Singh *et al.*
The Egyptian Journal of Otolaryngology (2023) 39:150
https://doi.org/10.1186/s43163-023-00508-x

The Egyptian Journal of Otolaryngology

ORIGINAL ARTICLE Open Access

Probable impact of environmental radiation on thyroid swellings in areas of Eastern Hyderabad and Nalgonda

Namit Kant Singh[1*], Neemu Hage[1], Shailaja Prabhala[2], Balaji Ramamourthy[1], Sushmitha Nagaraju[1] and Krishna Medha Kappagantu[1]

Abstract

Introduction Thyroid swellings are prevalent in 4 to 7% of the Indian population and are commonly present in females. Thyroid swelling has been attributed to various causes, such as ingestion of goitrogens and low iodine in the diet in benign, radiation exposure, and genetic in malignancies. Eastern Hyderabad and Nalgonda have a high fluoride content in the ground water, which can potentially disrupt thyroid functioning. Moreover, the region also harbors high uranium content and environmental radiation; hence, a retrospective analysis of the FNAC and histopathology of the thyroid swellings was done to evaluate the paradigm.

Method A retrospective analysis of the patient's records from February 1, 2022, to January 31, 2023, was conducted considering all the patients who presented with thyroid swelling. The variables taken into consideration were age, gender, and FNAC findings. A correlation was also made with the histopathology of the specimen of operated patients.

Result A total of 88 medical records of the patients were evaluated, and it was determined that there was a preponderance of females with a ratio of 8.77:1. Majority of the swellings were Benign labeled as Bethesda category 2 ($n=61$) followed by category 3 ($n=11$). To be considered are the cases of malignancies falling into category 6, which comprise 7.95% ($n=7$). The majority of the patients were seen between the ages of 31 to 40 ($n=28$), followed by 41 to 50 ($n=25$).

On comparing with the histopathological reports, two cases of category 5 were found to be having papillary thyroid carcinoma and another with follicular thyroid carcinoma making the number of proven malignancies to be 10.22% ($n=9$). Other histopathological findings correlated with the results of FNAC.

Conclusion Through this pilot study, we conclude that most thyroid swellings were benign, but there is a higher incidence of thyroid malignancies (10.22%), significantly higher than the country average of 2 to 4%. The higher number of malignant cases can be attributed to many factors, including high fluoride content and environmental radiation. Further studies need to be conducted, taking each element individually.

Keywords Thyroid neoplasms, Fine needle aspiration, Bethesda classification, Histopathology, Papillary thyroid cancer, Diagnostic imaging, Thyroid nodule, Follicular thyroid cancer

*Correspondence:
Namit Kant Singh
drnamit@rediffmail.com
Full list of author information is available at the end of the article

Background

Thyroid malignancy occurs in 5 to 15% of thyroid nodules [1]. The prevalence of thyroid malignancy, or thyroid cancer, varies depending on several factors such as age, gender, and geographic location [1, 2].

According to the American Cancer Society's most recent estimates for thyroid cancer in the USA, for 2023, there are about 43,720 new cases of thyroid cancer (12,540 in men and 31,180 in women) and about 2120 deaths from thyroid cancer (970 in men and 1150 in women) [3]. Ultrasound diagnosis of thyroid nodules has greatly increased their detection rate. Their malignancy risk is estimated at 7 and 15% in data from specialized centers used for guideline recommendations [4].

Ultrasonographic findings associated with malignant thyroid nodules include various characteristics. Malignant nodules often appear as completely solid or prominently solid on ultrasound imaging [5]. Microcalcifications within a nodule are also considered suspicious features for malignancy [5, 6]. Irregular or micro-lobulated margins, marked hypoechogenicity compared with the strap muscles, and increased intranodular vascularity on Doppler imaging are additional ultrasound findings associated with malignant nodules. In contrast, malignant nodules may exhibit a taller than wide orientation, while benign nodules are typically wider than tall [5]. Other suspicious sonographic criteria include marked hypoechogenicity, irregular margins, and abnormal lymph nodes. Eggshell calcifications surrounding the nodule are more commonly associated with benign nodules [6].

Clinical findings associated with malignant thyroid nodules can also provide important insights. Certain age groups and female gender have been associated with a higher risk of thyroid malignancy [7]. Malignant nodules may be asymptomatic or present with symptoms such as pain or tenderness [7]. The size and location of the nodules can raise suspicion for malignancy, with larger nodules and those located in specific regions of the thyroid gland being more concerning [8]. Abnormal thyroid function tests, such as elevated thyroid-stimulating hormone (TSH) levels, have also been associated with malignancy [9]. Additionally, the presence of enlarged lymph nodes in the neck, particularly those with abnormal sonographic features, may indicate the spread of malignancy [10, 11].

The incidence of thyroid malignancy in the Indian population is not well-established, as there is limited data available on the prevalence and incidence of thyroid cancer in India.

Studies have suggested that the incidence rate of thyroid cancer in India in women increased from 2.4 (95% confidence interval (CI) 2.2–2.7) to 3.9 (95%CI 3.6–4.2) and in men from 0.9 (95% CI 0.8–1.1) to 1.3 (95% CI 1.2–1.5), a relative increase of 62% and 48% respectively [12].

The higher incidence of thyroid malignancies in Eastern Hyderabad and Nalgonda can be attributed to the region's high levels of environmental radiation. Radiation exposure is a well-established risk factor for the development of thyroid malignancy [13], and Eastern Hyderabad and Nalgonda, a district in the Indian state of Telangana, has been identified as an area with high levels of environmental radiation [14–16]. The region is known for its large deposits of uranium, and past mining and milling activities have resulted in the release of radioactive materials into the surrounding environment [17].

Methods

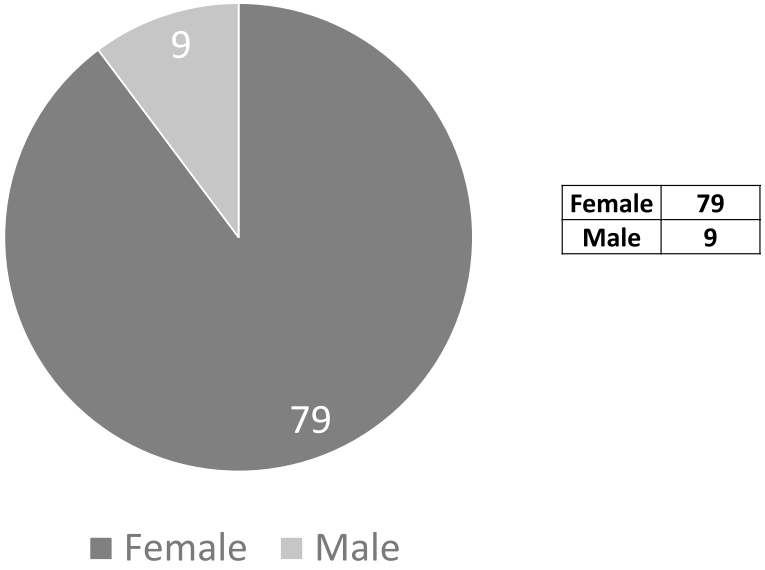
A retrospective analysis was conducted on patient records between February 1, 2022, and January 31, 2023, including individuals with thyroid swelling. Due approval was taken from the concerned head of the department and competent authority to review the patient's records. The study analyzed various variables such as age, gender, and fine-needle aspiration cytology (FNAC) findings. The Bethesda classification system was used to categorize FNAC findings into six categories: nondiagnostic, benign, atypia of undetermined significance (AUS)/follicular lesion of undetermined significance (FLUS), follicular neoplasm/suspicious for follicular neoplasm (SFN), suspicious for malignancy, and malignant. Additionally, the study compared FNAC findings with the histopathology results of operated patients.

Results

Evaluating 88 medical records (data summarized in thyroid.xlsx submitted as Supplementary material) found that most patients were female, with a ratio of 8.77:1 (Fig. 1). Most of the swellings were determined to be benign and categorized as Bethesda 2 ($n=61$) or Bethesda 3 ($n=11$), while malignancies fell under the Bethesda 6 category and accounted for 7.95% ($n=7$) of cases (Fig. 2). The highest cases were observed in patients aged 31 to 40 ($n=28$) and those aged 41 to 50 ($n=25$) (Fig. 3). Compared with the histopathological reports, two cases of category 5 were found to have papillary thyroid carcinoma and another with follicular thyroid carcinoma, making the number of proven malignancies 10.22% ($n=9$) (Fig. 4). Other histopathological findings correlated with the results of FNAC.

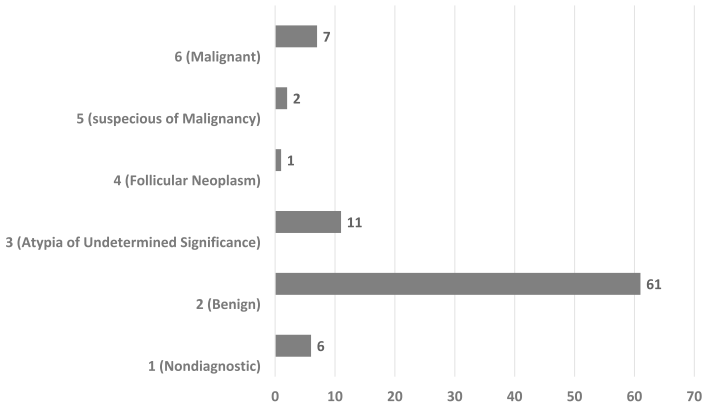
Discussion

The increased occurrence of thyroid malignancies in Eastern Hyderabad and Nalgonda (a district in the Indian state of Telangana) can be attributed to the region's elevated levels of environmental radiation. As supported



Female	79
Male	9

Fig. 1 Incidence in females and males



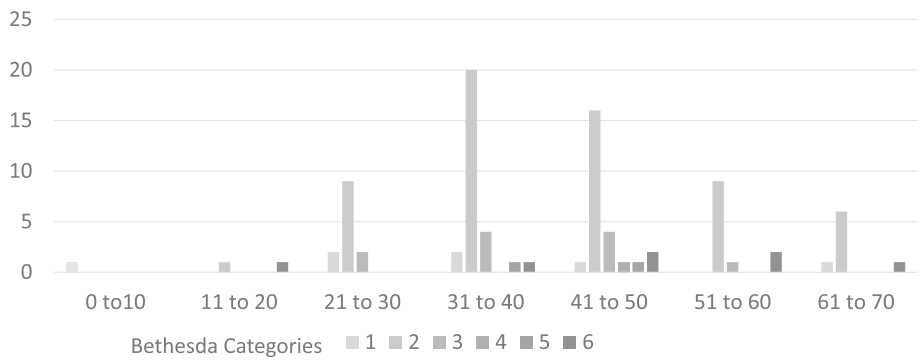
1 (Nondiagnostic)	2 (Benign)	3 (Atypia of Undetermined Significance)	4 (Follicular Neoplasm)	5 (suspecious of Malignancy)	6 (Malignant)
6	61	11	1	2	7

Fig. 2 FNAC findings

by studies, environmental radiation has long been recognized as a significant risk factor for the development of thyroid malignancies [13]. Specifically, Eastern Hyderabad and Nalgonda have been identified as areas with notable environmental radiation levels, with several studies indicating this [14–16]. This region is renowned for its abundant uranium deposits, and previous mining and milling activities have led to the release of radioactive substances into the surrounding environment [17].

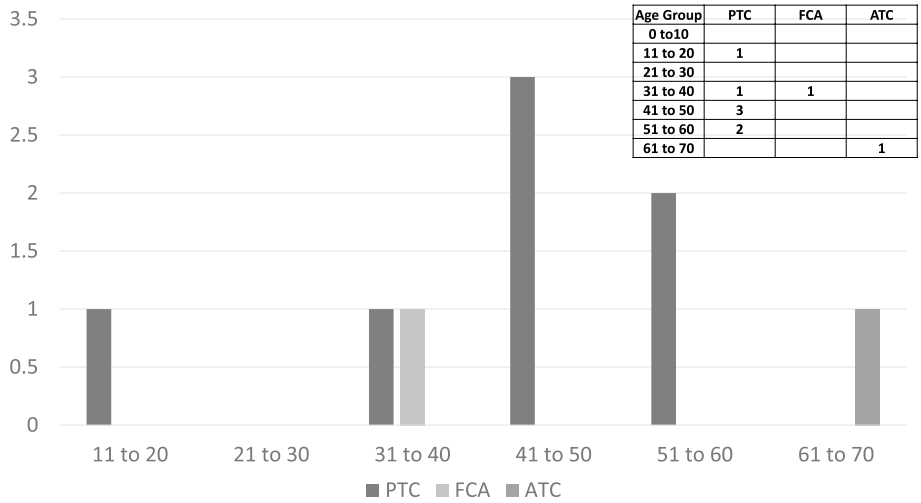
Several studies have documented elevated levels of radiation exposure among residents of Eastern Hyderabad and Nalgonda and surrounding areas, including higher levels of naturally occurring radioactive materials such as radium and uranium in soil and groundwater [14–16].

Ionizing radiation can cause thyroid malignancies through several mechanisms, including direct DNA damage, indirect DNA damage, and altering gene expression, most commonly RET/PTC rearrangements increasing cell proliferation [18]. Studies have demonstrated that radiation exposure can induce the formation of RET/PTC rearrangements in thyroid cells [19]. The risk of RET/PTC rearrangements increases with higher radiation doses delivered to the thyroid gland, with a higher susceptibility observed during childhood and decreasing with older age at exposure [18]. The latency period



Age Group	Bethesda Categories					
	1	2	3	4	5	6
0 to10						
11 to 20		1				1
21 to 30	2	9	2			
31 to 40	2	20	4		1	1
41 to 50	1	16	4	1	1	2
51 to 60		9	1			2
61 to 70	1	6				1

Fig. 3 Age group distribution of FNAC as per Bethesda



Age Group	PTC	FCA	ATC
0 to10			
11 to 20	1		
21 to 30			
31 to 40	1	1	
41 to 50	3		
51 to 60	2		
61 to 70			1

Fig. 4 Thyroid malignancies in various age groups

between radiation exposure and the onset of thyroid cancer with RET/PTC rearrangements typically ranges from 5 to 10 years [18].

While RET/PTC rearrangements can also occur in sporadic cases of thyroid cancer, their prevalence is higher in radiation-associated thyroid cancer compared to sporadic cases [20]. These findings underscore the impact of radiation-induced genetic alterations in the pathogenesis of thyroid cancer and highlight the significance of understanding the role of environmental radiation in disease development.

Genetic causes associated with thyroid malignancy are a mutation linked to RET proto-oncogene and association with multiple endocrine neoplasia 2 syndrome or a family history of medullary carcinoma of the thyroid [21].

Studies conducted in the region of Hyderabad and surrounding areas dealing with the cytological and histopathological correlation and others documenting the incidence in their health care center have reported the range of thyroid malignancies in the range of 10 to 14% which is significantly more than the national average of 3 to 4% [22–25].

Other risk factors, age, gender, and exposure to certain chemicals or substances, do not significantly affect the disease process.

Conclusion

This pilot study has led us to a significant finding—while most thyroid swellings were benign, there was a notably higher incidence of thyroid malignancies (10.22%). This percentage is substantially higher than the country's average range of 2 to 4%, which is a cause for concern. We suspect this high incidence of malignancies could be attributed to various factors, with environmental radiation being a significant contributor. It is essential to conduct further studies that explore and investigate each factor individually to understand the underlying causes better. The implications of these findings are significant, and they call for immediate attention to this pressing issue.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43163-023-00508-x.

Additional file 1.

Acknowledgements

I extend my thanks to Dr. Naina Kumar, Adhvan Singh, and Nutty Singh, who helped me in conducting this analysis and provided valuable information. Furthermore, I acknowledge the support and guidance of my colleagues and mentors, who provided me with the necessary resources and expertise throughout the study.

Authors' contributions

NKS: research idea and data collection. NH: data collection and language editing. SP: permission to assess and analyze pathological records. BR: data collection. SN: literature review. KMK: literature review.

Funding

There is no funding involved in the present study.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Declarations

Ethics approval and consent to participate

The ethical approval has been granted by the Institutional Ethical Committee of All India Institute of Medical Sciences, Bibinagar, Hyderabad, India with the IEC Reference number AIIMS/BBN/IEC/2023/296.

Consent for publication

The study is a retrospective study of the patients records and does not include any sort of intervention on Human participants, hence the informed consent was not required and was waived off by Institutional Ethical Committee.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Otorhinolaryngology and Head and Neck Surgery, All India Institute of Medical Sciences, Bibinagar, Hyderabad, India. [2]Department of Pathology, All India Institute of Medical Sciences, Bibinagar, Hyderabad, India.

Received: 30 May 2023 Accepted: 11 August 2023
Published online: 27 September 2023

References

1. Megwalu UC (2017) Risk of malignancy in thyroid nodules 4 cm or larger. Endocrinol Metab 32(1):77–82. https://doi.org/10.3803/EnM.2017.32.1.77
2. Pellegriti G, Frasca F, Regalbuto C, Squatrito S, Vigneri R (2013) Worldwide increasing incidence of thyroid cancer: update on epidemiology and risk factors. J Cancer Epidemiol 2013:965212. https://doi.org/10.1155/2013/965212
3. Key Statistics for Thyroid Cancer.https://www.cancer.org/cancer/thyroid-cancer/about/key-statistics.html. Accessed 12 Apr 2023
4. Grussendorf M, Ruschenburg I, Brabant G (2022) Malignancy rates in thyroid nodules: a long-term cohort study of 17,592 patients. Eur Thyroid J 11(4):e220027. https://doi.org/10.1530/ETJ-22-0027
5. Jeh SK, Jung SL, Kim BS, Lee YK (2007) Evaluating the degree of conformity of papillary carcinoma and follicular carcinoma to the reported ultrasonographic findings of malignant thyroid tumor. Korean J Radiol 8:192–7. https://doi.org/10.3348/kjr.2007.8.3.192
6. Kim BG, Kim EK, Kim EK et al (2008) Sonographic differentiation of thyroid nodules with eggshell calcifications. J Ultrasound Med 27:1425–30. https://doi.org/10.7863/jum.2008.27.10.1425
7. Omori N, Omori K, Takano K (2008) Association of the ultrasonographic findings of subacute thyroiditis with thyroid pain and laboratory findings. Endocr J 55:583–8. https://doi.org/10.1507/endocrj.k07e-163
8. Ryu YH, Jung YK, Yoon HJ et al (2014) Atypia of undetermined significance on thyroid fine needle aspiration: surgical outcome and risk factors for malignancy. Ann Surg Treat Res 86:109–14. https://doi.org/10.4174/astr.2014.86.3.109
9. Liu Y (2009) Clinical significance of thyroid uptake on F18-fluorodeoxyglucose positron emission tomography. Ann Nucl Med. 23:17–23. https://doi.org/10.1007/s12149-008-0198-0
10. Escobar FA, Pantanowitz L, Picarsic J et al (2018) Cytomorphology and sonographic features of ectopic thymic tissue diagnosed in paediatric FNA biopsies. Cytopathology 29:241–246. https://doi.org/10.1111/cyt.12529
11. Yoo RE, Kim JH, Bae JM et al (2020) Ultrasonographic indeterminate lymph nodes in preoperative thyroid cancer patients: malignancy risk and ultrasonographic findings predictive of malignancy. Korean J Radiol. 21:598–604. https://doi.org/10.3348/kjr.2019.0755
12. SekkathVeedu J, Wang K, Lei F, Chen Q, Huang B, Mathew A (2018) Trends in thyroid cancer incidence in India. J Clin Oncol 36(15_suppl):e18095–e18095. https://doi.org/10.1200/JCO.2018.36.15_suppl.e18095
13. BogovićCrnčić T, IlićTomaš M, Girotto N, Grbac IS (2020) Risk factors for thyroid cancer: what do we know so far? Acta Clin Croat 59(Suppl 1):66–72. https://doi.org/10.20471/acc.2020.59.s1.08
14. Keesari T, Mohokar HV, Sahoo BK, Mallesh G (2014) Assessment of environmental radioactive elements in groundwater in parts of Nalgonda district, Andhra Pradesh, South India using scintillation detection methods. J Radioanal Nucl Chem 302(3):1391–1398. https://doi.org/10.1007/s10967-014-3566-3
15. Reddy MS, Suman G, Reddy KVK, Reddy MS, Reddy CG, Reddy PY (2021) Ambient natural gamma radiation dose measurement in Devarakonda town, Nalgonda district, India. AIP Conf Proc 2352(1):050007. https://doi.org/10.1063/5.0052396
16. Suman G, Vinay Kumar Reddy K, Sreenath Reddy M, Vidyasagar D, Gopal Reddy C, Yadagiri Reddy P (2022) Dose assessment due to natural gamma radiation levels and radioactive nuclides in the environment of Dasarlapally, Nalgonda District, Telangana State, India. Int J Environ Anal Chem 102(19):7409–7418. https://doi.org/10.1080/03067319.2020.1830984
17. EJOLT. Nalgonda Uranium Mining, Andhra Pradesh, India | EJAtlas. Environmental Justice Atlas. Accessed 12 Apr 2023. https://ejatlas.org/conflict/nalgonda-uranium-mining-andhra-pradesh-india
18. Iglesias ML, Schmidt A, Ghuzlan AA et al (2017) Radiation exposure and thyroid cancer: a review. Arch Endocrinol Metab 61(2):180–187. https://doi.org/10.1590/2359-3997000000257
19. Leeman-Neill RJ, Kelly LM, Liu P et al (2013) ETV6-NTRK3 is a common chromosomal rearrangement in radiation-associated thyroid cancer. Cancer. https://doi.org/10.1002/cncr.28484
20. Handkiewicz-Junak D, Swierniak M, Rusinek D et al (2016) Gene signature of the post-chernobyl papillary thyroid cancer. Eur J Nucl Med Mol Imaging. 43:1267–77. https://doi.org/10.1007/s00259-015-3303-3

21. Thyroid Cancer - Risk Factors. Cancer.Net. Published June 25th, 2012. Accessed 12 Apr 2023.https://www.cancer.net/cancer-types/thyroid-cancer/risk-factors
22. ucjournals. Cytohistopathological correlation of thyroid swellings, a retrospective study in a tertiary hospital - Unified Citation Journals. Published April 11th, 2023. Accessed 15 Jul 2023.https://ucjournals.com/cytohistopathological-correlation-of-thyroid-swellings-a-retrospective-study-in-a-tertiary-hospital/,https://ucjournals.com/cytohistopathological-correlation-of-thyroid-swellings-a-retrospective-study-in-a-tertiary-hospital/
23. Hakeem SA (2020) Analysis of thyroid cases in a teaching hospital. Acad J Surg 3(1):155–158. https://doi.org/10.47008/ajs/2020.3.1.33
24. Bhanumathi V, Rao SVR (2017) Retrospective study of thyroid swelling-role of FNAC and histopathology in diagnosis. J Evol Med Dent Sci 6(77):5502–5504. Accessed 15 July 2023.https://go.gale.com/ps/i.do?p=AONE&sw=w&issn=22784748&v=2.1&it=r&id=GALE%7CA511789148&sid=googleScholar&linkaccess=abs
25. Sayanna S, Shankar MU, Babu KR (2019) Incidence of thyroid diseases in a tertiary hospital: a retrospective study. Int Surg J 6(4):1254–1258. https://doi.org/10.18203/2349-2902.isj20191258

Publisher's Note