicaid, private insurance, self-pay, no charge, other), zip code income quartile (as provided by the NIS), U.S. region (Northeast, Midwest, South and West), hospital size (small, medium and large), hospital urbanicity/teaching status (rural, urban nonteaching, urban teaching), and Elixhauser Comorbidity Index, which was calculated based on ICD-9 diagnosis codes[7] and used as a measure of comorbidities and severity of illness.

Statistical analysis

Reported statistics in this study are adjusted estimates of national rates. Descriptive statistics focused on counts and proportions were used to analyze patient- and facility-level characteristics. Chi-square analysis was used compare categorical variables. Multivariable logistic regression models controlling for potential confounders were used to determine specific patient- and facility-related characteristics associated with patients with goiters requiring thyroidectomy.

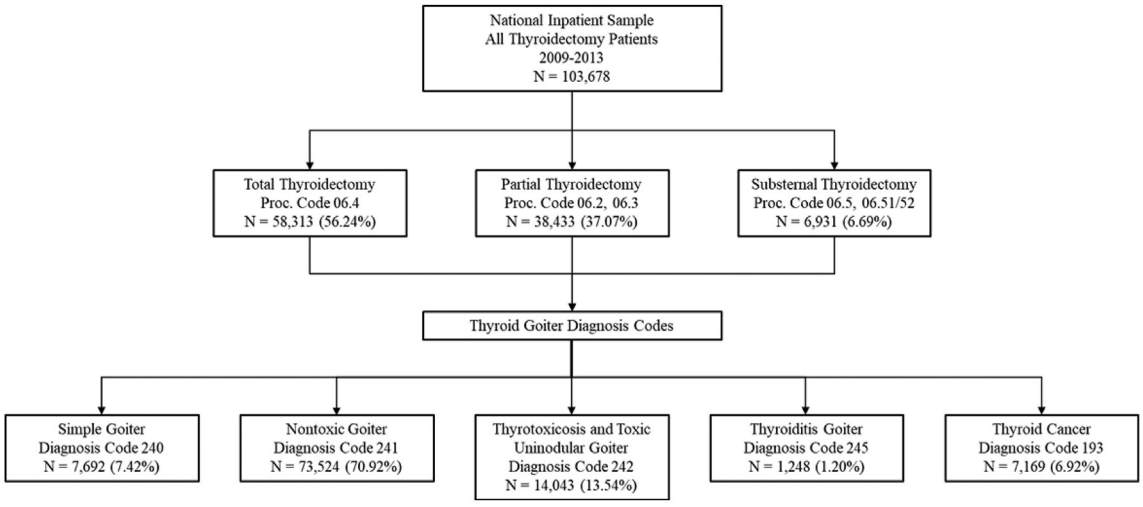

Fig. 1. Flow Diagram of Patient Stratification
Caption: All patients in the NIS that underwent thyroidectomy between 2009 and 13 are identified and stratified based upon ICD-9 diagnosis codes for various types of goiter.

Results

Patient-level demographics

The study group consisted of 103,678 patients who underwent thyroidectomy with a diagnosis of goiter during the study period. Within this group, 58,313 (56.2%) underwent total thyroidectomy, 38,433 (37.1%) partial thyroidectomy, and 6391 (6.7%) substernal thyroidectomy. A diagnosis of simple goiter was established in 7692 patients (7.4%), nodular goiter in 73,524 (70.9%), thyrotoxicosis goiter in 14,043 (13.5%), thyroiditis goiter in 1248 (1.2%), and thyroid cancer goiter in 7169 (6.9%). Overall, most patients with thyroid goiters undergoing thyroidectomy were white (63.4%), female (83.5%), between ages 45–65 (49.3%), and privately insured (64.2%).

Compared to other etiologies of goiter, patients with simple goiters undergoing thyroidectomy were made up of significantly greater frequencies of those who were over 65 years of age (31%), Black (27.3%), male (21.6%), insured by Medicare (35.5%) self-paid (4.3%), and in the lowest income quartile by zip code (32.6%). Patients with simple goiter also made up the lowest proportion of those with private insurance (45.8%). Nontoxic nodular goiter was the most common etiology of goiter undergoing thyroidectomy overall (70.9%). Patients with nontoxic nodular goiter comprised the highest proportion of patients between ages 45 and 65 years (51.2%). Patients with thyrotoxicosis-related goiters undergoing thyroidectomy made up the highest proportion of those younger than 45 years of age (44%). Thyroiditis-related goiters (i.e. Hashimoto's) undergoing thyroidectomy made up the highest proportion of white (81.7%) and female (92.9%) patients. Finally, patients with thyroid cancer undergoing thyroidectomy made up the highest proportion of those in the highest income quartile (35.7%) across all types of goiter. The lowest proportion of people who were in the bottom income quartile (18.1%) or that were self-paid/uninsured (1.9%) were also seen in thyroid cancer goiters undergoing thyroidectomy. The highest proportion of patients with an ECI score of 0–1 was found among patients with thyrotoxicosis-related goiters (65.2%), while the highest proportion of patients with a score of four or greater was found among those with thyroid cancer goiters (20.7%). These results are summarized in Table 1.

Hospital-level and regional characteristics

Overall, patients with goiters undergoing thyroidectomy were most often treated in the South (31.1%) and at large (67.9%) or urban teaching hospitals (61.2%). Rates of thyroidectomy among patients with simple goiter varied significantly across regions between the South (38.7%), West (21.7%), Midwest (20.7%), and Northeast (19%; $p = 0.0002$). Regarding other hospital-based factors, simple goiter thyroidectomy patients were most often treated at large hospitals classified by number of beds (66.6%), and at urban teaching hospitals (57.6%). Patients with simple goiters undergoing thyroidectomy had the highest proportion of patients treated in the South across all goiters (38.7%), whereas the percentage of patients with thyrotoxicosis related goiter who underwent thyroidectomy in the West (24.4%) was greater than the percentage of patients undergoing thyroidectomy for any other type of goiter in the West. Thyroid cancer-related goiters were the only group to be treated most often in the Northeast (47.3%) compared to all other regions. They were also disproportionately treated more often in urban teaching hospitals (74.6%, $p < 0.01$). Patients with thyroiditis-related goiters underwent thyroidectomy at urban nonteaching hospitals more often than any other type of goiter (39.9%, $p = 0.03$). These results are summarized in Table 2.

Table 1
Patient level demographics by type of goiter.

	All Goiters (%)	Simple Goiter (%)	Nontoxic Goiter (%)	Thyrotoxicosis-Related Goiter (%)	Thyroiditis Goiter (%)	Thyroid Cancer Goiter (%)	P
Total	103678 (100)	7692 (7.42)	73524 (70.92)	14043 (13.54)	1248 (1.20)	7169 (6.92)	
Age							**<0.0001**
<45	27390 (26.4)	1522 (19.8)	17375 (23.6)	6173 (44)	478 (38.3)	1842 (25.7)	
45–65	51192 (49.3)	3782 (49.2)	37657 (51.2)	5703 (40.6)	580 (46.5)	3470 (48.4)	
>65	25094 (24.2)	2387 (31)	18493 (25.2)	2167 (15.4)	190 (15.2)	1857 (25.9)	
Race							**<0.0001**
White	58563 (63.4)	3843 (57.1)	41488 (63.4)	7537 (61.8)	945 (81.7)	4750 (71)	
Black	18325 (19.9)	1838 (27.3)	13267 (20.3)	2464 (20.2)	70 (6.1)	686 (10.3)	
Hispanic	8026 (8.7)	568 (8.4)	5618 (8.6)	1146 (9.4)	76 (6.6)	618 (9.2)	
Asian/Pacific Islander	3613 (3.9)	206 (3.1)	2529 (3.9)	486 (4)	30 (2.6)	362 (5.4)	
Native American	370 (0.4)	39 (0.6)	251 (0.4)	59 (0.5)	[a]	21 (0.3)	
Other	3339 (3.6)	233 (3.5)	2316 (3.5)	503 (4.1)	30 (2.6)	257 (3.8)	
Gender							**<0.0001**
Male	16970 (16.5)	1645 (21.6)	11713 (16.1)	2078 (14.9)	89 (7.1)	1445 (20.2)	
Female	85958 (83.5)	5956 (78.4)	61262 (83.9)	11864 (85.1)	1160 (92.9)	5716 (79.8)	
Primary Payer							**<0.0001**
Medicare	30014 (29.0)	2724 (35.5)	22202 (30.2)	2849 (20.3)	269 (21.5)	1970 (27.5)	
Medicaid	10154 (13.8)	752 (9.8)	6537 (8.9)	2137 (15.3)	140 (11.2)	588 (8.2)	
Private Insurance	56380 (64.2)	3516 (45.8)	40055 (54.5)	7723 (55.1)	779 (62.4)	4307 (60.1)	
Self-pay	2821 (5.1)	334 (4.3)	1761 (2.4)	563 (4)	24 (1.9)	139 (1.9)	
No charge	602 (0.7)	51 (0.7)	441 (0.6)	110 (0.8)	0 (0)	[a]	
Other	3580 (3.4)	301 (3.9)	2462 (3.4)	631 (4.5)	36 (2.9)	150 (2.1)	
Zip Income Quartile							**<0.0001**
0–25th	24354 (24)	2440 (32.6)	17007 (23.6)	3360 (24.5)	280 (22.9)	1267 (18.1)	
26th-50th	24472 (24.2)	1901 (25.4)	17140 (23.8)	3635 (26.5)	301 (24.6)	1495 (21.4)	
51st-75th	25635 (25.3)	1671 (22.3)	18448 (25.7)	3444 (25.1)	344 (28.1)	1728 (24.7)	
76th-100th	26873 (26.3)	1478 (19.7)	19325 (26.9)	3272 (23.9)	300 (24.5)	2498 (35.7)	
Elixhauser Comorbidities							**<0.0001**
0–1	59,206 (57.1)	2561 (33.3)	44,994 (61.2)	9149 (65.2)	758 (60.7)	1744 (24.3)	
2	22,885 (22.1)	2259 (29.4)	15,343 (20.9)	2723 (19.4)	284 (22.7)	2277 (31.8)	
3	12,382 (11.9)	1489 (19.4)	7823 (10.6)	1287 (9.2)	119 (9.5)	1665 (23.2)	
4+	9204 (8.9)	1383 (18.0)	5365 (7.3)	883 (6.3)	88 (7.1)	1484 (20.7)	

[a] HCUP Data Use Agreement prevents showing numbers <10.

Table 2
Hospital level demographics by type of goiter.

	All Goiter (%)	Simple Goiter (%)	Nontoxic Goiter (%)	Thyrotoxicosis & Toxic Uninodular Goiter (%)	Thyroiditis Goiter (%)	Thyroid Cancer Goiter (%)	P
Hospital Region							**0.0002**
Northeast	28465 (27.5)	1460 (19)	19633 (26.7)	3599 (25.6)	385 (30.8)	3388 (47.3)	
Midwest	19248 (18.6)	1589 (20.7)	13704 (18.6)	2915 (20.8)	182 (14.6)	858 (12)	
South	32280 (31.1)	2975 (38.7)	23134 (31.5)	4097 (29.2)	419 (33.6)	1655 (23.1)	
West	23685 (22.8)	1668 (21.7)	17053 (23.2)	3432 (24.4)	263 (21)	1269 (17.7)	
Hospital bedsize							**0.0303**
Small	11285 (11)	818 (10.7)	8300 (11.4)	1239 (8.9)	140 (11.3)	788 (11)	
Medium	21760 (21.1)	1731 (22.7)	15638 (21.4)	2852 (20.4)	284 (22.9)	1255 (17.6)	
Large	69876 (67.9)	5085 (66.6)	49017 (67.2)	9866 (70.7)	816 (65.8)	5092 (71.4)	
Hospital Location							**0.0003**
Rural	6675 (6.5)	558 (7.3)	4771 (6.5)	899 (6.4)	99 (8)	348 (4.9)	
Urban nonteaching	33264 (32.3)	2680 (35.1)	24272 (33.3)	4353 (31.2)	494 (39.9)	1465 (20.5)	
Urban teaching	62982 (61.2)	4396 (57.6)	43913 (60.2)	8706 (62.4)	646 (52.1)	5321 (74.6)	

Factors associated with goiters requiring thyroidectomy

Simple goiter

Multivariable analysis showed the strongest odds ratios for thyroidectomy for simple goiter were seen in elderly patients (>65 years old), who were 43% more likely to undergo thyroidectomy compared to patients under 45 years (AOR 1.43 [1.15–1.79]); and patients who were uninsured, who were more than twice as likely compared to patients with private insurance (AOR 2.13 [1.52–2.98]) (see Table 3). Other factors independently associated with simple goiter undergoing thyroidectomy included being Black relative to White (AOR 1.35 [1.14–1.58]), and being treated in the Midwest (AOR 1.59 [1.19–2.12]), South (AOR 1.53 [1.18–2.00]), or West (AOR 1.39 [1.05–1.84]) relative to being treated in the Northeast. Women were 27% less likely than men to undergo a thyroidectomy for simple goiter (AOR 0.73 [0.63–0.84]). Those in the highest zip code-based income quartile were 35% less likely to have surgery for simple goiter compared to those in the lowest income quartile (AOR 0.65 [0.51–0.83]). The odds of undergoing thyroidectomy for simple goiter increased sequentially with higher ECI scores; a score of four or greater was associated with a greater than three-fold increase in the odds of undergoing thyroidectomy for simple goiter (AOR 3.51 [2.93–4.22]).

Nontoxic nodular goiter

The strongest odds ratios for undergoing thyroidectomy for nontoxic nodular goiter were seen in patients ages 45–65 (AOR 1.89 [1.74–2.05]), ages > 65 (AOR 1.8 [1.57–2.05]), black race (AOR 1.3 [1.17–1.45]), and women (AOR 1.13 [1.03–1.23]). Patients with nontoxic nodular goiter were more likely to undergo treatment in a private hospital than in an urban teaching hospital (AOR 1.14 [1.02–1.27]). Those with Medicaid and self-payment plans had 12% and 46% decreased odds of having surgery for nontoxic nodular goiter compared to those with private insurance (AOR 0.88 [0.78–1.00]; AOR 0.54 [0.43–0.68]). Patients with ECI scores of four or greater were three times less likely to undergo surgery for nontoxic nodular goiter compared to those with ECI scores of 0–1 (AOR 0.33 [0.29–0.38]).

Thyrotoxicosis and toxic uninodular/multinodular goiter

In our multivariable analysis, elderly (>65 years of age) and middle-aged (45–65 years of age) patients were significantly less likely to undergo thyroidectomy for thyrotoxicosis-related goiters compared to those under 45 years of age (AOR 0.36 [0.30–0.44]; AOR 0.46 [0.42–0.51]). Those with Medicaid and self-payment plans had 53% and 84% increased odds of having surgery compared to those with private insurance (AOR 1.53 [1.30–1.81]; AOR 1.84 [1.46–2.32]). Patients with toxic uninodular goiter were most likely to be treated in large hospitals (AOR 1.35 [1.09–1.67]). A higher ECI score of four or greater correlated with a 26% decreased odds of undergoing thyroidectomy for thyrotoxicosis-related goiter compared to an ECI score of 0–1 (AOR 0.74 [0.61–0.90]).

Thyroiditis

Elderly (>65 years old) and middle-aged (45–65 years old) patients were significantly less likely to undergo thyroidectomy for thyroiditis-related goiter compared to those under 45 years of age (AOR 0.68 [0.51–0.90]; AOR 0.40 [0.24–0.67]). Blacks and Hispanics were significantly less likely to undergo thyroidectomy for thyroiditis compared to Whites (AOR 0.20 [0.11–0.37]; AOR 0.50 [0.28–0.89]). Women had significantly higher odds of undergoing thyroidectomy for thyroiditis compared to men (AOR 2.24 [1.34–3.75]).

Thyroid cancer

Thyroidectomy for goiters with cancer was less likely to be performed among black patients than white patients (AOR 0.38 [0.31–0.48]) and was more likely to be performed in the Northeast than the Midwest (AOR 0.34 [0.24–0.48]), South (AOR 0.46 [0.32–0.65]), or West (AOR 0.47 [0.34–0.67]). Being privately insured was associated with significantly increased odds of undergoing thyroidectomy for a goiter with thyroid cancer than being uninsured (AOR 0.25 [0.07–0.89]), on Medicaid (AOR 0.57 [0.43–0.77]), or on Medicare (AOR 0.54 [0.44–0.66]). Living in the areas with the highest income quartile was associated with 42% increased odds of undergoing thyroidectomy for thyroid cancer goiter (AOR 1.42 [1.09–1.85]). An ECI score of four or greater was also associated with significantly increased odds of thyroidectomy compared to an ECI score of 0–1 (AOR 10.18 [8.36–12.39]).

Discussion

In this study we have described the current demographics, disparities, and factors associated with the various types of patients with goiters undergoing thyroidectomy in the United States. Nontoxic goiters make up the majority of causes for these operations, followed by thyrotoxicosis-related goiters. Thyroid cancer and simple goiters are a smaller subset of patients with goiters undergoing thyroidectomy but undergo surgery with similar frequency nationwide.

The results of this study are consistent with information known about the demographics of thyroid disease nationwide, such as that the majority of patients with thyroid disease are female and Caucasian.[9] This study, however, focuses on patients with goiters

Table 3
Odds ratios.

	Simple Goiter OR (95% CI)	Nontoxic Goiter OR (95% CI)	Thyrotoxicosis & Toxic Uninodular Goiter OR (95% CI)	Thyroiditis Goiter OR (95% CI)	Thyroid cancer goiter OR (95% CI)
Age					
<45	Ref.				
45–65	1.08 (0.93–1.27)	**1.89 (1.74–2.05)**	**0.46 (0.42–0.51)**	**0.68 (0.51–0.9)**	**0.66 (0.56–0.77)**
>65	**1.43 (1.15–1.79)**	**1.8 (1.57–2.05)**	**0.36 (0.3–0.44)**	**0.4 (0.24–0.67)**	0.81 (0.65–1.01)
Race					
White	Ref.				
Black	**1.35 (1.14–1.58)**	**1.3 (1.17–1.45)**	0.93 (0.81–1.07)	**0.2 (0.11–0.37)**	**0.38 (0.31–0.48)**
Hispanic	1.02 (0.82–1.28)	1.09 (0.95–1.24)	0.89 (0.75–1.05)	**0.5 (0.28–0.89)**	1.1 (0.88–1.37)
Asian	1.08 (0.76–1.52)	0.92 (0.77–1.11)	0.92 (0.69–1.23)	0.54 (0.23–1.26)	**1.57 (1.17–2.1)**
Gender					
Male	Ref.				
Female	**0.73 (0.63–0.84)**	**1.13 (1.03–1.23)**	0.98 (0.87–1.11)	**2.24 (1.34–3.75)**	0.92 (0.81–1.05)
Primary Payer					
Private	Ref.				
Medicare	0.88 (0.73–1.05)	**1.25 (1.11–1.4)**	1.08 (0.92–1.27)	1.03 (0.65–1.62)	**0.54 (0.44–0.66)**
Medicaid	1.03 (0.81–1.3)	**0.88 (0.78–1)**	**1.53 (1.3–1.81)**	1.23 (0.79–1.9)	**0.57 (0.43–0.77)**
Self-pay	**2.13 (1.52–2.98)**	**0.54 (0.43–0.68)**	**1.84 (1.46–2.32)**	0.73 (0.26–2.04)	0.82 (0.54–1.24)
No charge	1.1 (0.51–2.35)	0.97 (0.62–1.51)	1.56 (0.93–2.61)	–	**0.25 (0.07–0.89)**
Other	1.3 (0.93–1.82)	0.84 (0.69–1.01)	**1.46 (1.15–1.85)**	0.93 (0.43–2.02)	**0.57 (0.36–0.9)**
Zip Income Quartile					
0-25th	Ref.				
26th to 50th	**0.84 (0.71–0.99)**	1 (0.9–1.12)	1.06 (0.92–1.21)	0.99 (0.68–1.44)	1.14 (0.94–1.39)
51st to 75th	**0.69 (0.57–0.83)**	**1.12 (1–1.26)**	0.94 (0.81–1.08)	1.01 (0.67–1.52)	1.2 (0.97–1.49)
76th to 100th	**0.65 (0.51–0.83)**	1.09 (0.94–1.26)	0.92 (0.79–1.07)	0.8 (0.53–1.21)	**1.42 (1.09–1.85)**
Elixhauser Comorbidities					
0–1	Ref.				
2	**2.18 (1.87–2.55)**	**0.55 (0.5–0.61)**	**0.87 (0.78–0.98)**	1.23 (0.87–1.73)	**4.43 (3.69–5.32)**
3	**2.73 (2.29–3.25)**	**0.42 (0.37–0.49)**	**0.81 (0.69–0.94)**	0.96 (0.58–1.56)	**7.2 (5.78–8.98)**
4+	**3.51 (2.93–4.22)**	**0.33 (0.29–0.38)**	**0.74 (0.61–0.9)**	1.13 (0.68–1.87)	**10.18 (8.36–12.39)**
Hospital Region					
Northeast	Ref.				
Midwest	**1.59 (1.19–2.12)**	1.16 (0.98–1.38)	1.18 (0.96–1.45)	0.71 (0.44–1.14)	**0.34 (0.24–0.48)**
South	**1.53 (1.18–2)**	1.16 (0.99–1.35)	1.03 (0.85–1.25)	0.91 (0.63–1.32)	**0.46 (0.32–0.65)**
West	**1.39 (1.05–1.84)**	1.12 (0.94–1.34)	1.2 (0.97–1.5)	0.7 (0.47–1.04)	**0.47 (0.34–0.67)**
Hospital bedsize					
Small	Ref.				
Medium	1.14 (0.87–1.5)	0.89 (0.77–1.03)	1.23 (0.98–1.55)	1.05 (0.63–1.76)	0.87 (0.66–1.14)
Large	1.02 (0.8–1.31)	**0.82 (0.71–0.94)**	**1.35 (1.09–1.67)**	1.01 (0.65–1.59)	1.09 (0.8–1.49)
Hospital Location					
Urban teaching	Ref.				
Rural	0.94 (0.7–1.26)	1.19 (0.97–1.46)	0.86 (0.66–1.12)	1.15 (0.66–2)	0.78 (0.55–1.11)
Urban private	1.15 (0.96–1.38)	**1.14 (1.02–1.27)**	0.97 (0.85–1.12)	1.34 (0.97–1.85)	**0.53 (0.42–0.66)**

undergoing operation and adds previously unknown information about income, geography, and hospital utilization among each subtype of goiter.

A prior study by Vashishta et al. included goiters among other types of thyroid diagnoses in the United States using NIS data from 2009 and focused on predictors of outcomes after thyroidectomy for all causes.[10] This study found the prevalence of simple goiter to be 4.5% among all thyroidectomies performed. In our study, which focused on goiters only, the prevalence of simple goiter was 7%. Our study similarly describes patients undergoing thyroidectomy but is unique in focusing only on those with goiters and examining the demographic differences between the subtypes. Our study distinguishes between the goiter subtypes with relation to demographics, associated factors, and regional variation.

The disparities found between the different patient populations of goiters undergoing thyroidectomy may guide efforts to target screening and outreach towards certain high-risk populations. For example, our results that demonstrate an association of simple goiters with lower income and the South or Midwest region may be used to effectively guide further research into socioeconomic factors associated with simple goiters in the U.S. in a manner analogous to efforts that have been effective in addressing iodine deficiency related goiters that are region-specific in many other countries. We discuss specific patient- and hospital-level factors associated with each type of goiter and their implications in more detail below.

Simple goiters

In the ICD-9, simple goiter is defined as “goiter unspecified, iodine-deficiency related, and non-toxic goiter.” This breadth of definition can result in some ambiguity in classification. However, these nationally representative results demonstrate that the category of simple goiter makes up a substantial proportion of the patients with goiters undergoing thyroidectomy in the United States, with a prevalence among goiters similar to that of thyroid cancer. Furthermore, these patients with simple goiters clearly represent a demographically distinct entity from the other listed causes of goiter with distinct socioeconomic and geographical disparities.

Simple goiters are most commonly associated with iodine deficiency; however, that is not their only cause. Goiter related to

iodine deficiency affects an estimated 16% of the population worldwide, with rates reaching as high as 28% in some areas of the world.[11] Simple goiters related to iodine deficiency are not limited to developing countries. In more affluent countries that have established national iodine fortification programs such as China, Germany, Greece, and Italy, iodine deficiency remains a major focus of public health reform.[12–15]

In contrast, the number of Americans with goiters resulting from iodine deficiency has been estimated to be extremely low based on widespread dietary fortification, such as with iodized salt.[16] Nearly a century ago in the U.S., the "Goiter Belt," which included the Appalachians, Great Lakes, and Northwest, was known for endemic iodine deficiency related simple goiters. Iodine fortification efforts markedly reduced the incidence of iodine deficiency and correspondingly reduced the incidence of simple goiters.[17] Our contemporary results show that the South and Midwest regions now have the greatest odds for having patients with simple goiters undergoing thyroidectomy, which is a different regional distribution than the historical goiter belt. The reasons for this regional association warrant further study but suggest additional, alternative etiologies of simple goiter besides regional iodine deficiency.

We have identified that certain factors, age >65, Black race, male sex, living in the South or Midwest, lack of health insurance, increasing medical comorbidities, and the lowest income quartile are associated with patients who underwent thyroidectomy for simple goiter. This suggests that an older and sicker population with decreased access to healthcare may be preferentially undergoing surgery for simple goiters. Socioeconomic status may potentially substantially impact susceptibility to develop a simple, potentially iodine deficiency-related goiter. This may be plausibly explained if lower socioeconomic status predisposes people towards a diet that consists primarily of processed foods, which do not require the use of iodine-fortified salt.[18] The population undergoing thyroidectomy for simple goiter in the U.S. has not previously been described in detail in our current era. Further research is warranted.

Nontoxic nodular goiter

Nontoxic nodular goiters are overwhelmingly the most common reason for thyroidectomy among all goiter types. This category of goiters includes all benign diffuse or multinodular goiters without abnormal thyroid function and may also have significant overlap with the simple goiter category. Both simple goiters and nontoxic nodular goiters can phenotypically appear as benign, nonfunctioning, multinodular goiters; the difference lies in their ICD-9 definitions, which specifies "iodine deficiency disorder" as a prerequisite for simple goiter but does not do the same for nontoxic nodular goiters.[19]

Indeed, we do see some overlap between the demographics of patients with nontoxic, nodular goiters and those with simple goiters — similar to those with simple goiters, patients with nontoxic nodular goiters have higher odds of undergoing surgery if they are Black, elderly, or treated in rural or urban non-teaching hospitals. Like simple goiters, nodular goiter formation is a chronic process that is most likely to manifest symptoms in the elderly, who have had the disease for several years, or those who have less frequent access to healthcare services.[20] However, unlike for simple goiter, female gender, lower comorbidity index scores, and increasing income levels are associated with increased likelihood of undergoing surgery for nontoxic goiter, suggesting that these two pathologies may affect distinct populations, or that the nontoxic nodular category is inclusive of other types of goiter unrelated to iodine deficiency. We may explain the association between lower ECI score and thyroidectomy for nontoxic goiter by reasoning that surgeons may be less likely to resect a benign, nonfunctioning, nodular goiter in patients with multiple comorbidities unless it is causing severe symptoms.

Thyrotoxicosis and toxic uninodular/multinodular goiter

Thyrotoxicosis-related goiters include, toxic uninodular and multinodular goiter and Graves' disease.[21] Although medical management remains a common first-line treatment for Graves' disease and toxic multinodular goiters, total or bilateral subtotal thyroidectomy serves as a definitive treatment option for goiters refractory to anti-thyroid medication or for patients who do not wish to take antithyroid medications or radioactive iodine. Patients undergoing thyroidectomy for thyrotoxicosis are overwhelmingly young and female, consistent with what previously has been described in the literature across all cases of hyperthyroidism.[22] White race has also been reported as a significant predictor of hyperthyroidism; however, in this national analysis there appears to be no increased likelihood of undergoing thyroidectomy for toxic goiters with any particular race. Interestingly, patients on Medicaid or having self-paid or "other" (i.e. unlisted) forms of insurance were more likely to undergo surgical management of these goiters.

The increased likelihood of undergoing thyroidectomy observed for patients on Medicaid or who are uninsured may not simply be a reflection of disease burden. Historically, a minority of patients with hyperthyroidism have undergone surgery for medically refractory hyperthyroidism, and little is known about the demographics of the group maintained on medical treatment. There may be certain unseen biases that predispose physicians to refer certain patients for thyroidectomy over others. In this case, it is possible that providers see uninsured, younger patients with fewer comorbidities as being higher risk for becoming lost to follow-up or being poorly compliant with long-term medical therapy, precluding them from safe non-operative management of their chronic, toxic goiter. This bias has been corroborated by a study of over 600 Graves' disease patients at an urban county hospital, which showed that surgically-managed patients were more likely to have a lower median income and be uninsured than those who are medically managed.[23] As such, this study may show us as much about provider preference as it does about the disease burden of goiters.

Thyroiditis goiter

The ICD-9 code for thyroiditis goiters is largely synonymous with Hashimoto's (chronic lymphocytic) thyroiditis, the most common cause of hypothyroidism in developed countries.[24] Patients uncommonly undergo surgery for thyroiditis, as medical supplementation of thyroid hormone successfully corrects hypothyroidism in most patients.[25] In those that do undergo surgery for thyroiditis, a majority of them (up to 67%) will undergo surgery for compressive symptoms.[26] Consistent with what has been described for most patients with Hashimoto's thyroiditis overall, the population undergoing surgery for goiter is predominantly female and White. However, it appears that the likelihood of undergoing thyroidectomy for thyroiditis-related goiter decreases with age, whereas the overall incidence of Hashimoto's has been observed to increase with age.[27] This suggests that young patients may be more likely to have surgery for thyroiditis and older patients are more likely to be medically managed. Further research may investigate whether thyroiditis occurring in younger patients is more likely to develop into a symptomatic goiter compared to thyroiditis in older patients given the age difference in likelihood of thyroidectomy for thyroiditis goiter across age groups.

Thyroid cancer goiter

Patients undergoing thyroidectomy for thyroid cancer goiters in the NIS are demographically consistent with reports of patients with thyroid cancer in the Surveillance, Epidemiology, and End-Results-9 (SEER-9) cancer registry program. In both datasets, these patients are more likely to be older and White.[28] Thyroidectomy, whether total or subtotal, is the definitive treatment for thyroid cancer.[29] However, we find that women have decreased odds of undergoing thyroidectomy for goiters with cancer compared to men, which is contrary to what has been described for thyroid cancer in the United States. Of note, global studies of thyroid cancer have shown that although the incidence of thyroid cancer has increased significantly across both sexes worldwide; the annual percentage increase of thyroid cancer rates is greater for men than women in certain areas.[30] Furthermore, the gender ratio of occult carcinomas discovered upon autopsy is close to 1:1.[31] These results demonstrate that the association of gender and thyroid cancer is evolving.

Our study also shines light on economic factors for undergoing thyroidectomy for thyroid cancer in the United States. The population of goiter patients with cancer undergoing thyroidectomy is more likely to have private insurance than to be uninsured or on Medicare or Medicaid. An association between living in a high-income zip code and undergoing thyroidectomy for a goiter with thyroid cancer also approaches significance (AOR 1.3 [1–1.69], $p = 0.051$). This relationship of socioeconomic status and thyroidectomy for goiter with cancer has not been previously described on the national level in the U.S. In certain regions of the United States, higher monthly household income and education level have been shown to be independent predictors for development of thyroid cancer[32–34]; this has been corroborated in Canada and Korea as well.[35,36] This phenomenon likely can be attributed to better access to primary care and screening in higher socioeconomic groups, leading to increased detection and surgery.

Improved means of screening for and diagnosing thyroid cancers have significantly raised the incidence of thyroid cancer across all ages and races during the last two decades.[37] However, it is also widely recognized that improved screening and diagnosis has led to the detection of many indolent lesions that may not truly require surgery, such as some papillary microcarcinomas.[38] On the other hand, surgery for thyroid cancer-related goiters is significantly more likely to happen in those with a higher comorbidity index; this may suggest that thyroid cancer often appears among patients with multiple comorbidities, and that surgeons will accept the risks of thyroidectomy in this patient population in favor of surgical treatment. In the absence of cancer staging data, we may speculate that higher stage lesions are more often found in generally sicker patients. This trend may also reflect national variance among surgeons performing thyroidectomy; whereas American surgeons may choose an initially non-operative, surveillance-driven approach for certain lesions, European physicians may be more likely to adopt a surgery-first approach based upon the relatively more aggressive guidelines from the British Thyroid Association and other professional European endocrine organizations.[39,40]

Limitations

The strength of this study as nationally representative is also its limitation as a secondary dataset. The data are limited to the existing criteria, and there is the potential for misclassification or miscoding. This is a study of patients who have undergone thyroidectomy operations for goiter. This study does not include those diagnosed with goiters who have not undergone thyroidectomy. Therefore, it is not an estimate of the complete prevalence of goiter. Issues with access to healthcare, provider biases, insurance coverage limitations, and cultural preferences may affect the ability of certain populations to undergo thyroidectomy for goiter.

Furthermore, our analyses only included patients with goiter who underwent thyroidectomy in the inpatient setting. Although, goiters are still more frequently performed as inpatient procedures,[41] many thyroidectomies are also performed in the outpatient setting.[42] Those patients undergoing outpatient thyroidectomy are more likely to be White, female, and privately insured than those undergoing inpatient thyroidectomy.[43] Therefore, the study population results may underestimate the true prevalence of thyroidectomy for goiters in the United States, particularly among these groups. Although the database has certain limitations, we have provided updated estimates of patients with contemporary goiters undergoing thyroidectomy on a national scale.

Conclusion

In the United States, thyroidectomy for goiter remains a frequently performed operation despite previous public health interventions that have reduced the diagnosis of simple goiter. In this epidemiological assessment of social determinants for patients undergoing thyroidectomy for goiter, we have characterized the current distribution of patients with different goiter subtypes undergoing thyroidectomy in the U.S. and elucidated the demographics and factors associated with each subtype. The information gleaned from this study can be used to help identify at-risk populations and to guide further research into modifiable factors for particular types of goiter.

Summary for table of contents

In the United States, thyroidectomy for goiter remains a frequently performed operation despite previous public health interventions that have reduced the diagnosis of simple goiter. Using the National Inpatient Sample, we demonstrate that different socioeconomic and demographic factors are associated with specific populations undergoing thyroidectomy for varying causes of goiter.

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Declaration of competing interest

The authors of this work do not have any conflicts of interest to disclose.

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