International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Artificial Intelligence & Machine Learning Models to Predict Thyroid Cancer during Pregnancy: A Review

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Abstract: ***Thyroid cancer is the second most prevalent cancer diagnosed during pregnancy, after breast cancer. Controlling cancer and averting problems caused by maternal hypothyroidism are the main objectives of therapy. There was no clear association found when the role of female sex hormones as an etiologic factor was investigated. Pregnancy may trigger an existing thyroid nodule to enlarge owing to the structural similarities between TSH and BHCG as well as the naturally generated oestrogen receptors on thyroid gland cells. Pregnancy's impact on the development and prognosis of differentiated thyroid tumors (follicular and papillary) has also been studied. Patients with thyroid cancer who were diagnosed while pregnant or who became pregnant after receiving curative treatment do not have a worse prognosis. Pregnancy termination is not at all advised; surgery can wait until after delivery, except for malignant tumors that are growing quickly. While radioactive iodine ablation is categorically contraindicated during pregnancy, the novel systemic therapies are not thoroughly researched. But almost most of these new substances are FDA categories C or D, which means they should be avoided. Pregnancy's effect on other types of thyroid cancer (medullary and anaplastic thyroid tumors) has not been extensively investigated because of the rarity of pregnancy is. It is crucial to control thyroid cancer endocrinologically while pregnant. Fetal hypothyroidism may result from the hypothyroidism brought on by a complete thyroidectomy. A multidisciplinary team is therefore required for the care of thyroid cancer linked to pregnancy. Here, we provide Artificial Intelligence & Machine Learning based predictions for early intervention by the medical fraternity in Thyroid Cancer during Pregnancy.***

Keywords: Maternal Health, Clinical Decision Support, Fetal Health, Diagnostic Tools

1. Introduction

Thyroid cancer is the second most prevalent kind of cancer diagnosed during pregnancy. In this case, addressing thyroid cancer entails controlling the disease, managing hormonal problems after thyroidectomy, and minimizing the fetus from experiencing harm from the mother's hypothyroidism. A complete or almost complete thyroidectomy is the cornerstone of care for patients with thyroid cancer. In the case of differentiated thyroid tumors, radioactive iodine is then administered as an adjuvant therapy. Thyroid-stimulating hormone (TSH) levels show physiological changes in the mother's thyroid hormones during pregnancy, declining in the first trimester and then returning to normal just before delivery. The high concentrations of -human chorionic gonadotropin (-hCG) in the placenta increase the production of thyroid hormones by activating the mother's thyroid gland and interacting with TSH receptors.

The administration of radioactive iodine is completely contraindicated during pregnancy. When treating a case of thyroid cancer associated with pregnancy, it's vital to discuss the scheduling of surgery, how pregnancy affects the prognosis of the disease, and how to monitor pregnant women with thyroid cancer.

To answer concerns regarding the appropriate management of such individuals, this article will conduct a literature study to find pertinent information about this clinical condition. Thyroid-stimulating hormone (TSH) values show physiological changes in the mother's thyroid hormones during pregnancy declining in the first trimester and then returning to normal shortly before delivery. This is due to the placenta's high production of hCG, or human chorionic gonadotropin, which stimulates the mother thyroid gland's activity and interacts with TSH receptors to increase the production of thyroid hormones.

2. Materials and Methods

2.1 Epidemiology and risk factors

Globally, thyroid cancer is growing more prevalent. The increase affects people of all races and ages, although women under 45 are more vulnerable. There may have been some regional variation in the increase since the Chernobyl nuclear power plant accident, with a noticeable increase in Eastern Europe and nations affected by radioactive fallout, such as Belarus and Ukraine. This demonstrates the latent character of the disease since an increase in cause-specific mortality rates is expected to happen several years after an increase in incidence.

There has been discussion on whether this rise in incidence a real rise is or is being inflated by a rise in diagnoses. Some writers ascribe the rise in occurrence to the greater use of delicate radiological techniques, such as ultrasound, in healthcare, which has allowed for the detection of lesions that could have gone undiagnosed otherwise. This idea explains why there are more tiny tumors nowadays. The increase in papillary histological subtype and the rise in large tumor incidence almost exclusively support the theory of a true global increase in incidence, and the concept of a spurious increase due to early detection may be disproved.

Women are more likely than men to acquire thyroid cancer, with a potential 3-1 ratio. Thyroid cancer is the second most common cancer during pregnancy, with a frequency of 14 per 100,000 live births; breast cancer is the most common. Thyroid cancer risk factors include a history of radiation exposure and iodine shortage. MEN2, a genetic disorder, was present in one to two percent of thyroid cancer patients. Given the predominance of females and the age-specific increase in thyroid cancer incidence in women during the childbearing period, it was hypothesized that sex hormones may contribute to the development of thyroid cancer, namely differentiated thyroid cancer (papillary and follicular thyroid tumors). Throughout pregnancy, the mother's thyroid hormones alter physiologically; during the first trimester, thyroid-stimulating hormone (TSH) levels decrease, and before delivery, they rise. The reason for this is that the placenta releases large amounts of hCG (human chorionic gonadotropin), which interacts with TSH receptors in the mother's thyroid gland to increase their activity and stimulate the synthesis of thyroid hormones.

A pooled study of 14 case control studies involving 2247 female patients found that age at menarche, age at first pregnancy, and menopause were among the reproductive and menstrual characteristics that had a weak association with the risk of thyroid cancer. Nevertheless, the theory behind this association has also been studied in large prospective cohorts, yielding inconsistent results. The California teacher's cohort study looked at menstrual, reproductive, and other hormonal factors as well as the association between exogenous hormone intake and the incidence of papillary thyroid cancer. A later age at menarche and a longer menstrual cycle (more than 30 days) are linked to an increased risk of papillary thyroid cancer, per this prospective cohort of 117,646 women. However, the large prospective cohort research EPIC (345,157 women) did not find a weak association between reproductive factors and the risk of thyroid cancer. The study had a median follow-up of 11 years. Both trials did, however, find a positive connection between the risk of thyroid cancer and recent pregnancy (within 5 years of cohort membership).

This problem was resolved using a meta-analysis of 21 papers that included 406,329 patients. This meta-analysis revealed a substantial correlation between thyroid cancer risk with parity (3 pregnancies). It supported the earlier finding of a temporary rise in thyroid cancer risk following a recent pregnancy (within five years of the prior pregnancy).

2.1.1 Pregnancy and thyroid

The thyroid gland normally expands by 30% throughout the first and third trimesters of pregnancy (). The TSH fluctuates throughout pregnancy, peaking in the first trimester before returning to normal. Because the fetal thyroid does not begin to concentrate iodine until week 12 of gestation, the foetus's only source of thyroid hormones is the mother's T4. During pregnancy, specific reference ranges related to gestational age are used to avoid misinterpreting thyroid function tests. When monitoring patients who are known to have thyroid cancer, the TSH level is crucial because it provides a reference point for modifying the dose of levothyroxin suppressive medication. A rise in HCG levels and an increase in blood oestrogen levels are the two main processes that could explain how pregnancy affects the thyroid gland. () Since the same gene produces both TSH and HCG, which are glycoprotein hormones with similar structures, HCG stimulates TSH receptors, increasing the thyroid gland's activity. The TSH level then gradually drops during the next 12 weeks of pregnancy, before returning to normal. Less than 10% of individuals with prenatal trophoblastic disorders exhibit evident hyperthyroidism, and thyrotoxicosis occurs in extremely rare instances. These conditions are known to cause exceedingly high amounts of HCG.

A higher serum level of thyroxin-binding globulin has an indirect effect by raising the action of oestrogen through more complex pathways. The thyroid gland cells' oestrogen receptors are what cause the direct action. Nuclear intracellular receptors called ER and ER are present in both healthy and cancerous thyroid cells. Cell proliferation is boosted by estradiol binding to ER, while ER suppresses these effects and triggers apoptosis. In contrast to normal thyroid cells, malignant thyroid cells express ER at varied levels, according to some recent investigations. There have also been reports of oestrogen DNA adducting and abnormal oestrogen metabolism in thyroid cancer patients. An association between ER expression and the illness severity at presentation and throughout recurrence was postulated by another investigation.

2.1.2 Pregnancy's impact on the prognosis of thyroid cancer

A distinct thyroid lesion that differs radiologically from the surrounding parenchyma is referred to as a thyroid nodule. The number and size of nodules that already exist as well as the number of newly emerging nodules linked to thyroid nodular diseases increase during pregnancy (). When detected during or within a year after childbirth, differentiated thyroid carcinoma (DTC), which is associated with pregnancy, is considered to have occurred.

Pregnancy and its potential to impact the prognosis of DTC or cause a relapse in a patient who has already undergone therapy have been studied. This is an important query. The literature has addressed the relationship between pregnancy and thyroid cancer in detail. To make a final determination, a 2011 systematic review revised four important studies to evaluate the effect of pregnancy on overall survival, illness persistence, and recurrence. Each of these studies had different primary findings: the second focused on overall survival; the third on death and recurrence related to thyroid cancer; and the fourth on recurrence or persistent disease. The third experiment found no increase in the chances of disease-related death or recurrence; however, the final study found a connection between chronic or recurrent illness and pregnancy.

Because the included studies' primary outcomes differed and their methodology was uneven, a meta-analysis could not be carried out. The final trial's use of various outcome measurement predictors—which was more sensitive than the previous trials—was attributed by the authors to the difference in outcomes. This is accurate for DTC, but for micro papillary thyroid cancer carcinomas, which have a maximum diameter of 10 mm, a small retrospective study evaluated the effect of pregnancy. One study suggests that during pregnancy, its size may increase.

2.1.3 Artificial Intelligence

ANNs, or artificial neural networks, are flexible artificial systems that mimic the functions of the human brain. These systems possess the ability to modify their internal structure in reaction to a function's goal. They work especially well with nonlinear difficulties, since they can reproduce the fuzzy rules determining the optimal solution for this kind of problem. The essential parts of an ANN are the connections and nodes, sometimes referred to as processing elements (PE). Every node has an output that it uses to interact with other nodes or the outside world, and an input that it uses to receive messages from these sources. Finally, each node has a function f that it uses to convert its own global input into output. (Fig. 1).

Each link is defined by the extent to which pairs of nodes are suppressed or active. Excitatory or inhibitory connections are represented by positive or negative values, respectively. The connections amongst the nodes may alter over time.

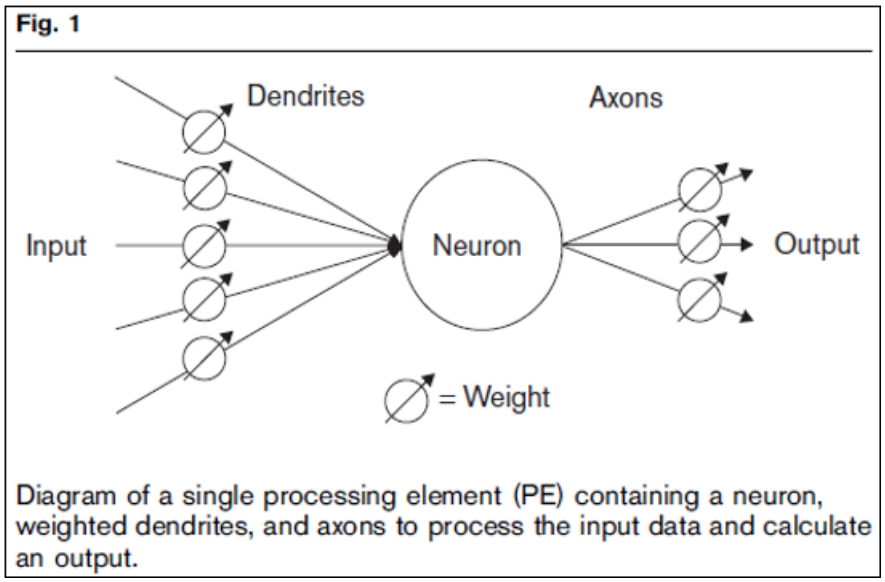


Figure 1: Diagram of a single processing element (PE) containing a neuron, weighted dendrites, and axons to process then input data & calculate an output

This dynamic causes the entire ANN to start learning. Nodes adjust to their surroundings through a process known as the "Law of Learning." The overall dynamic of an ANN depends on time. For the ANN to modify its own connections, the environment needs to interact with it more frequently. Data comprise the environment of the ANN. Thus, the learning process is one of the core characteristics of ANNs, which are thought of as adaptive processing systems. The learning process is a way of adjusting an ANN's connections to the data structure of the environment and, consequently, a way of "understanding" the environment and the relationships that characterize it.

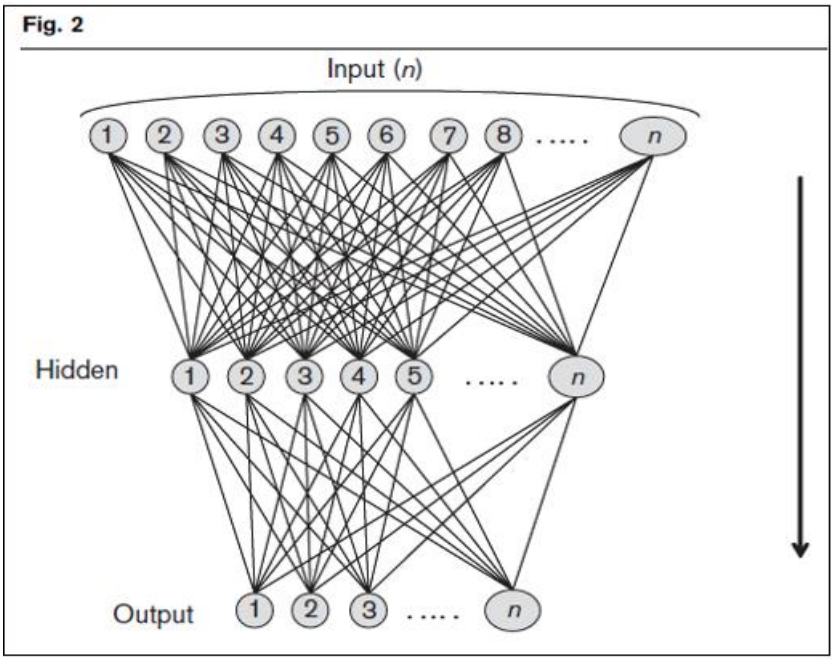


Figure 2: represents the most popular architecture of neural networks: back propagation

Neurons can be topologically structured in any form (e.g., as one- or two-dimensional layers, three-dimensional blocks, or more-dimensional structures), depending on the kind and volume of input data. ANNs that are most widely used consist of a "feed forward topology." Generally, the number of PEs integrated into an input layer depends on the number of input variables. One or more hidden layers functioning inside the ANN receive the data. The output layer is the last part of this system and provides the result. The output layer has a single PE, regardless of whether the result is a single number or a binary value.

Every PE inside the ANN is connected to other PEs nearby. The neural network type may affect the techniques employed to establish these connections. Each of these connections has a "weight" that affects the value of the input or output. The values of these connection weights are set during the training process. These abilities form the basis of the ANN's learning potential. It is important to understand that there are no explicit categorization rules in the algorithm. All the network does is identify and classify input patterns in samples.

2.1.4 Properties of artificial neural networks

ANNs are robust classifiers that possess a high degree of pattern recognition-like abilities, which are necessary for pattern identification and decision-making. This allows them to generalize and make decisions from large and generally ambiguous input data. ANNs are modeling approaches that are particularly good at tackling nonlinear problems. In theory, a system is considered simple if the function employed to represent it is linear, in which case the two equations that follow hold true:

$$f(cx) = cf(x)$$

and

$$f(x1+ x2) = f(x1) + f(x2)$$

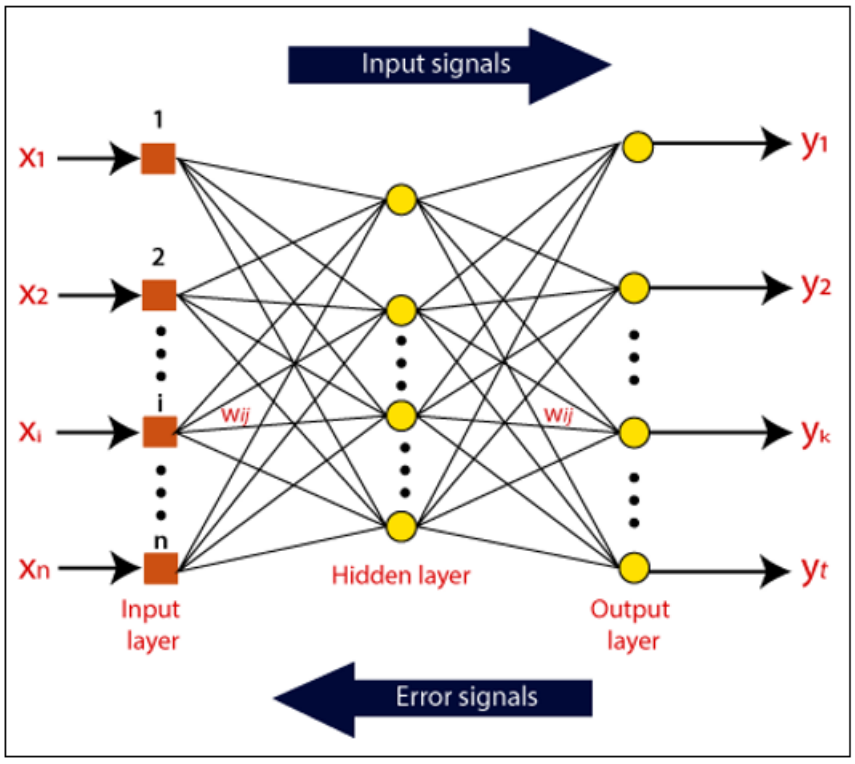
A nonlinear, complicated system breaks one or both requirements. In short, using an artificial neural network (ANN) to try and decipher the rules, R, that control the behaviour within the black box is more beneficial the more nonlinear the function y=f(x) is.

2.1.5 Artificial neural networks uncover a problem's hidden rules:

ANNs are data processing systems that, instead of processing data in accordance with preset rules, utilize the data they receive to learn the rules governing them. As a result, ANNs are particularly useful for solving issues for which we have the necessary data but are unclear about how to relate it.

2.1.6 Artificial neural networks can recognize, anticipate, and generalize:

Once trained with proper data, an artificial neural network (ANN) can learn the latent rules governing a given event and can suitably generalize to data it has never seen before.



2.1.7 Methodology

Thyroid Cancer during Pregnancy prediction using Artificial Intelligence & Machine Learning

Data collection: of the women impacted with Thyroid Cancer during Pregnancy from 2020 till 2022 such as Patients Demography, Family medical history, patient medical history, Lifestyle, Eating pattern etc.

- Medical history of the patients and of the family members will be collected from Hospitals, Path labs etc.
- Lifestyle and Eating details will be collected via survey.

Model Building: The data collected will be used to train a Neural Network based predictive model which will be used

for forecasting the side effects in terms of Obesity development due to Hormonal changes 12 months in advance.

- The data collected in the initial step will be placed in the Drives.
- The Neural Network model will be developed on Google Collab
- The data collected in the initial stage will be used for developing the model.

3. Results

Prediction: Trained model developed will be used for forecasting the probable development of Thyroid Cancer during Pregnancy in women 12 months in advance to initiate the course correction

4. Discussion

Pregnancy is the second most common time for thyroid cancer diagnoses. In this instance, treating thyroid cancer means managing the disease, addressing hormonal issues following thyroidectomy, and reducing the risk that the mother's hypothyroidism would harm the fetus. The cornerstone of care for patients with thyroid cancer is a thyroidectomy, either full or almost full. As an adjuvant therapy, radioactive iodine is then given in cases of differentiated thyroid cancers. of thyroid hormones through stimulating the thyroid gland in the mother (1) and influencing TSH receptors. Thyroid-stimulating hormone (TSH) levels during pregnancy indicate physiological changes in the mother's thyroid hormones, which decrease during the first trimester and then peak just before delivery. By stimulating the mother's thyroid gland (1) and binding to TSH receptors, the placenta's high quantity of -human chorionic gonadotropin (-hCG) stimulates the thyroid's hormone synthesis.

It is totally not recommended to administer radioactive iodine while a pregnant woman is. In the course of managing a pregnancy-related case of thyroid cancer, it is imperative to address issues related to surgical scheduling, the impact of pregnancy on the prognosis of the condition, and the monitoring of these women.

This study will review relevant literature on this clinical condition in order to address issues about how best to handle such patients. The mother's thyroid hormones undergo physiological changes during pregnancy (5), with a decline in the first trimester and a return to normalcy just before birth when TSH levels are measured. The reason for this is because the placenta produces a lot of hCG, or human chorionic gonadotropin, which interacts with TSH receptors to enhance the synthesis of thyroid hormones by stimulating the activity of the mother thyroid gland.

5. Conclusions

Prediction: Trained model developed will be used for forecasting the probable development of Thyroid Cancer during Pregnancy in women 12 months in advance to initiate the course correction

Use of AI tools declaration
The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Acknowledgments (All sources of funding of the study must be disclosed)
Not Applicable

Conflict of interest
Not Applicable

References

[1] Anas Taha, Baraa Saad, Stephanie Taha-MehlitzVincent Ochs,Joelle El-Awar, Mohammed M. Mourad ,Katerina Neumann, Christine Glaser, Robert Rosenberg , Philippe C. Cattin (2024) Analysis of artificial intelligence in thyroid diagnostics and surgery: A scoping review. *The American Journal of Surgery,* 229, P54-64.

[2] Muhammad Nazrul Islam, Sumaiya Nuha Mustafina, Tahasin Mahmud & Nafiz Imtiaz Khan (2022) Machine learning to predict pregnancy outcomes: a systematic review, synthesizing framework and future research agenda. BMC *Pregnancy and Childbirth* volume 22, Article number: 348.

[3] Daniela Mennickent, Andrs Rodríguez,Andrés Rodríguez, Ma. Cecilia Opazo,Ma. Cecilia Opazo, Claudia A. Riedel,Claudia A. Riedel, Erica CastroErica Castro8Alma Eriz-SalinasAlma Eriz-Salinas Javiera Appel-RubioJaviera Appel-Rubio1Claudio AguayoClaudio Aguayo1Alicia E. Damiano,Alicia E. Damiano,Enrique Guzm n-Guti rrez, Enrique Guzmán-GutiérrezJuan Araya,Juan Araya.(2023). Machine learning applied in maternal and fetal health: a narrative review focused on pregnancy diseases and complications. *Front Endocrinol* (Lausanne). 14: 1130139.

[4] Muhammad Javed I, Zeeshan J, Haleema S, Ijaz A. Q, Asma I, Rais A, Kausar M, Shahid R, Asif A, Raffaele P & Javad S-Rad (2021). Clinical applications of artificial intelligence and machine learning in cancer diagnosis: looking into the future *Cancer Cell International* volume 21, Article number: 270.

[5] Gibelli B, Zamperini P, Proh M, And Giugliano G (2011). Management and follow-up of thyroid cancer in pregnant women. *Acta Otorhinolaryngol Ital.Dec*; 31(6): 358–365.

[6] Christopher W. R and Kristien B. (2020) Thyroid Nodules and Thyroid Cancer Prior To, During, and Following Pregnancy. *Maternal-Fetal and Neonatal Endocrinology*, Pages 317-327.

[7] Syed Ali I and Murali R (2011) Management of Differentiated Thyroid Cancer in Pregnancy. *Journal of Thyroid Research* January 20112011(2):549609 DOI:10.4061/2011/549609.

[8] Prof Sui P, Yihao L, Weiming L, Longzhong L, Qian Z, Prof Hong Y, et al. (2021) Deep learning-based artificial intelligence model to assist thyroid nodule diagnosis and management: a multicentre diagnostic study. The Lancet digital health. April 2021, VOLUME 3, ISSUE 4, E250-E259.

[9] Debottama D, M. Sriram I, Mohammad S. M, Jeffrey J. R & Mahmoud A. (2024) Deep learning for thyroid nodule examination: a technical review. Journal: *Artificial Intelligence Review* https://doi.org/10.1007/s10462-023-10635-, № 3

[10] Maksymilian L, Bartłomiej L, Agnieszka M, Szymon B, Jerzy R, and Krzysztof K (2023). The Use of Artificial Intelligence in the Diagnosis and Classification of Thyroid Nodules: An Update. *Cancers* Feb; 15(3): 708.

[11] Lakshmi N, Joseph M P, Cornelius J F. (2023). Artificial intelligence in the diagnosis of thyroid cancer: *Recent advances and future directions.* 4(1): 1-10 [DOI: 10.35713/aic.v4.i1.1].

[12] Jingmei T, Xiaojuan S, and Heqin S. Am J T (2023). Artificial intelligence technology enhances the performance of shear wave elastography in thyroid nodule diagnosis. Res. 2023; 15(10): 6226–6233.

[13] Artificial Intelligence for Thyroid Disorders: A Systematic Review May 2022 SINTECH (*Science and Information Technology*) Journal 2(2) May 20222(2), DOI:10.31763/sitech.v2i2.694.

[14] N. H. Patil, S. H. Patel, and S.D. Lawand (2023). Research Paper On Artificial Intelligence And It's Applications. *Journal Of Advanced Zoology* 44(S8)

[15] Yassine H, Yassine H, Hamza K, Abdelkrim B, Shadi A, Ammar C, Abdelmalik Ouamane , Wathiq Mansoor (2023) AI in Thyroid Cancer Diagnosis: Techniques, Trends, and Future Directions by 2. 11(10), 519; https://doi.org/10.3390/systems11100519.

[16] Wen-Juan T, Shao-Hong W, Mei-Qing C, et al. (2023) Integration of Artificial Intelligence Decision Aids to Reduce Workload and Enhance Efficiency in Thyroid Nodule Management.6(5):e2313674. doi:10.1001/jamanetworkopen.2023.13674.

[17] Damien G, Pradeep D, Sanja S, Evgenija H. (2022) Artificial intelligence and thyroid disease management: considerations for thyroid function tests, *Biochemia Medica* 32(2), June 202232(2), DOI:10.11613/BM.2022.020601,

[18] Chun-Li C, Qiao-Li L, Jin T, Li-Nan S, Wen-Xiao L, Ya Xu, Jing Cheng, Ting-Ting Du, Jun L, and Xin-W (2023). Artificial intelligence in thyroid ultrasound. *Front Oncol*. 2023; 13: 1060702. Published online May 12. doi: 10.3389/fonc.2023.1060702.

[19] Anas T, Baraa S, Stephanie Taha-M , Vincent O , Joelle E , Mohammed M. M , Katerina N, Christine G , Robert R , Philippe C. C (2024) Analysis of artificial intelligence in thyroid diagnostics and surgery: A scoping review.. *The American Journal of Surgery,* Volume 229, Pages 57-64.

[20] Xiaobin Z (2024). Global research on artificial intelligence in thyroid-associated ophthalmopathy: A bibliometric analysis. *Advances in Ophthalmology Practice and Research*. Volume 4, Issue 1, February–March, Pages 1-7.

[21] Lerina A, Mario Luca B, Marta C, Martina I , Paolo Emidio M , Immacolata Cristina N , Chiara V (2021). Thyroid Disease Treatment prediction with machine learning approaches. *Procedia Computer Science* Volume 192, Pages 1031-1040.

[22] Siqiong Y, Pengcheng S, Tongwei D, Fang D, Yun W, Weituo Z, Hui L (2023). Human understandable thyroid ultrasound imaging AI report system — A bridge between AI and clinicians. 7. VOLUME 26, ISSUE 4, 106530, APRIL 21,

[23] Ambika Gopalakrishnan U and Usha V. Menon (2011) Thyroid disorders in India: An epidemiological perspective. *Indian J Endocrinol Metab*. Jul; 15(Suppl2): S78–S81.doi: 10.4103/2230-8210.83329

[24] Layal C, Salman R, Isabela M. Bensenor, Fereidoun A, Elizabeth N. Pearce & Robin P. Peeters (2022). Hypothyroidism. *Nature Reviews Disease* Primers volume 8, Article number: 30.

[25] Won Sang Y, Sollip K, Young Joo P, Sang Hoon S, Kyunghoon L, Eun Kyung L, Jehoon L, Ho-Young L, Yun Jae C, Hyun Kyung C, Jin Chul P, Minje H and Ho-Cheol K (2023). Comparison of Thyroid-Stimulating Hormone Results from Eight Different Reagents and Assay-Specific Korean Reference Interval for Subclinical Hypothyroidism Treatment. *Int J Thyroidol* 16(2):166-174.

[26] Prof. Neha Saini (2023). Research Paper on Artificial Intelligence & Its Applications. Ijrti | Volume 8, Issue 4 | Issn: 2456-3315.

[27] Artificial Intelligence, Anant Manish Singh, Wasif Bilal Haju, DOI Link: https://doi.org/10.22214/ijraset.2022.44306.

[28] Christopher C, Denis D, Kieran C, Patrick M. Artificial intelligence in information systems research: A systematic literature review and research agenda (2023). *International Journal of Information Management*, Volume 60, October 2021, 102383.

[29] Olaf ZR, Victoria I. M, Melissa B & F (2019) Systematic review of research on artificial intelligence applications in higher education – where are the educators? Gouverneur *International Journal of Educational Technology in Higher Education volume* 16, Article number: 39.

[30] Brie K and Oscar L (2021), Artificial Intelligence in Thyroid Fine Needle Aspiration Biopsies. *Acta Cytologica*. 65 (4): 324–329.