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Artificial Intelligence for Thyroid Disorders: A Systematic Review

Rosyid Ridlo Al Hakim [a,1,*], Muhammad Haikal Satria [a,2], Yanuar Zulardiansyah Arief [a,b,3], Antonius Darma Setiawan [a,4], Agung Pangestu [a,5], Hexa Apriliana Hidayah [c,6]

[a] Jakarta Global University, Grand Depok City Jl. Boulevard Raya No. 2, Depok 16412, Indonesia
[b] Universiti Malaysia Sarawak, Datuk Mohammad Musa Street, Sarawak 94300, Malaysia
[c] Universitas Jenderal Soedirman, Jl. Dr. Soeparno No. 63, Purwokerto 53122, Indonesia
[1] rosyidridlo@student.jgu.ac.id ; [2] haikal@jgu.ac.id; [3] yanuar@jgu.ac.id; [4] a.darma.setiawan@gmail.com; [5] agungp@jgu.ac.id; [6] hexa.hidayah@unsoed.ac.id
* Corresponding Author

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ABSTRACT

The thyroid gland plays a very important role in hormonal regulation in the human body. If the thyroid gland has a disorder, it can affect the performance of body functions. The development of artificial intelligence technology today allows an expert such as a doctor to be helped by his work. One of the important roles of artificial intelligence is helping doctors, among others, to diagnose a patient to determine appropriate post-diagnosis care. The study aims to shed light on the role of artificial intelligence in the treatment of thyroid disorders.

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1. Introduction

The thyroid is a gland that plays a role in various things, such as its role of laryngeal lubrication, acting as a reservoir of blood in providing flow to the brain [1]. In addition, the thyroid gland plays an important role related in hormonal regulation. If there is a problem with the thyroid gland, it can affect several body functions. Many factors can cause disorders of the thyroid gland. Thyroid disorders common in the community include hypothyroidism and hyperthyroidism [2]–[4]. Generally, if a person has a disorder in the thyroid gland, sometimes it is difficult to detect the symptoms experienced, so it is necessary to have a system that can assist doctors in diagnosing the symptoms experienced; this is because some of the symptoms that arise in patients with hypothyroidism and hyperthyroidism have similar symptoms. However, there is a possibility that the symptoms experienced can lead to thyroid disorders other than hypothyroidism and hyperthyroidism [3]–[5]. In diagnosing patients whether they have certain thyroid disorders, artificial intelligence-based systems need to be assisted so that the results of the diagnosis are correct to examine the symptoms experienced by the patient, and this is important to assist doctors in providing therapy to the results of the patient's diagnosis [4].

Medical informatics (healthcare informatics) is a computing technology that offers fast and accurate prediction, screening, and diagnosis methods to help health services [6]. One of the systems used in diagnosing a disease or health disorder based on the symptoms experienced by the patient is a branch of artificial intelligence in the form of an expert system. The expert system plays a role in helping an expert (in this case, a doctor) diagnose a patient in determining a disease or health problem. This expert system is a branch of artificial intelligence. The expert system can be used to carry out self-diagnosis based on the symptoms experienced [4], [7], [8].

This study seeks to describe the role of artificial intelligence (AI) technology and its derivative disciplines in diagnosing, treating, and treating patients with thyroid disorders. Given that, some studies that implement artificial intelligence for the health sector, including, in this case, thyroid disorders. So to facilitate the systematic review of previous studies, it is necessary to conduct a systematic review study about the implementation of artificial intelligence for thyroid disorders or diseases.

2. Method

2.1. Search Strategy

The methodology of this study refers to the study of Al Hakim et al.[9], with modified stages consisting of identification, screening, and selection. The systematic review process is carried out by searching for databases of publication results from the Scopus, Crossref, and PubMed portals. Search the database using Publish or Perish (PoP) software version 8. Inclusion criteria consisted of English scientific articles with search keywords combined with boolean logic: "*artificial intelligence OR intelligent system OR expert system AND thyroid OR hyperthyroid OR hypothyroid OR goiter OR Grave OR Hashimoto*." Especially for searches on the Crossref database, the use of "AND" logic is changed to "+." The exclusion criteria included pre-print articles, conference abstracts, comments, editorial sections, case reports or clinical reports, letters to the editor, and book chapters—the year's publication between 2017 and 2022.

2.2. Identification

Based on search keywords combined with boolean logic, the search record results (n) from the database Crossref = 28, PubMed = 47, and Scopus = 145.

2.3. Screening

The record results at the identification stage are then re-selected to match the inclusion criteria. If the scientific article is included in the exclusion criteria, it is removed from the record.

The number of recorded articles (n) was obtained from this screening stage. Crossref database = 23, with the deletion of 1 article in the form of a pre-print article, 1 article as a book chapter, and 3 articles that did not meet any criteria. From the PubMed database = 39, with deletion of 8 articles not meeting any of the criteria. At the same time, the Scopus database = 57, with 88 articles not meeting any criteria.

2.4. Selection

This stage is more about selecting whether the topic is included in the scope of this review study or not. Because the topic of coverage focuses on the implementation of artificial intelligence for thyroid disorders, it includes the implementation of software forms and algorithms, as well as the implementation of hardware and medical devices. In addition to these coverage topics, selected scientific articles in the previous stage were disqualified from being included in the review study. Duplicates from different databases also counted as one scientific article, bringing 82 selected articles. In more detail, all stages of this review study can be seen in Fig. 1.

3. Results and Discussion

3.1. Summary of Search Result

The review study results were based on the search for scientific publications on the Scopus, Crossref, and PubMed databases. 82 scientific articles were found that matched the criteria set out in this study. From these 82 scientific articles or publications, the application of artificial intelligence to thyroid disorders is very diverse (Table 1).

Table 1. Summary of scientific publications related to the application of artificial intelligence for thyroid disorders

Applied of AI	Reference
Analysis	[10]–[17]
Clinical Asessment	[18]–[21]
Detection and Identification	[22]–[29]
Diagnose	[30]–[55]
Classification and Characterization	[56]–[64]
Performance Improvement, Accuracy, and Diagnostic Evaluation (Optimization)	[65]–[82]
Treatment and Management	[52], [39], [83]–[85]
Prediction	[86]–[89]
Medical Robot	[90]
Telemedicine	[91]

The number of applied artificial intelligence for thyroid disorders is generally used to diagnose thyroid disorders (n = 26) and then followed to improve performance, accuracy, and diagnostic evaluation (n = 18). Generally, this application is based on CAD (computer-aided diagnosis) either in the form of ultrasound or other types of radiology and is also related to medical images.

Artificial intelligence (AI) in the medical field, especially diagnosing disease, is already commonly applied. AI can help a doctor or medical professional determine the type of disease based on the symptoms experienced by the patient. In some cases of infectious diseases, the contribution of artificial intelligence here is very important. In addition to preventing transmission [92] can also help doctors or medical professionals diagnose the disease so that treatment can be done immediately [8].

The role of artificial intelligence for thyroid disorders, including the types of thyroid disorders, is currently more focused on the application of the standard data system and medical image reporting of thyroid disease issued by the American College of Radiology in the form of Thyroid Imaging Reporting & Data System (TI-RADS™). In addition, the use of CAD (computer-aided diagnosis) has also been widely introduced with artificial intelligence to increase the accuracy of diagnosis or detection of abnormalities in the thyroid gland. Of course, artificial intelligence is here to improve, validate, and evaluate the standard system. Details of scientific publications which mostly dominate the application of artificial intelligence for TI-RADS and CAD can be seen in Fig. 2.

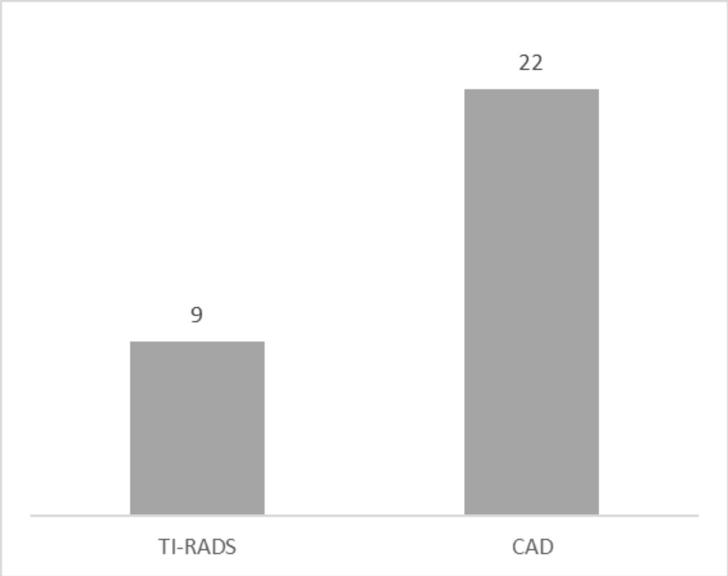

Fig. 1. Data on the number of scientific publications on artificial intelligence related to TI-RADS and CAD in diagnosing thyroid disorders.

Of the 82 scientific articles selected, 9 scientific articles were topics related to TI-RADS, and 22 scientific articles were topics related to CAD in treating or managing thyroid disorders. These two topics are trend topics that currently involve artificial intelligence technology in improving or accelerating the treatment of thyroid disorders. Although this CAD technology has been based on artificial intelligence, the existing research integrates CAD with machine learning which is part of artificial intelligence.

3.2. Applied of AI Contribute to Thyroid Disorders

Artificial intelligence (AI) contains various derivatives of its branches of science and the development of computer science technology and biomedical engineering. The application of artificial intelligence for the treatment or management of thyroid disorders is dominated by machine learning and biomedical engineering (such as CAD, medical robots, medical imagery, and other medical technologies). Fig. 2 describes the distribution of various branches of artificial intelligence in the treatment or management of thyroid disorders.

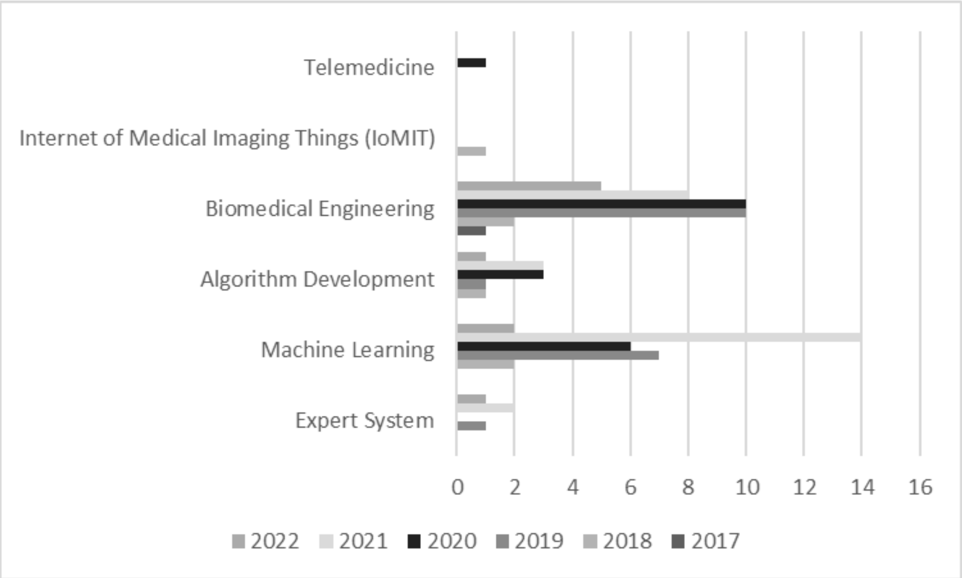

Fig. 2. Distribution diagram of the application of artificial intelligence for thyroid disorders by year of publication.

The relatively new branches of artificial intelligence, such as telemedicine and the internet of medical imaging things (IoMIT), have an important role in treating thyroid disorders. In addition, the field of expert systems, which is a relatively old branch of artificial intelligence, has begun little research. However, the development of expert systems has now been taken over by machine learning (ML).

3.3. Future Prospect

Several branches of artificial intelligence have contributed greatly to the treatment and management of thyroid disorders, such as medical analysis, clinical assessment, early detection and identification, diagnosis of thyroid disorders or diseases, classification and characterization, performance improvement, accuracy, and diagnostic evaluation image segmentation, medical technology and integrated with medical technology (CAD, robotics, IoMIT) or optimization, telemedicine, to treatment and management efforts. With the development of artificial intelligence algorithms, artificial intelligence can assist some clinical management. However, this needs to be considered in ethics and clinical assessment standards because artificial intelligence can only assist in medical treatment. In this case, doctors find it easier to carry out medical actions with the help of artificial intelligence but cannot replace the role of a doctor in medical treatment, including thyroid disorders. Several opportunities in the future with the development of artificial intelligence for the treatment of thyroid disorders may be applied in biomedical technology and accelerate detection, diagnosis, and determine the right treatment accompanied by a good level of accuracy.

4. Conclusion

Artificial intelligence and its branch to treat thyroid disorders focus on analysis, clinical assessment, early detection and identification, diagnosis, classification and characterization, optimization, treatment and management, and telemedicine. Artificial intelligence has contributed to assisting data systems and medical image reporting in thyroid disease (TI-RADS) and is being integrated into computer-aided diagnosis (CAD) in radiology. Advances in artificial intelligence technology in the future are possible to help doctors manage and manage patients with thyroid disorders by increasing performance, accuracy, efficiency, and accuracy in the treatment of thyroid disorders.

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