

# Artificial Intelligence Algorithm for Diabetes Detection: Systematic Literature Review

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## ABSTRACT

The number of diabetes sufferers increases from year to year, both in terms of number of cases and prevalence. Adults with diabetes also have a two- to three-fold increased risk of heart attack and stroke. During pregnancy, diabetes that is not well controlled will increase the risk of fetal death and other complications. Considering the link between the risk of developing complications from diabetes and the effects of death caused by this disease, early detection of diabetes is important. One way to detect diabetes is to use Artificial Intelligence for Diabetes Detection. The purpose of this writing is to identify the development of Artificial Intelligence Algorithms for Diabetes Detection. This research uses a systematic literature review using Preferred Reporting Items for Systematic Reviews (PRISMA). The results of article screening and selection found 72 potential articles that met the inclusion criteria. The research results show that with earlier detection, someone can check diabetes earlier using the help of machine learning. Before carrying out further medical checks, if the classification results show that the person is diagnosed with diabetes. One way to detect diabetes is by utilizing an Artificial Intelligence algorithm with a better level of accuracy.

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## 1. INTRODUCTION

Diabetes is a chronic disease in which the body is unable to produce or use insulin properly [1]. Insulin itself is a hormone released from the pancreas which functions to control the conversion of glucose into cells and glucose metabolism [2]; [3]; [4]; [5]. Insulin dysfunction is what initiates excess glucose in the blood, so that it is excreted in the urine [6]; [7]; [8]. The International Diabetes Federation (IDF) estimates that around 463 million people aged 20-79 years worldwide suffer from diabetes in 2019. This figure is equivalent to 9.3% of the total world population and is predicted to increase to 700 million in 2045 [9]. Indonesia itself is ranked 7th as the country with the highest number of diabetes sufferers in the world, namely 10.7 million [10].

According to the 2018 Basic Health Research, the total number of cases or prevalence of diabetes mellitus in Indonesia for those aged over 15 years is 2 percent [11]. However, this figure does not include data on people with diabetes who have not been diagnosed. The prevalence of diabetes mellitus in 2018 based on blood sugar examination results was 8.5%, an increase from 6.9% in 2013. From this research, almost all provinces showed an increase in prevalence during 2013-2018, except East Nusa Tenggara [12]. The three provinces in Indonesia with the highest number of diabetes sufferers are DI Yogyakarta, DKI Jakarta and North Sulawesi. The results of the 2018 Basic Health Research also show that only 1 in 4 people with diabetes have been diagnosed with the disease [13]. In other words, the majority of people with diabetes

in Indonesia are still unaware that they have this disease [14]; [15]; [16]. Seeing this condition, it is very important for Indonesian people to have insight into early detection of diabetes [17]; [18]; [19]. Along with the emergence of applications in the health care sector, efforts to detect diabetes have also received the help of newer technology originating from Artificial Intelligence Algorithms [20].

The Artificial Intelligence created is based on the use of algorithms that are able to learn by trial and error and improve their performance over time, not just by coding instructions, step by step based on logic [21]. Artificial intelligence is ideas for creating computer software that has intelligence so that the computer software can do work that is done by humans, in other words making a computer able to think and reason like humans [22]. The goal of artificial intelligence is to make computers smarter, understand intelligence and make machines more useful for humans [23]; [24]. Artificial intelligence can help lighten the human workload, for example in making decisions, searching for information more accurately or making computers easier to use with displays that are easier to understand. The way artificial intelligence works is to receive input, then process it and then produce output in the form of decisions. According to [25], an expert system is a process for knowing and modeling human thought processes and designing machines so that they can imitate human behavior [25]. This intelligence or intelligence can be based on knowledge and experience, so that the software developed can have intelligence. So the software must be given knowledge and the ability to reason.

From the knowledge that has been gained in finding solutions or conclusions like an expert in a specific field, artificial intelligence also offers media and tests of intelligence theory. The implementation of artificial intelligence can now be found in the health sector because one of the important medical problems is the detection of diabetes at an early stage. Current studies say that detection of diabetes in its early stages can play an important role in treatment. Simple awareness steps such as a low-sugar diet, regular physical activity and a healthy lifestyle can prevent obesity. AI finds application in the field of forecasting and quite a number of studies have been carried out on how to detect diseases. One disease that can be detected using intelligence from AI is diabetes [26]; [27]; [28]. In order to make it easier for people to detect diabetes, they developed an artificial intelligence-based prototype platform called "DIA-BEAT: Smart Eye Screening for Diabetic Retinopathy Detection [29].

The web-app-based platform is used for early detection of type 1 diabetes [30]; [31]; [32]; [33]; [34]. Type 1 diabetes is caused by the inability of the pancreas to produce insulin [35]; [36]. Generally, complicated type 1 diabetes will also cause damage to the blood vessels in the eyes [37]; [38]. The initial examination for type 1 diabetes sufferers is carried out through a taker test

## 2. METHODS

This research uses a systematic literature review method using Preferred Reporting Items for Systematic Reviews (PRISMA). Research was carried out systematically through appropriate research stages. The data provided is comprehensive, balanced and aims to synthesize relevant research results. The stages of systematic literature review research include writing the background, research objectives, formulating research questions, literature search, screening and selecting relevant articles, filtering and selecting appropriate research articles, then analyzing, synthesizing qualitative findings, and creating a research report. [34]; [35].

## 3. RESULTS AND DISCUSSION

Systematic literature review is a research method that aims to identify, analyze, evaluate all previous research results. The research results that have been obtained are in accordance with the research stages that have been carried out.

### 3.1. Formulate research questions

The results of the formulation of research questions related to the Artificial Intelligence Algorithm for Diabetes Detection: Systematic Literature Review can be seen in Table 1.

**Table 1.** Systematic Literature Review

Code	Research Question	Motivation
RQ1	How is artificial intelligence related to diabetes detection?	Identify articles related to the relationship between artificial intelligence and diabetes detection
RQ2	How is the development of Artificial Intelligence Algorithms?	Identify articles related to the development of Artificial Intelligence Algorithms

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RQ3	How is the development of the Artificial Intelligence Algorithm for diabetes detection?	Identify articles related to the development of Artificial Intelligence Algorithms for diabetes detection
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### 3.2. Literature Search

A literature search was carried out on relevant articles using keywords, namely Algorithms, Artificial Intelligence, Diabetes Detection, Health. Articles are collected from various databases, such as Scopus, Web of Science, and Researchgate. The strategy used to search for articles is predetermined inclusion and exclusion criteria. This aims to ensure certainty in finding the article you are looking for.

### 3.3. Screening and selection of articles

Screening and selection of articles uses inclusion criteria to direct the search and selection of English language research articles, complete articles published in international journals from 2014-2023, which are indexed in a database, and have the theme Artificial Intelligence Algorithms for Diabetes Detection. The results of screening and selection of articles using the PRISMA chart obtained 162 articles from three databases, Pubmed, Web of Science, and Scopus (Figure 1). All articles (n= 162) were logged to Mendeley Desktop version 1.19.8, and articles that were duplicates, ineligible by the automation tool, and removed. Consecutively, 90 articles were excluded for various reasons mentioned in Figure 1. Ultimately, 72 articles were proposed for review in the article manuscript. The resource persons tasked with conducting the assessment are two reviewers who work independently.

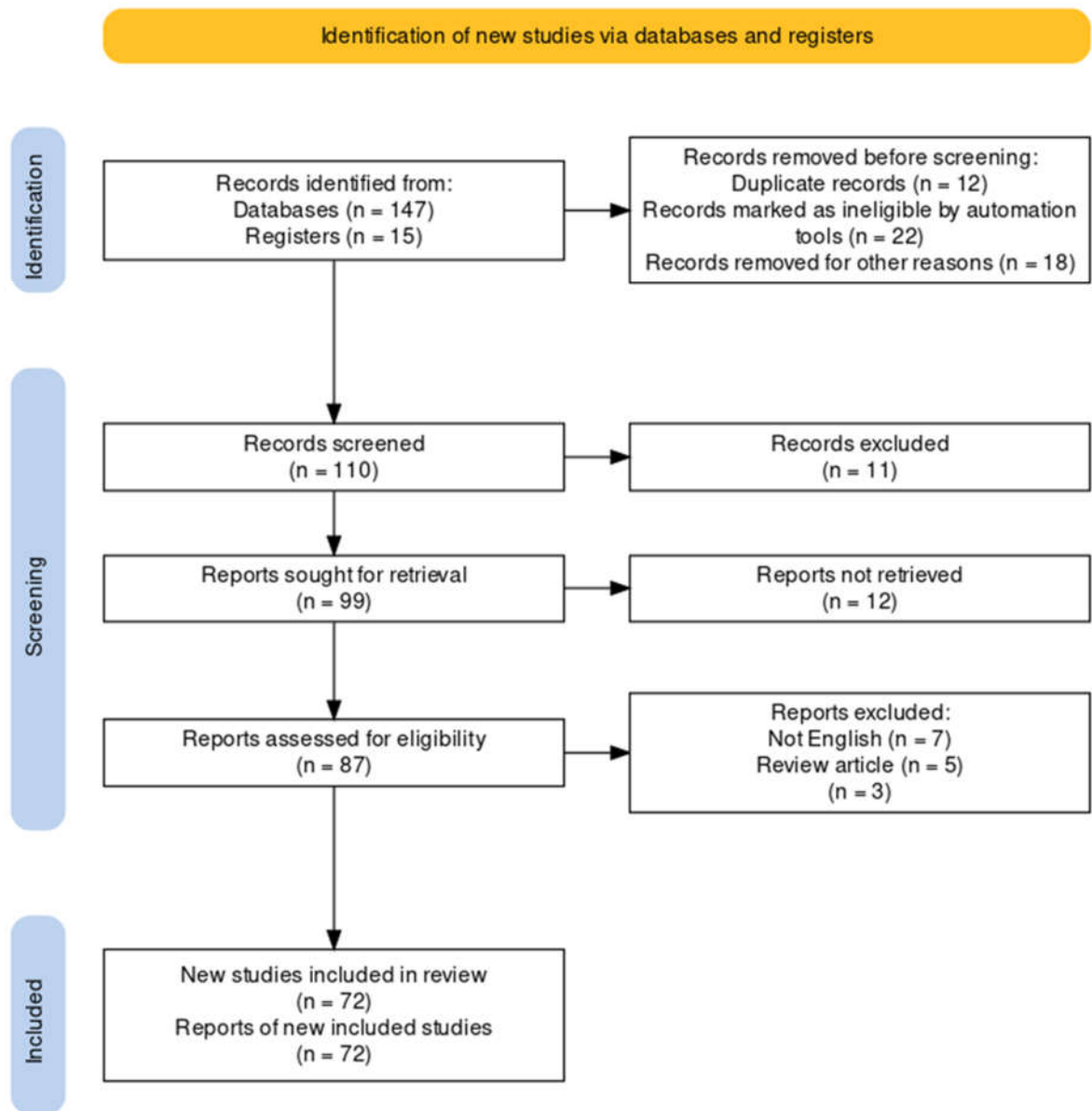


Fig. 1. PRISMA Method

### 3.4. Data extraction, primary study quality testing, and synthesis

Data extraction aims to collect data in order to answer predetermined research questions. Research quality testing plays a role in determining the interpretation of the synthesis of findings and compiling the conclusions explained. Data synthesis aims to collect evidence from selected studies to answer research questions.

A search for articles in three databases was successfully carried out and 162 articles were obtained. The results of article screening and selection obtained 72 potential articles that met the inclusion criteria. The theme "Artificial Intelligent Algorithms for Diabetes Detection" was used as the theme of the new statement from the meta-analysis of 110 articles. In this theme the author begins by discussing Diabetes. Diabetes is a syndrome characterized by increased blood glucose levels due to decreased insulin secretion [44]; [45]; [46]; [47]; [48]. Diabetes is a non-communicable disease that can affect all age groups [49]; [50]; [51]. Diabetes Mellitus can be divided into 2 types, namely, type I and type II DM. a. Type I DM or Insulin Dependent Diabetes Mellitus (IDDM) occurs due to a reduced ratio of insulin in the blood circulation due to the loss of insulin-producing beta cells in the pancreatic islets of Langerhans [52].

Type I diabetes mellitus occurs due to beta cell destruction which results in absolute insulin deficiency which is autoimmune and idiopathic [53]. b. Type II DM or Non-Insulin Dependent Diabetes Mellitus (NIDDM) is a condition where the body does not receive enough insulin, causing high blood sugar levels [54]. Type 2 diabetes mellitus occurs due to various causes, ranging from predominance of resistance accompanied by relative insulin deficiency to predominance of insulin secretion defects accompanied by insulin resistance [55]. In type 1 diabetes mellitus, the decrease in secretion is caused by damage to beta cells due to an autoimmune reaction, while in type 2 diabetes mellitus, the decrease in secretion is caused by progressive reduction in beta cells due to glucotoxicity, pototoxicity, amyloide buildup and other factors caused by insulin resistance. Diabetes sufferers will also be seen from several symptoms they experience in their daily lives.

Symptoms of diabetes that often appear are [56]: Polyuria (a lot of urination) is an early symptom of diabetes that occurs when blood sugar levels reach above 160-180 mg/dl [57]. High blood glucose levels will be excreted through urine. If the blood glucose levels are higher, the kidneys will produce large amounts of urine. As a result, diabetics often urinate in large quantities; Polydipsia (drinking a lot) occurs because a lot of urine is excreted, so the sufferer will feel excessively thirsty so they drink a lot [58]; Polyphagia (eating a lot) occurs due to a reduced ability of insulin to regulate blood sugar levels so that sufferers feel excessive hunger; Weight loss occurs because the body breaks down other energy reserves in the body such as fat [59]; [60]. The recommended blood glucose test is an enzymatic glucose test using venous blood plasma [61].

To detect diabetes based on the symptoms above, a basic blood glucose level examination is carried out. Triggers for increased blood glucose levels (hyperglycemia) in the body are pancreatic dysfunction, insulin resistance, impaired blood glucose tolerance and impaired fasting blood glucose [62]. Meanwhile, a decrease in blood glucose levels is caused by the use of insulin or oral glycemic drugs, hyperinsulinemia, endocrinopathy, liver dysfunction, chronic kidney dysfunction, the influence of pharmacological agents, surgery for neoplasms and congenital metabolic disorders [63]. Monitoring treatment results can be done using capillary blood glucose examination with a glucometer [64]; [65]. Examination results that do not meet normal criteria or DM criteria are classified into the prediabetes group which includes: impaired glucose tolerance (IGT) and impaired fasting blood glucose (GDPT). Diabetes detection cannot be separated from the development of Artificial Intelligence Algorithms [66]; [67]; [68]; [69]; [70]; [71]; [72]; [73].

Artificial Intelligence has been known since 1950, coined by Alan Turing. Alan Turing created a test called the Turing Test. The Turing Test is a test of intelligence in computer machines which shows that a human being is unable to differentiate between the answers of a machine and another human being when asked the same question.

its intelligence can be measured as equivalent to that of humans [74]. There are several goals of Artificial Intelligence, namely: making computers smarter [75], understanding intelligence [76], and making machines more useful [77]. Intelligence is the ability to learn or understand from experience, understand contradictory and ambiguous messages, respond quickly and well to new situations, use reasoning to solve problems and resolve them effectively [78]. Several expert opinions regarding the definition of artificial intelligence are: According to [79]; [80]; [81]; [82], "Artificial intelligence is a part of computer science that makes machines (computers) able to do work like and as well as humans do." According to Avron Barr and Edward E. Feigenbaum (1982), Artificial Intelligence is a part of computer science that studies (in the sense of designing) intelligent computer systems, namely systems that have the characteristics of thinking like humans. According to Rich and Knight (1991) artificial intelligence is the study of how to make computers do things that humans can currently do better. Artificial intelligence algorithms are used for data processing, calculations, testing and automatic problem solving. An algorithm is a complete transparency of a system algorithm given the reasons why the system chose it and how it can be useful for predictions [83]. That is the reason why algorithms are integrated into computers and can make systems smarter and AI is much needed in the health sector.

Healthcare is an industry that always requires making informed decisions, whether it is treatment, testing or discharge. Several AI-based techniques have been applied in diabetes care [84]. With the advent of AI, diabetes diagnosis has evolved beyond just a few measurements of blood glucose and glycosylated hemoglobin (HbA1c) levels [85]; [86]. Any negligence in the health sector can cause major harm to patients and medical practitioners [87]; [88]. It becomes a challenge for patients to believe that these decisions are made by a machine that does not explain how it reached certain conclusions. So the use of explainable AI is a must in predicting diseases which will help to gain confidence in the results of AI systems [89]; [90]. Explainable AI helps to get fair and correct results without errors. Diabetes often occurs due to modern food intake, and the body needs to monitor it. AI in Diabetes helps predict or Detect Diabetes [91]; [92].

Early detection of diabetic retinopathy using AI is a cost-effective alternative to reduce eye complications and preventable diabetes-related blindness [93]; [94]; [95]; [96]. Continuous glucose monitoring (CGM) has the potential to reduce health care costs for diabetes [97]; [98]. The use of image-based screening of retinal changes and diabetic foot ulcers can avoid delays in referral to specialty care and improve quality of life by allowing earlier and timely intervention [99].

To predict adult risk of developing type 2 diabetes, British researchers conducted a systematic assessment of 94 existing type 2 diabetes risk assessment models and assessment standards using quantitative and qualitative methods [100]; [101]; [102]; [103]; [104]; . They also select several assessment models and methods and apply them in practice. Experimental results proved the stability of most risk assessment approaches and verified these approaches in different patient groups [105]. It was found that the area under curve (AUC) value for 6 month and 1 year predictions was <0.8. This shows the feasibility of using electronic medical record data to automatically predict diabetes and identify people at high risk of developing diabetes [106]. Developed a postprandial hyperglycemia risk assessment model that can be used to identify people at high risk of developing this condition thereby ultimately reducing the number of people who have to undergo an oral glucose tolerance test (OGTT) [107]. In this regard, different scoring models should be developed for different races and AI models focusing on postprandial hyperglycemia are particularly promising to improve the efficiency of diabetes prediction [108]; [109].

There is a step by step approach to apply AI in Diabetes detection. From data selection to system implementation, Akira AI has a methodology and framework that can be applied to provide Explanations [110], such as:

- Selection of appropriate data and its preprocessing for the model.
- Appropriately select the appropriate algorithm for the system.
- Use various frameworks to make the model work transparently.
- Justify the model output and the factors on which it depends.
- To use a clear and clean implementation process.

#### 4. CONCLUSION

Diabetes is associated with various complications and significant morbidity and mortality. It is important to intervene not only to treat but also to prevent and detect diabetes in a timely manner. With technical advances in image visualization and widespread use of wearable devices, we believe that AI will play an important role in personalized lifestyle guidance and thereby help in diabetes management especially in detecting diabetes.

#### DECLARATION

##### Author Contribution

This research uses a systematic literature review method using Preferred Reporting Items for Systematic Reviews (PRISMA).

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##### Conflict of Interest

Declare conflicts of interest or state “The authors declare no conflict of interest.”

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