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Investigation on the factors that influence the prevalence of thyroid nodules in adults in Tianjin, China

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ABSTRACT

Studies have shown that prevalence of thyroid nodules (TNs) has been increasing recently. However, the factors that may influence TN prevalence is not fully understood. In this study, we aimed to understand the prevalence of TNs and identify possible factors that are associated with the prevalence of TNs in Tianjin, China. Subjects aged 18 years or older were randomly collected and all subjects received thyroid ultrasonography, physical examination and questionnaires. Subjects (n = 2647) were divided into the case group in which the subjects had TNs and the control group in which the subjects did not have TNs. Potential influencing factors on TNs including sex, age, iodine status, thyroid volume, thyroid hormone (TSH), thyroid autoantibody TPOAb, TGAb and living habits were analyzed. Our results showed that the overall TN prevalence was 26.7%. The prevalence of TNs in women was higher than that in men ($P < 0.05$). TN prevalence increased with age ($P < 0.001$), and a U-shaped curve relationship between urine iodine concentrations (UICs) and prevalence of TNs was observed. The positive rate of TPOAb and goiter rate in case group was higher than that in control group ($P < 0.05$). The thyroid volume in case group was larger than that in control group ($P < 0.001$). Other factors that may influence TNs included high blood pressure, iodized salt, menopause, seafood intake, and education levels. None of UIC, TSH, TPOAb and TGAb were associated with TN prevalence in regression models. In conclusion, our results showed that TNs prevalence in Tianjin was high. TNs prevalence was higher in women than in men, and it increases with age. The older, female, high education level physical labor and goiter are independent risk factors for TNs.

1. Introduction

Thyroid nodules (TNs) are a common thyroid disease, and have been defined by the American Thyroid Association (ATA) as “discrete lesions within the thyroid gland, radiologically distinct from surrounding thyroid parenchyma” [1]. Most TNs are benign, and approximately 4% to 14% are malignant [2,3]. The prevalence of TNs was 3%–7% as determined by palpation, and the prevalence was 19%–67% as determined by high resolution ultrasound [4]. The TN prevalence has been increasing worldwide recently. A Chinese systematic review indicated that the prevalence of TNs after 2002 was 24.4%, which was much higher than the that prior to 2002 (11.0%) [5]. The high prevalence observed may be partly due to the application of more advancing and sensitive diagnostic techniques. Studies have also shown that many other factors, e.g., age, sex and radiation exposure, can affect the occurrence of TN [6]. Intake of iodine plays a very important role in the incidence of TNs. It is well known that iodine is closely associated with the occurrence of thyroid disease with abnormal synthesis of thyroid hormone (TH). It has been demonstrated that low iodine intake can lead to the occurrence of TNs [7]. However, whether excessive iodine can lead to the increase in the prevalence of TNs is still inconclusive. The goal of this study was to identify possible factors that may influence TN prevalence through thyroid ultrasonography, questionnaires, and physical examination. So as to provide a fundamental base for better prevention and treatment of TNs.

2. Subjects and methods

2.1. Subjects

This study was conducted from March to October of 2015 in Tianjin, China. Random cluster sampling was used to select one district in city and country respectively. In order to meet the study’s requirements, the subjects were enrolled according to the following criteria: 1) adult

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Table 1
characteristics of subjects.

group	N	age(y)	Height (cm)	Weight (kg)	BMI(kg/m^2)
District					
Urban	1381	43 ± 15.47	166.7 ± 8.87	70.4 ± 32.21	25.2 ± 11.33
Suburban	1266	43 ± 15.53	166.7 ± 8.60	69.6 ± 13.19	24.95 ± 3.77
Gender					
Male	1352	43 ± 15.75	172.8 ± 6.42*	77.3 ± 28.11*	25.87 ± 9.61*
Female	1295	43 ± 15.21	160.4 ± 5.92*	62.4 ± 18.41*	24.29 ± 7.29*
Total	2647	43 ± 15.49	166.7 ± 8.74	70.0 ± 24.99	25.10 ± 8.59

*: $P < 0.05$, BMI = Body Mass Index.

residents over the age of 18 years; 2) Han nationality; 3) Living in Tianjin for at least 5 years; and 4) without receiving iodine contrast agent examination or taking iodine-containing drugs in recent three months. Besides, pregnant, maternal and breastfeeding women were excluded. The Medical Ethics Committee of Tianjin Medical University approved the research protocol. All of the participants provided written informed consent before the study.

2.2. Thyroid ultrasonography

Thyroid ultrasonography was performed by an experienced examiner using a 7.5 MHz transducer (Madison Portable B-SA-600), with all of the subjects having supine position and fully exposed neck. Thyroid lobe volume was calculated by the following formula: V (mL) = 0.479 × d × w × l (mm)/1000, and was recorded as the sum of both lobes. The normal volume was ≤18 ml and ≥25 ml for female and male adults, respectively [8]. Additional ultrasound structural focal abnormalities were described as nodules (circumscribed areas of greatly reduced or absent echogenicity).

2.3. Urinary iodine

The midstream urine samples in the morning were collected for all the subjects during examination. UIC was determined by arseric-cerium catalysis assay at the Key Laboratory of Hormone and Development (Ministry of Health), Metabolic Diseases Hospital and the Tianjin Institute of Endocrinology, Tianjin Medical University. Ammonium persulfate digestion with spectrophotometric detection of the Sandell-Kolthoff reaction assay was used to measure urinary iodine concentration. Four levels of certified reference material-lyophilized human urine (lot nos. GBW09108l, GBW09110n, GBW09111a, and GBW09112a; National Reference Laboratory for Iodine Deficiency Disorders, Beijing) with mean certified iodine concentrations of 68 μg/L (reference range: 59–77 μg/L), 195 μg/L (reference range: 185–205 μg/L), 558 μg/L (reference range: 541–575 μg/L), and 885 μg/L (reference range: 857–913 μg/L), respectively, were run together with each batch of samples. The reference range of urine iodine concentration adopted the criteria of WHO [9].

2.4. Thyroid hormones and autoantibodies

Blood samples (4 to 5 ml) were collected from the cubital vein of the forearm and stored in a clean glass tube. Serum specimens were obtained approximately two hours after blood collection, and the aliquots were frozen at −20 °C until thyroid hormones were analyzed. All of the blood samples were tested in the clinical laboratory of Tianjin Medical University General Hospital. Serum TSH concentration was measured with an acridinium ester using the ADVIA Centaur system and this assay is based upon a two-site sandwich principle. TGAb and TPOAb concentrations were determined with chemiluminescent reaction using the IMMULITE 2000 system (Simens Healthcare Diagnostics Inc, Gwynedd, United Kingdom). The normal ranges were 0.27–4.2mIU/L for sTSH, 0–34IU/L for thyroperoxidase antibody (TPOAb) and 0–50IU/L for thyroglobulin antibody (TGAb).

2.5. Statistical analyses

All the statistical analyses were performed by the Statistical Package for Social Sciences version 20.0 (IBM SPSS Inc.), and Microsoft Excel (Win7 2007). Normally distributed data was expressed as means ($\bar{x}$ ± SD); non-normally distributed data were expressed as medians (25th percentile, 75th percentiles). The comparison of TNs prevalence in different groups were performed using χ^2 test. Multivariate binary logistic analysis (backward stepwise) was used to identify independent factors may associated with TNs prevalence. Significance was set at two-tailed $\alpha < 0.05$.

3. Results

3.1. Characteristics of participants

A total of 2647 adults (1352 males and 1295 females) were enrolled in the final analyses. A total of 1381 subjects were from the urban area and 1266 subjects were from suburb area. The anthropometric characteristics are shown in Table 1. The age, height and weight were not significantly different between urban and suburb subjects.

3.2. Concentration of urinary iodine (UIC)

A total of 2505 morning urine samples were collected and the UIC was 134 μg/L (79–208 μg/L). UIC of urban residents was lower than that of suburb residents, and UIC of males was higher than that of females ($P < 0.05$) (Table 2). There were 35.6% of the subjects whose UIC was lower than 100 μg/L, and 10.3% was higher than 300 μg/L (Table 2).

3.3. Thyroid volume and GR

A total of 2619 subjects accepted thyroid ultrasound examination. The Thyroid Volume M (*P*25-*P*75) of the participants was 9 ml (7–12 ml). Thyroid volume of suburb residents was significantly larger than that of urban residents ($Z = -12.585$, $P < 0.001$). Thyroid volume of males was significantly larger than that of females ($Z = -17.323$, $P < 0.001$) (Table 3). The overall goiter rate (GR) was 1.9%. GR of females was significantly higher than that males (3.0% *vs* 1.1%, $P < 0.001$) (Table 3). Volume of left and right thyroid was 4.41 ml (3.38–5.69 ml) and 4.63 ml (3.56–5.99 ml), respectively, with the volume of right thyroid being significantly larger than that of the left thyroid ($Z = -16.36$, $P < 0.05$) (Table 3).

3.4. Association of TN prevalence with age and gender

The overall prevalence of TNs was 26.7% (698/2619). Age-adjusted prevalence of TN based on the whole population of Tianjin was 28.8%. Prevalence of TNs increased with the age (Table 4). TN prevalence of females was significantly higher than that of males (29.1% *vs* 23.4%,