Comparative Analysis of Using Artificial Intelligence (AI) for Diagnosis and Treatment of Tuberculosis and Diabetes

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Abstract— **The world's epidemic and population killer are diabetes and tuberculosis. A lot of people are poorly diagnosed and untreated prior to death. These diseases cause patients slow weakening of the immune system. As the quote states, "prevention is better than cure", this is what Artificial Intelligence (AI) is to offer. AI is developed in so many applications; among them is AI in medicine and healthcare. AI compared to conventional methods of disease detection is a huge help for patients to cope up early with their sickness. With AI providing early disease detection to tuberculosis and diabetes, patients with these illnesses can prevent severe conditions of it, better yet - avoidance. Differentiating the characteristics of these illnesses, it also has its own conventional methods of testing. Tuberculosis uses sputum sampling, skin test, blood test, and Xray while diabetes is diagnosed via fasting blood sugar. AI algorithms such as Fuzzy, Support Vector Regression, Naive Bayes Classifier, Decision trees, Genetic, AdaboostM1, Random committee classifier, and many more are the ones used for the study. These algorithms' detection accuracy rates on the above-mentioned diseases were the factor of comparison in concluding and recommending for the future directives of these developments. Among those machine learning techniques, Support Vector Machine with AIRS exhibited a 92% to 100% (near-perfect-to-perfect) range in performance for Tuberculosis vs to a 83.0% accuracy in the training set and 76.9% in an independent testing set for Diabetes. Thus, proving efficacy of AI disease detection on both, yet showing accuracy dominance on Tuberculosis detection. AI in medicine and healthcare is still just a tip of the iceberg. Healthcare and engineering combined results to help mankind. Hopefully, this will be the future to prolong the lives of the human race.**

Index Terms— **world epidemic, Artificial Intelligence (AI), conventional method, early disease detection**

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I. Introduction

Artificial Intelligence (AI) was first used by John McCarthy during a workshop in Dartmouth College in which M.L Minsky, N Rochester (IBM), C.E Shannon has attended [1][2][3]. AI had its so-called depreciation era named "AI winter" wherein this caused findings for its development to decline [4]. Nevertheless, it continued its pavements in recent years where it played a huge role in the healthcare system. Health apps and wearables have become their initial diagnosis for vital health [5]. As the developments continue, AI worked its way to secure and assess patient information on various diseases. One of which is Tuberculosis (TB). TB is 1 of the 10 topmost causes of deaths worldwide [4]. TB is an airborne disease classified into two types: Pulmonary Tuberculosis (PTB) and Extrapulmonary Tuberculosis (EPTB). Exposure to an aerosolized Mycobacterium Tuberculosis causes tuberculosis [4], [6]. The common diagnosis for TB is through TB Skin Test and TB Blood Test. Other examinations include: chest X-ray and sputum sampling are evidence on determining TB on a person. Meanwhile, diabetes is also a disease which paved its way in the field of AI today. Diabetes is a metabolic, chronic disease and is a worldwide healthcare sickness [7]. Categorized into 2, which are: Type 1 as hereditary and Type 2 as caused by lifestyle - in short - obesity. This is alarming because a lot of people are poorly diagnosed and untreated prior to death [8]. Many years of planned investigations have set up that escalated treatment adequately defers the beginning and eases back the movement of diabetes-related entanglements, for example, retinopathy, nephropathy, and neuropathy [9].

Diabetes and tuberculosis are both global diseases [4], [7]. Tuberculosis is highly-contagious [4], [7]. Mistreated and mishandled, patients die due to slow weakening of the immune system- Diabetes Mellitus (DM) and Tuberculosis [10]. An early diagnosis of these is a help for individuals who suffer from it. Providing insulin therapy and anti-tuberculosis drugs will prolong the life of the patients who are diagnosed of the sickness [10], [11]. AI being available and developed in the field of medicine and healthcare can provide early detection, or better yet - prevention.

In this paper, it aims to compare, analyze and discuss the diseases: tuberculosis and diabetes with their conventional method of detection vs the developments of AI. In the current implementation of AI in medicine and healthcare, through the help of published journals, articles and writings, the study will provide brief and concise comparative statements on the detection of the aforementioned diseases. Correlate the conventional method of determining sickness to enhanced AI methods and techniques. Compare and contrast the accuracy and efficiency between the AI detection on Diabetes and Tuberculosis.

Medicine and Healthcare is obviously a need for the public. With the help of engineering, instruments used for check-ups, diagnosis, and all other operational equipment are developed and produced. AI is arguably the number one driving force of technology in the first half of this century, and will change nearly every industry, if not every human effort in general [12]. AI in the field of medicine and healthcare is only one of the many benefits technology can offer. Diseases like diabetes and tuberculosis, which are proven fatal, will be provided a better awareness through the help and contributions of AI.

II. Machine Learning and Disease Diagnosis

A. Machine Learning

Machine Learning is an AI technology which allows systems to evolve and learn based on their experiences without having to be programmed. Machine learning is concerned with creating computer algorithms that can utilize and access data to learn on their own. The aim is for computers to be able to identify themselves without the need for human interference or assistance, and to change their acts accordingly. Machine learning allows for the processing of vast volumes of information. While it normally produces more accurate and faster results in detecting lucrative chances or harmful risks, it may also mandate more resources and time to maintain. Combining machine learning with AI and cognitive technology to process large amounts of data will make it much more effective [13].

Machine learning processes are supervised or unsupervised in nature. To foretell events in the future, supervised machine learning algorithms may use classification strategies to apply lessons of the past to new data. Beginning with the study of a recognized dataset, the learning program develops an approximate function to provide predictions about performance values. The framework will equip goals for any new data followed by adequate planning. The learning algorithm may also compare its outcome with the right, expected outcome in order to identify errors and change the model accordingly. Unsupervised machine learning algorithms are used where the data used for training is neither identified nor named. Unsupervised learning examines how machines may deduce features from unlabeled data in order to illustrate a secret system. The framework does not find the correct outcome, but it provides analysis on the specifics and can give you conclusions from datasets to clarify in the system's unlabeled hidden structures [14], [15].

Since for training, they use both labeled and unlabeled data, semi-supervised machine learning programs direct somewhere between supervised and unsupervised learning. They typically use a small amount of labeled data and a large amount of unlabeled data. This approach will dramatically increase learning accuracy in systems that use it. Semi-regulated learning is often preferred when talented and valuable assets are needed to prepare/gain from the obtained named knowledge. Obtaining unlabeled data, on the other hand, typically does not necessitate additional resources [14], [15].

Reinforcement machine learning algorithms communicate with the environment by creating habits and detecting errors or rewards. The trial and error search and delayed reward are two of the most critical aspects of learning reinforcement. This approach allows machines and software agents to determine automatically its optimal actions in a component for its utmost performance. Simple reward feedback is mandated for the agent to distinguish which behavior is better; it is also named as the reinforcement signal [16].

B. Diabetes

Diabetes is a chronic disease caused by high blood sugar levels. The sugar from the ones we eat are converted into energy through the help of the insulin hormone [17]. Diabetes is divided into two distinctions: Type 1 - does not let the body emit insulin, and Type 2, being the most common - the body cannot create and put insulin into proper use [18]. Diabetes may amputate the nerves, the eyes and the kidneys, leading to complications like stroke and heart disease [19]. To identify a diabetic patient, his accumulative blood glucose level for the past 3 months (HPA1C) should exceed 7 [20].

El_Jerjawi and Abu-Naser [21] utilized Data Mining to create a simulation categorizing control level of a diabetic patient from past medical records. The authors produced a new forecasting simulation exploiting data mining processes which would categorize the control level of a diabetic patient from the history of the medical records. The study took place by using three data mining processes namely: J48, Logistic, and Naïve Bayes and utilized the WEKA application for it to be implemented. The study results in J48 were as follows: 0.54 precision average, 0.735 recall, 0.623 F-measure, and 73.5% accuracy. The Logistic process results were: 0.73 precision average, 0.744 recall, 0.653 F-measure, and 74.4% accuracy. Meanwhile, Naïve Bayes results were: 0.717 precision average, 0.742 recall, 0.653 F-measure and 74.2% accuracy. Having this, it is proved that the Logistic algorithm is the most accurate compared to the 2. The study conducted considered Type 2 diabetes only. They have neglected to acknowledge the simple discovery of suitable features and the validation of those features.

Ahmed, et al. [22], [23] produced a predictive simulation treatment plan for Type 2 diabetes exploiting data mining. The author's drive was due to the high-risk and dangerous complications brought on by the chronic disease which required amputation of one of the patients. The author produced a new simulation for categorizing Type 2 diabetes treatment plans that would help control diabetic patients' blood glucose level. The author exploited the J48 algorithm and used the 318 medical records from JABER ABN ABU ALIZ clinic, Sudan's diabetes center. The basic control data presented 5.3% for Diet, 59.1% for Oral Hypoglycemic, and 35.5% for Insulin. The WEKA application was used to create analysis. The study considered type 2 Diabetes alone, and would have been better if it also considered type 1. Also, to boost the accuracy of the system, the diet system and exercise should have been included.

Elzamly et al. [24], [25] used boosting ensemble simulation in predicting DM. Their drive was focused on treating patients with diabetes to have themselves fit into their normal lifestyle through early prediction and tracking of their state. Their intention was to forecast the diabetes types of patients through their clinical and physical data exploiting boosting ensemble processes. They utilized the boosting ensemble process whereas it uses an internal random committee classifier. The blueprint utilized was backed up by components prediction, integration, data management, and learning. The study results were as follows: 0.81 TP rate, 0.198 FP rate, 0.81 Precision, 0.81 Recall, 0.82 F-measure, and 0.82 ROC area for type 1 and type 2 diabetes. The aim of the study was to build something that could be incorporated into a chronic diseases' clinical decision support system that is cloud-based, with a feedback mechanism to enhance user satisfaction.

Sernyak made use of logistic regression evaluation to measure the odds ratio of a neuroleptic rare version and a diabetes diagnosis in each of the age groups, monitor for population impact, and diagnose diabetes [26], [27]. Thirugnanam has created developments in predicting diabetes exploiting fuzzy neural networks [28]. Hamid and his colleagues used hybrid intelligent systems to diagnose microalbuminuria in patients with diabetes type 2 without testing urinary albumin levels [29]. Javad and his colleagues suggested automatic learning on diabetes type 2 to regulate blood sugar [30].

C. Tuberculosis

Tuberculosis (TB) is a health condition problem worldwide. Estimates of about 1 billion individuals are carrying the disease globally, 10 million of which are new and 3 million die each year [31]. It refers to a disease caused by mycobacterium tuberculosis or tubercle bacilli, which are infectious agents [32]. Phthisis, Scrofula, tabes, bronchitis, and inflammation of the lungs, hectic fever, gastric fever, and lupus are some of the other names for the disease [32]. It was also known as "consumption" or "the great white plague" [33].

Microorganisms usually enter the lungs via breathing and spread throughout the body through the blood circulatory system, which is a direct extension to other organs, in this infectious disease [34]. Tuberculosis spread takes place when the aerosols is spread through air via (particles in the air from the mouth and respiratory tract) coughing, sneezing, or through any violent excretion. When a susceptible recipient inhales these particles, they infect a new patient, and the disease tends to propagate in that person within weeks to months [35]. The development of an expert diagnosing system to a person who needs medical treatment was brainstormed through the efforts of computer scientists, medical practitioners, electronics engineers, and computer engineers. Many strategies have been used to create such systems but neural networks, fuzzy logic, swarm intelligence and genetic algorithms were the most widely put-to-use in the literature as stated in [36] "The Fuzzy Expert System has proved its usefulness significantly in the medical diagnosis for the quantitative analysis and qualitative evaluation of medical data, consequently achieving the correctness of results."

The Genedia MTB/NTM Detection Kit is a PCR multiplex analyzer kit that is used to differentiate between Mycobacterium tuberculosis complex (MTBC) and nontuberculous mycobacteria (NTM). This is acknowledged because information on the recital of kit analysis up to now is minimal. The package is used to read and interpret 687 sputum samples in total. Based on the culture, 19 samples are MTBC positive and 69 (10.0%) are NTM positive. Both investigations yielded MTBC findings in every sample. The association between positive NTM and the study of NTM respiratory syndrome using genedia MTB/NTM is not important. For MTBC identification, the PCR assays indicated an analytical routine [37].

For 124 sputum models, the VereMTBTM Kit routine for identifying multidrug resistant tuberculosis (MDR-TB) has been validated. The Kit VereMTB's to identify MTBC has a 97.0% specificity and 98.3% sensitivity, in comparison to MGIT culture. Kit VereMTB has 85.7% specificity and 93.9% sensitivity for RIFs detecting resistance it has 75.0%, and for INH resistance it has 95.7% detection, as compared to MGIT DST. NTM models were correctly identified in 6 instances. In sputum models, the Package VereMTB easily and reliably recognizes MDR TB [38].

Tuberculosis is diagnosed using standard approaches such as culture and smear. The cell's diameter varies at an interval of 0.3 and 0.5 µm, and it is also classified as a rod-shaped bacilli. This bacteria has a slow growth rate and is classified into groups such as positive gram and acid form with quick bacillus [39]. Pressure in the abdomen, cough lasting longer than 3 weeks to a month, immense fever and night sweats, weight loss, pallor, and weakness are all signs of tuberculosis. When an infected person sneezes or coughs, tuberculosis spreads to the healthy person [40]. Tuberculosis bacteria have a cell wall with a massive acid layer called mycolic acid [41].

Jaramillo et al. stresses the importance of creating a device that can identify tuberculosis-related biomarkers and provide a rapid diagnosis so that care can begin right away. As potential bio-receptors, a piezoelectric immunosensor was developed for rapid and effective tuberculosis detection. In combination with functionalized quartz crystals, The immune reagents obtained will be used as particular recognition bioactive molecules in the construction of a piezoelectric immunosensor for the identification of biomarkers linked to Mycobacterium tuberculosis [42].

Manual disease detection, according to M.K. Osman, is a laborious, time-consuming, and repetitive operation. Image processing and artificial intelligence with a neural network approach are utilized to isolate and classify bacilli in tissue parts with tuberculosis detection. The following procedures were followed: in Ziehl-Neelsen staining after satin images were seized for bacilli for specimens, cluster method like K-means was put-to-use for tissue extraction and tuberculosis bacilli, and finally geometric features were considered. This research used an experimental approach to obtain a result that is more efficient and accurate in identifying tuberculosis-causing bacteria in tissue [43]. Multiple methods are used to diagnose tissue with tuberculosis, according to Osman, and weaknesses of the existing method are used to detect tuberculosis. A non-invasive strategy has been discovered in which the properties of electricity are projected to increase its speed and eliminate complexity in the mycobacterium TB analysis process.

II. Methodology

A. Distribution of Papers by Journals

Previous useful papers were extracted and remembered in this review. Most of these articles contain relevant and informative data about the diseases, tuberculosis and diabetes. The literature search was performed using keywords such as: "artificial intelligence", "machine learning", "disease prediction", "tuberculosis", and "diabetes" based on predefined questions and goals.

To perform the analysis, 50 respected journals were chosen to serve as reference. Table 1 contains the list of the publishers that were chosen, with its number of citations and its percentage of the total. IEEE, IJASEIT, RSNA, Elsevier, and Science Report, all ranked first with 6%.

Table I
Distribution of Papers

Publisher	Article	Percentage
IEEE	3	6%
International Journal on Advance Science Engineering and Information Technology	3	6%
RSNA	3	6%
Elsevier	3	6%
Science Report	3	6%
Global Journal of Computer Science & Technology	2	4%
AI Magazine	2	4%
Prentice-Hall, Englewood Cliff	1	2%
Lulu Press	1	2%
New England Journal of Medicine	1	2%
Springer Link	1	2%
Neural Networks	1	2%
Now Publisher	1	2%
MIT Press	1	2%
Simon and Schuster	1	2%

Biological Psychiatry	1	2%
Diabetes research and clinical Practice	1	2%
Journal of Computer Science	1	2%
International Journal of Hybrid Information Technology	1	2%
Journal of Theoretical and Applied Information Technology	1	2%
International Journal of Engineering and Computer Science	1	2%
Procedia Engineering	1	2%
The American Journal of Psychiatry	1	2%
International Diabetes Federation	1	2%
International Journal of Medical Science	1	2%
International Journal of Applied Science	1	2%
Journal of Diabetes & Metabolic Disorder	1	2%
International Journal of Computer Application	1	2%
Annals of Laboratory Medicine	1	2%
PLoS One	1	2%
Journal of Clinical Microbiology	1	2%
The American Journal of Medicine	1	2%
International Conference on Global Trends in Signal Processing, Information Computing and Communication	1	2%
Advance Informatics for Computing Research	1	2%
Eye Mag	1	2%
Science Direct	1	2%
International Journal of Soft Computing	1	2%
Journal of Bacteriology	1	2%
Total	50	100%

B. Study Selection and Paper Eligibility

The findings from 50 articles were taken into account in this segment. The journals were selected or considered based on requirements for inclusion and exclusion. Only eligible articles and chapters from books, theses, and summary reports were chosen based on the exclusion criteria. The following requirements were considered for inclusion: the author's reference, the year of publication, the concept of artificial intelligence, tuberculosis and diabetes; their forms and complications, goals, and the type of machine learning methods used.

C. Extraction and Summarizing Data

In order to make the required classification, inspection, and integration of the included articles in light of the current requirements, a form was established. The data extraction form that was generated was extremely helpful in achieving the desired results and drawing an acceptable conclusion. The author's reference, year of publication, whether it was published in a journal or a conference proceeding, the concept of artificial intelligence, tuberculosis and diabetes; their forms and complications, goals, a research error, and the type of machine learning methods used were all considered. The analysis was performed by carefully analyzing all of the articles that were chosen, with the articles that applied artificial intelligence, machine learning, and diseases such as tuberculosis and diabetes being retained.

III. Results and Discussion

This research was carried out to investigate the effect of Artificial intelligence on the diagnosis of Diabetes and Tuberculosis. Just a few evaluation analysis papers have been published to assess how powerful AI approaches are in the healthcare system. While technology improves and widens its horizons, the objective of AI has changed drastically from predictive algorithms to CADx System and deep learning (CNN) [4]. A new machine learning method for tuberculosis diagnosis has been offered [24]. This method is a mix of fuzzy and data reduction phase, with a classification precision of 99.70% obtained via 10-fold cross validation. There have been some predictive algorithms implemented in Machine learning for tuberculosis and diabetes diagnosis. These algorithms have been identified and enhance the accuracy of the models. Fuzzy logic, Genetic algorithms, and Artificial systems have also been used in different combinations. Table 2 shows the summary of findings based on research goals.

Table II.
Summary of Findings

Citation Number/ Year Published	Research goals	Methodology	Findings	Accuracy of AI
[4] 2019	To explain the various AI methods used in the diagnosis of tuberculosis	Fuzzy algorithms, Support Vector machine, Naive Bayes Classifier, Decision trees, and Genetic algorithms	Research results the high accuracy of the different algorithms used in determining TB	94.50%
[7] 2020	Assist in the transformation of diabetes treatment through AI from traditional management to building tailored data-driven precision care.	Support Vector Regression, Machine and deep learning, Case-based reasoning, and artificial neural network	The development of prediction models to estimate the risk of diabetes and its complications is aided by AI.	80.84%
[12] 2014	To evaluate the techniques of a real set data and prediction accuracy based on experiments performed	AdaboostM1 algorithm, Random committee classifier	Proposed a novel ensemble method to predict the types of diabetes of patients.	81.00%
[21] 2018	To develop a predictive simulation for type 2 diabetes treatment plans exploiting data mining	Data mining algorithms, J48 algorithms, and WEKA application	Classify the type 2 diabetes patients treatment plans in aiding them control their blood glucose level	70.80%
[24], [25] 2015 2017	The aim of the Fuzzy Logic based Diabetes diagnosis method is to demonstrate the significance of the urine parameter for diabetes diagnosis and the accuracy of the fuzzy verdict mechanism.	Fuzzy Logic Based Diabetes Diagnosis System, Fuzzy Verdict Mechanism	The fuzzy verdict process applies the rule to decide whether or not a person has diabetes and then provides a summary of the outcome.	94.00%
[29] 2014	Learning automata theory is used to predict the required insulin dose and to record the patient's history in Gaussian probability parameters	Learning automata-based mechanism, Gaussian Probability distribution function,	Illustrates that the algorithm performs the optimal insulin dose and the proposed glucose control method is efficient in treating type 2 diabetes	90.00%
[30] 2014	Aim at TB diagnosis with the use of hybrid machine learning	Artificial immune recognition system and Fuzzy logic controller	This procedure provides better diagnostic outcomes in terms of detection precision as compared to other observational methods.	10-fold cross validation 97.45% Neural networks 95.08% Neuro-fuzzy 96.00%
[34] 2011	To develop a Neuro-fuzzy technology for tuberculosis detection	MATLAB 7.0 Fuzzy and Neural toolbox	Based on the rules of the Neuro-fuzzy system, it clearly envisions the relationship between various I/O.	TB meningitis 51.00%

[37] 2020	The sensitivity and specificity of the VereMTB Detection Kit for MTBC detection are comparable to that of MGIT culture	BACTEC MGIT 960 culture and VereMTB Detection Kit test	The VereMTB Detection Kit demonstrated high sensitivity in detecting MTB, RIF, and/ or NIH resistance TB from sputum specimens, as well as detecting and identifying NTM in the same test.	VereMTB Detection Kit sensitivity 97.00% specificity 98.30% MGIT DST sensitivity 85.70% specificity 75.00%

IV. Conclusions

AI compared to the conventional method of providing patient information, specifically in disease detection, gives us the same results. This proves the efficiency of AI in its progressing studies. AI provides accurate and efficient results, while our conventional methods provide accuracy alone. With AI still being developed, test kits of these diseases might give us results of less than a minute, which might be the most efficient. Providing early detection can be a huge saving factor for these diseases. TB, being an infectious disease and is proven contagious, can save others from contamination. Diabetes being a silent killer, since it will show no symptoms, can save the patient from continuous spread of the disease through AI's fast detection.

In comparison of the two diseases, AI detection on TB is more efficient and accurate vs the current AI developments on Diabetes. Tuberculosis accuracy rates using a Support Vector Machine with AIRS range from 92% to 100%, while diabetes prediction accuracy rates were 83.0% in the training set and 76.9% in an independent testing set, making it superior to traditional fasting glucose monitoring.

AI developments on TB are vastly improving compared to the current studies on Diabetes AI applications. Consequently providing rapid results of testing for TB patients as compared to Diabetes patients. Faster aid has been possible through the application of AI has been observed in TB patients than in Diabetes patients.

V. Recommendations

As part of a development in the study, since Tuberculosis overrules Diabetes in terms of accuracy in detection and diagnosis, the researchers recommend an intensive experiment and sampling to determine the lapses in its accuracy. Considering that TB results in a near-perfect-to-perfect detection and diagnosis by the use of AI, it reaches its peak in determining and treating its patients accordingly. For Diabetes, there are still more rooms for improvement. Diabetes studies as stated are only limited to determine type 2. There are still no studies which are affiliated in determining type 1, which is a call for improvement in the field of study.

Second thing to consider is having these results via cloud, a development calling for everything to be digital and web-based. This improvement helps patients to be more engaged with themselves on how to be more cautious and live a healthier lifestyle since the results are always accessible online. This results in better awareness of the health of a person.

Lastly, through the efforts of the medical practitioners and the AI developers, advised medications, instructed health undertakings, and the necessary do's and dont's for a patient shall be also provided through the web-based interface. This promotes awareness, better health monitoring and time efficiency. Consequently providing immediate response for the patients and prolonging the lifeline of an individual.

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