www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 6 Issue 9 September 2017, Page No. 22398-22315
Index Copernicus value (2015): 58.10 DOI: 10.18535/ijecs/v6i9.03

A Systematic Literature Review on Diabetes Diagnosis Management System (DDM-SYS)

F.M. Okikiola[1*], A.M. Mustapha[2], O.A. Akinade[3], E.O. Adeleye[4], C.Y. Alonge[5]

[1,3,4,5] Department of Computer Technology,
Yaba College of Technology, Lagos, Nigeria,
sade.mercy@yahoo.com[1], akinadetoyin2811@gmail.com[3], thelordsdoing_14@yahoo.com[4], yettykitan2@yahoo.com[5]
[2] Department of Computer Science,
Federal University of Agriculture,Abeokuta,Ogun State,Nigeria.,
abiodunmustapha11@gmail.com

Abstract: ***Diabetes mellitus has been a deadly and widespread disease majorly in Africa and Asia. A number of approaches have been employed in diagnosing this disease to provide awareness to patients who may have such. Several research work have been publishes and presented to look into a management system for its diagnosis. Some crucial elements are yet missing from some of these literatures. However, few reviews have been centered on this systematically and thoroughly, that is, none have performed review systematically capturing the entire crucial elements such as diabetes type addressed, control recommendation considered, main contributions and approach strengths. This have brought about the lack of sufficiently good context of operation. In this paper, we carried out a systematic review of existing literature concerning diabetes diagnosis management system in so as to present a summarized evidences regarding the issue and background for positioning new research activities appropriately.***

Keywords: Diabetes mellitus, Chronic disease, Diagnosis, Treatment, Glucose**.**

1. Introduction

Diabetes mellitus is a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbances of carbohydrate, fat, and protein metabolism; resulting from defects in insulin secretion, insulin action, or both [1]. Characteristic clinical features of the disease include glycosuria, polyuria, and polydipsia. Glucose spill-over in urine (glycosuria) occurs when renal threshold for glucose reabsorption is exceeded. This causes osmotic diuresis (polyuria), which results in increased dehydration and thirst, with increased drinking or polydipsia [2]. Weight loss in diabetes mellitus also occurs due to an increased breakdown and reduced synthesis of proteins. In the absence of insulin in acute conditions, diabetic ketoacidosis results and can lead to stupor, coma, and death. Chronic uncontrolled hyperglycemia progressively leads to the development of complications such as retinopathy, neuropathy, macro- and micro vascular diseases. There is currently a large body of supporting literature which states that setting performance goals has a positive effect on individuals and groups, particularly in the workplace.30-33 Identity theories have been used to examine organizational behavior in the workplace by studying group cohesion, decision making, work motivation and performance, leadership, turnover and mergers. One such theory, social identity theory, examines when and why individuals identify with, and behave as part of, social groups.34-36 Social identity theory explains identity in relation to categories or groups and identity is formed by either self-categorization or identification with groups. Self-esteem and self-efficacy are processes that occur when identity is activated.37-40 Feelings of confidence and a positive outlook is essential to not only set self-management goals, but to achieve them as well.

Few years now, some papers have centered on diabetes diagnosis system based on only one section in the paper/article and there are few which have carried out a review of diagnosis type addressed, control recommendations is core. After carrying out preliminary searches aimed at both identifying systematic reviews and assessing the volume of relevant studies that are relevant, there is therefore no sufficiently good context to operate in Diabetes Diagnosis Management System (DDM-SYS).

In this paper, we will be carrying out a systematic literature review of the existing literature related to DDM-SYS. Our aim is not to only provide a summary of existing evidence but to present a background for new research activities to be positioned. The systematic review will be performed by employing the guideline for systematic review proposed by Kitchenham [3], which is good for researchers in requirements engineering. It as well makes it possible to plan and execute systematic review in software engineering.

2. Research Questions Formalization

This paper gives a description of a number of research directions that we are taking towards challenges faced in the diagnosis of diabetes. The research objectives will be clearly define in this section.

2.1 Questions focus

The questions focuses on the identification of initiatives and experience reports in DDM-SYS with the consideration of techniques, diabetes type diagnosed and control recommendation in the process so as to develop an effective, efficient, easy-to-use and flexible system.

2.2 Question quality and amplitude

Although, there are many health organizations that publish documents of detection and self-care recommendation approach for diabetes patient. Notwithstanding, some previous works have focused on the recommendation of food, exercise which slows the control of this disease [4, 5]. Several approaches have been employed which exempted the knowledge management of drug prescription other that physical recommendations. Some research works have been centered on one or two diabetes type exempting the other [6, 7, 8]. Some of the employed approaches are also not flexible in terms of usage as well as require background knowledge before using them. The following research questions (RQs) will be addressed in this research:

RQ1: What diabetes type have been diagnosed in recent?

RQ2: What recommendation have been given to address them?

RQ3: What diagnosis approaches have been employed?

The expected result at the end of this systematic review is the identification of DDM-SYS approaches, most addressed diabetes types, and recommendation that have been more proposed and a comparative analysis of several works that have been carried out in this field of research. Key application areas such as expert systems, medical diagnosis and data management systems will gain immensely from this systematic literature review. A background will be therefore presented which will position new research activities appropriately in diabetes diagnosis management.

3. Review Method

The review method is founded on the research protocol. This description of the strategy employed in searching for literatures, their sources, the selection of studies and the execution of selection is done in this section.

3.1 Source selection

The objective of this section is to select the sources in which searches for primary studies will be executed. The initial search string term "Diabetes AND Diagnosis System" was used. Article title, Abstract and keywords were also used for conducting searches. A second search string constructed consisted of "Diabetes Mellitus Management AND Expert System". The limitation criteria used for filtering the results addressed for publications and setting research boundaries are as follows;

(1) Publications between 2010 and 2017.
(2) Publications by document type of conference papers and articles.
(3) English Publications

The manual review of eligible publications resulted in the paper to be selected and used in the next steps. Table 1 shows the sources of literature search that was conducted using the search strings from Scopus, Web of science and Google Scholar from conference proceedings. Table 2 shows the sources from journals.

Table 1: Sources from Conference Proceedings

• Machine Intelligence and Research Advancement (ICMIRA), 2013 International Conference
• Industrial and Information Systems (IIS), 2010 2nd International Conference.
• International Conference on Ubiquitous Computing and Ambient Intelligence
• Engineering and Technology (ICET), 2014 International Conference
• Computer Engineering & Systems (ICCES), 2014 9th International Conference
• Computer, Control, Informatics and Its Applications (IC3INA), 2013 International Conference
• Phenotype Day at ISMB, 2015

Table 2: Sources of Selected Journals

Source	No.
Journal of Theoretical and Applied Information Technology	2
IEICE Transactions on Information and Systems	1
International Journal of Computer, Consumer and Control	1
Applied Informatics	1
International Journal of Advanced Networking and Applications	1
International Journal of innovative Research in Computer and Communication Engineering	1
IEEE Transactions on Systems, Man, and Cybernetics	1
International Journal of Computational Engineering Research	1
Research on Biomedical Engineering	1
International Journal of Information Technology and Computer Science	1
International Journal of Innovative Research in Science, Engineering and technology	1
International Journal of Scientific Research Engineering & Technology	1
International Journal of Applied Engineering Research	1
Information Science and Applications	1
International Journal of Medical Informatics	1

3.2 Selection execution

The execution of the search was carried out to obtain the initial list of studies for further evaluation. The verification of the articles was done to verify and ensure that their studies fit appropriately into answering the research questions that were presented in this paper initiating from a maximum of 7 years. The studies that were obtained which fit completely into all the criteria that are defined are as follows:

- Ahmed (2016a) - Using Data Mining To Develop Model For Classifying Diabetic Patient Control Level Based On Historical Medical Records. [5]
- Ahmed (2016b). Developing a Predicted Model for Diabetes Type 2 Treatment Plans by Using Data Mining. [9]
- Ali et al. (2014). Prediction of diabetes mellitus based on boosting ensemble modeling. [10]
- Buranarach et al. (2011) - Design and implementation of an ontology-based clinical reminder system to support chronic disease healthcare. [11]
- Chen and Bau (2013) - An ontological approach for guideline-based decision support system. [12]
- Chen et al. (2010) - Diabetes Care Decision Support System.[13]
- Cole-Lewis et al. (2015) - Participatory approach to the development of a knowledge base for problem-solving in Diabetes-Self Management. [14]
- El-Sappagh and Ali (2016) - DDO: A Diabetes Mellitus Diagnosis Ontology. [15]
- El-Sappagh et al. (2014a) - A Diabetes Diagnostic Domain Ontology for CBR System from the Conceptual Model of SNOMED CT. [16]
- El-Sappagh et al. (2014b) - A Proposed SNOMED CT Ontology-based Encoding Methodology for Diabetes Diagnosis Case Base. [17]
- Hayuhardhika et al. (2013) - Weights Ontology and Weighted Tree Similarity Algorithm for Diagnosing Diabetes Mellitus. [18]
- Hempo et al., (2015) - Personalized Care Recommendation Approach for Diabetes Patients Using Ontology and SWRL [4]
- Kalpana and Kumar (2011) - Fuzzy expert system for diabetes using fuzzy verdict mechanism. [19]
- Karegowda et al. (2011) - Application of genetic algorithm optimized neural network connection weights for medical diagnosis of pima Indians diabetes. [20]
- Khanna and Agarwal (2013) - An Integrated Approach towards the prediction of Likelihood of Diabetes. [21]
- Kumar and Sreejith (2016) - A Survey on Identification of Diabetes Risk Using Machine Learning Approaches. [22]
- Kumar and Velide (2014) - A Data Mining Approach for Prediction and Treatment of Diabetes Disease. [23]
- Lee and Wang (2011) - A fuzzy expert system for diabetes decision support application. [24]
- Mukherjee et al. (2015) - A Review of Soft computing Methods for Diabetes. [25]
- Muthuraman and Sankaran (2014) - A framework for personalized decision support system for the healthcare application.[26]
- Nakhal and Nouira, (2012) - Development of Ontology for the Representation of Adverse Drug Events of Diabetes Disease. [27]

- Pradhan et al. (2012) - Design of classifier for detection of diabetes using neural network and fuzzy k-nearest neighbor algorithm. [28]
- Rabina and Chopra (2016). Diabetes Prediction by Supervised and Unsupervised Learning with Feature Selection. [29]
- Rahimi et al. (2014) - Validating an ontology-based algorithm to identify patients with Type 2 Diabetes Mellitus in electronic health records. [30]
- Ribeiro et al. (2015) - Diabetes classification using a redundancy reduction preprocessor. [31]
- Shetty and Joshi (2016) - A Tool for Diabetes Prediction and Monitoring Using Data Mining Technique. [32]
- Soliman and AboElhamd (2014). Classification of Diabetes Mellitus using Modified Particle Swarm Optimization and Least Squares Support Vector Machine. [33]
- Sreedevi and Padmavathamma (2015) - A Threshold Genetic Algorithm for Diagnosis of Diabetes using Minkowski Distance Method. [34]
- Thiyagarajan et al. (2016) - A Survey on Diabetes Mellitus Prediction Using Machine Learning Techniques. [35]
- Vasant et al. (2015) -DIAB: An Ontology of Type 2 Diabetes Stages and Associated Phenotypes.[6]
- Villarreal et al. (2014) - Mobile and ubiquitous Architecture for the Medical Control of Chronic Disease through the use of intelligent devices: Using the architecture for patients with diabetes. [36]
- Zhang et al. (2015) - An Hl7 Rim-Driven, Ontology-based Approach to Healthcare Knowledge Base Development. [7]

4. Information Extraction

The information that were extracted from the studies contained techniques, methods, steps, strategies or any initiatives that were employed in the establishment of diabetes mellitus diagnosis management. The information forms that were defined for carrying out this systematic review is made up of study identification, motivation, methodology, results, strengths and weaknesses. The consideration in the extraction of methodology is focused on the diabetes mellitus type addressed, techniques employed and recommendation consideration. The consideration in terms of results of the approach is based on diabetes type addressed and recommendation approach of tackling the disease.

4.1 Ahmed (2016a) - Using Data Mining To Develop Model For Classifying Diabetic Patient Control Level Based On Historical Medical Records.

The author was motivated by the death caused by diabetes in the world which necessitated avoiding the complication of the disease. He intended to develop a new predicted model using data mining techniques which would classify diabetic patient control level based on historical medical records. The research was carried out using three data mining techniques which are Naïve Bayes, Logistic and J48. The research was implemented using WEKA application. The result showed that Logistic data mining algorithm gave a precision average of 0.73, recall of 0.744, F-measure of 0.653 and accuracy of 74.4%. Naïve Bayes gave a precision average of 0.717, recall of 0.742, F-measure of 0.653 and accuracy of 74.2%. J48 gave a precision average of 0.54, recall of 0.735, F-measure of 0.623 and accuracy of 73.5%. This proved that the logistic algorithm was more accurate than the other two. The research was limited in that only diabetes type 2 was considered. They also did not look into the discovery of appropriate features with minimal effort and validation on discovered features.

4.2 Ahmed (2016b) - Developing a Predicted Model for Diabetes Type 2 Treatment Plans By Using Data Mining.

The author was motivated by the highly dangerous complication of chronic disease as well as the complication which required amputation of one of the parties. He intended developing a new model for classifying diabetes type 2 treatment plan which could help the control of blood glucose level of diabetic patient. He made use of J48 algorithm in conducting the experiment on 318 medical records which was collected from JABER ABN ABU ALIZ clinic center for diabetes in Sudan. The basic control information showed that 59.1% of the record was considered for Oral Hypoglycemic, 35.5% for Insulin and 5.3% for Diet. The evaluation was done using the WEKA application. The research work did not consider diabetes type 1 patients which could have been included with additional attributes. Also, the nutrition system and exercise could have been included to increase the accuracy of the system.

4.3 Ali et al. (2014) - Prediction of diabetes mellitus based on boosting ensemble modeling.

They were motivated by the focus of aiding diabetes patients fit themselves into their normal activities of life by early predicting their state and tacking it. They intended to predict the diabetes types of patients based on physical and clinical information

using boosting ensemble technique. They made use of boosting ensemble technique which internally uses random committee classifier. The architecture used was supported by integrating data management, learning, and prediction components together. The evaluation result of the technique showed accuracy gave a weighted average TP rate of 0.81, FP rate of 0.198, Precision of 0.81, Recall of 0.81, F-measure of 0.82 and ROC area of 0.82 for diabetes type 1 and 2. The research work is intended to be extended in future the integration into a cloud based clinical decision support system for chronic diseases and the inclusion of a feedback mechanism to increase the level of satisfaction of user.

4.4 Buranarach et al. (2011) - Design and implementation of an ontology-based clinical reminder system to support chronic disease healthcare.

They were motivated by the improving quality of healthcare for chronic conditioned people which required informing healthcare providers and patients as well as making them knowledgeable. They intended describe an ontology-based information and knowledge management framework important for care management of chronic diseases. They also intended designing and implementing an ontology-based clinical reminder system for the support of chronic disease healthcare. They made use of a patient data in triggering based on patient data and recommendations given from clinical practice guideline. The reminder system linked clinical guideline knowledge with patient registries to provide support for evidenced based healthcare. The evaluation result of the technique showed that the offline reminder in terms of clarity and intuitiveness had 90% of neutral or positive response and 40% of positive response while the online reminder 85% of neutral or positive response and 30% of positive response. In terms of usefulness and adequacy, the offline reminder had 100% of neutral or positive response and 65% of positive response against the online reminder 90% of neutral or positive response and 60% of positive response. They intend to focus on the incorporation of some electronic health record standards which include HL7.

4.5 Chen and Bau (2013) - An ontological approach for guideline-based decision support system.

They were motivated by the increasing premature death and decreasing life quality of life due to vascular compilation. They intended to optimal assess and manage diabetes patients during surgery. They also were willing to computerize the key concepts and relationships in the clinical guidelines for the sharing, update and reuse of clinical knowledge. Also, they intended designing and developing an ontology-driven clinical decision support system for managing diabetic patients. They represented the clinical guideline as JENA rules for JENA reasoning. They also employed fuzzy logic due to the non-explicit nature of clinical decision making. They presented a result that showed some defined properties in the patient ontology comprising of property name, type, domain and range. The research work is intended to survey the clinical decision support system in terms of perceived usefulness, satisfied degree and behavioral intentions to use.

4.6 Chen et al. (2010) - Diabetes Care Decision Support System.

The author used artificial intelligence techniques (Case based Reasoning) to generate personalized diabetes care plan. The use of ontology was used to generate basic care plan to care professionals to enable them adjust it. The approach could successfully store solution of patient problems in the case base and reduced redundancy of processing data. The ontology employed helped handle insufficiency of cases. Notwithstanding, the adjustment of the ontology concepts based on users condition was not considered. Access control measure was not considered.

4.7 Cole-Lewis et al. (2015) - Participatory approach to the development of a knowledge base for problem-solving in Diabetes-Self Management.

The authors created a structure and component of a knowledge base in participatory design with academic diabetes educators using knowledge acquisition methods. The knowledge base validation was carried out with the use of a scenario-based approach using inductive and deductive method. The knowledge base validation showed high level completeness and accuracy. The participatory design approached help the capturing of implicit knowledge of practicing diabetes educator for reusability. It could enable the design of new generation of information interventions for facilitation problem solving in diabetes self-management. The knowledge structure were not formalized as well as the relationships between its different elements. The prescription of medication was not put into consideration and the knowledge base exempted the choice of a barrier that would precede the choice of a corrective action.

4.8 El-Sappagh and Ali (2016) - DDO: A Diabetes Mellitus Diagnosis Ontology.

They were motivated by the morbidity and mortality caused by diabetes to human which necessitates an early diagnosis for managing such condition. They intended to design an efficient, reliable, extendable, reusable and semantically intelligent knowledge bases. Also, the designing of an OWL2 diabetes diagnosis ontology. They also had the intention of developing a new generation of patient-centric decision support tool. The carried out the research and made use of Protégé software for the construction of the ontology. The ontology was centered on diagnosis of patients who likely had the disease making use of various key attributes in the construction of the ontology. The research was limited in that the treatment plan was not put into consideration during the construction of the ontology.

4.9 El-Sappagh et al. (2014a) - A Diabetes Diagnostic Domain Ontology for CBR System from the Conceptual Model of SNOMED CT.

The authors proposed a methodology for building ontology for diabetes concepts based on then recent diabetes clinical guideline. All the concepts based on the disease were collected using SNOMED CT standard terminologies. They concentrated on the use of Case Based Reasoning (CBR) for diabetes diagnosis. The ontology helped facilities semantic case retrieval. The relationship modeling used was easier. The research work did not address the issue of comorbidity. More expressive description logic language definition were not included. The prescription of medication was not addressed in the entire approach.

4.10 El-Sappagh et al. (2014b) - A Proposed SNOMED CT Ontology-based Encoding Methodology for Diabetes Diagnosis Case Base.

They proposed an encoding methodology for clinical data using systemized nomenclature of medicine-clinical terms (SNOMED CT) using a diabetes diagnosis data set as the case study. They made use of an encoded data set which was derived from electronic health record database represented as cased base knowledge. They applied the methodology using a knowledge intensive case based reasoning. The research was able to provide custom codes for uncovered terms in the ontology. They also considered the standardization of data in the Case Based Reasoning (CBR) systems. The ontologies aided the creation of the knowledge intensive CBR by reducing the knowledge acquisition bottle neck. The approach was based on diagnosis without prescription provision. The system did not consider access control measure into the system.

4.11 Hayuhardhika et al. (2013) - Weights Ontology and Weighted Tree Similarity Algorithm for Diagnosing Diabetes Mellitus.

The authors used Diabetes Mellitus classification based diseases diagnosis from World Health Organization Geneva. The system computes the weight of the patient ontology in the patient knowledge based on the density. Thereafter carryout a weighted tree similarity algorithm. The system had a high level of consistency. The representation in form of OWL Ontology could be used to represent knowledge. The ontology supported the search of data/information by defining the concept of convergent intended by user. The research work was limited in that the prescription class was not considered.

4.12 Hempo et al., (2015) - Personalized Care Recommendation Approach for Diabetes Patients Using Ontology and SWRL

They developed the diabetes knowledge-based ontologies which was expressed in Web Ontology Language (OWL) for the description of the patient profile, the general self-care practices for diabetes patients. The ontologies were mapped and incorporated with rules which was created through the use of Semantic Web Rule Language. The semantic rules was able to enable the semantic recommendation for personalized care of patient with diabetes corresponding to each condition of the patient. Most of the system recommendation corresponding to the physician had high precision value. The system could respond very well to the needs of patient condition. The ontology web application could only be implemented by only physicians. The reasoning rules were limited to some integrated diabetes ontology.

4.13 Kalpana and Kumar (2011) - Fuzzy expert system for diabetes using fuzzy verdict mechanism.

The authors were motivated by the attention drawn by the increasing number of diabetes patient in the world by various array of fields. Also, they underwent the research to provide a simple mechanism for the diagnoses of diabetes. They intended constructing a large scale diabetes knowledge based system with description and support as well as propose a fuzzy expert system framework. They developed a fuzzy expert system

framework using fuzzy verdict mechanism. The evaluation result showed that the study had an accuracy of 85.03% which was higher than other approaches that were used in benchmarking. The research work did not test the fuzzification approach that was used for similar tasks or diabetes related data sets for the evaluation of the capability to produce similar accuracy. They intend in future to undertake the implication and operators for s-norms and t-norms for accuracy improvement of Fuzzy Verdict Mechanism.

4.14 Karegowda et al. (2011) - Application of genetic algorithm optimized neural network connection weights for medical diagnosis of pima Indians diabetes.

They were motivated by the huge amount of data collected that has been as a result of the computerization in hospitals which necessitates data classification. They were also motivated to undertake the research to find a means of finding an efficient features classification method. They intended to present an application that integrated a hybrid model. They employed genetic algorithm and back propagation network approach. The genetic algorithm was employed for the initialization and optimization of the connection weights of back propagation network significant features. Decision tree and GA-CFS were used as input into the hybrid model for diagnosis of diabetes mellitus. The result showed that using a 8-20-1 network topology with 100 number of generation, two point crossover type the classification accuracy gave 77.707% with the GA-BPN inputs while the GA-CFS gave an accuracy of 84.713%. The research work was not clear or explicit about the diabetes type that was considered and features that was used. Also, the knowledge base was not put into consideration.

4.15 Khanna and Agarwal (2013) - An Integrated Approach towards the prediction of Likelihood of Diabetes.

The authors were motivated by the growth of information and communication technologies in the healthcare industry which produces large data extensively. This also was motivated by the management of large data and efficient knowledge discovery process. They intended to classify based on supervised learning which is data mining so as to predict the label of unknown samples as class. They also intended to classify the prediction of upcoming behavior of data sample instances of diabetes. They performed a classification on diabetes clinical guidelines. They also proposed Clustering algorithm applied on the dataset to divide it into classes and modified the by calculating the distance. The result showed that out of 403 records, 120 patients were at low risk, 114 at medium risk and 44 at high risk which belonged to three clusters. The performance of the classifier gave 0.832 accuracy, 0.897 specificity and 0.709 sensitivity. They intend to propose in future a diagnostic model which can be applied on various other chronic diseases for better treatment.

4.16 Kumar and Sreejith (2016) - A Survey on Identification of Diabetes Risk Using Machine Learning Approaches.

They were motivated by the machine learning approaches used in several health related studies and the fact that diabetes is a common and widely spread disease in India. They intended to survey different data mining approaches made use of in the handling of healthcare information. The carried out an exploration on the popular and effective machine learning techniques along with their advantages and disadvantages. The result showed that artificial neural network had an accuracy of 73.52%, decision tree 78.27% while regression 72.27% when used to test diabetes data. The research was limited in that only diabetes type 2 was considered. They also did not look into the discovery of appropriate features with minimal effort and validation on discovered features.

4.17 Kumar and Velide (2014) - A Data Mining Approach for Prediction and Treatment of Diabetes Disease.

They were motivated by the large amount of data provided by the advancement in computers and the major health problem of diabetes in India. They intended to analyze the obtained diabetic patient data by various data mining algorithm which could aid medical practitioners for accurate diagnosis of diabetes. They techniques considered are Naïve Bayes, J48(C4.5), JRip, Neural Networks, Decision trees, KNN, Fuzzy logic and Genetic Algorithms which were analyzed based on accuracy and time. They made use of the TANGARA data mining tool to classify the obtained data and evaluated using cross validation. Naïve Bayes classifier gave an accuracy of 95.85%, JRip 96.54%, J48(C.45) 100%, Decision trees 98.48% and Neural Networks 97.85%. The research work did not state what diabetes type was considered in the work as well as the effect of additional features on the accuracy of the result.

4.18 Lee and Wang (2011) - A fuzzy expert system for diabetes decision support application.

They were motivated by the insufficiency of ontology to classical ontologies to handle imprecise and vague knowledge for some real world application which they believed can be resolved by fuzzy ontology. They intended to model a diabetes knowledge and present a novel fuzzy expert system for diabetes decision support application. They developed a five layer fuzzy ontology which included the fuzzy knowledge layer, fuzzy group relation layer, fuzzy group domain layer, fuzzy personal relation layer, and fuzzy personal domain layer. They included a semantic decision support agent which included knowledge construction mechanism, fuzzy ontology generating mechanism and semantic fuzzy decision making mechanism. The result showed that the study for slightly old patients provided an accuracy of 91.2%, Young 90.3%, More or less young 85.9%, very young 81.7%, and very very young 77.3%. The research work is intended to be explored in other domains with respect to increasing acceptability. They also intend in future to improve the fuzzy ontology for diabetes domain and make the disease prediction much mature by undertaking additional experiments and proofs. The instance whereby a dataset changes which could include the change of fuzzy rules was not considered in the research.

4.19 Mukherjee et al. (2015) - A Review of Soft computing Methods for Diabetes.

They were motivated to carry out the research work based on the silently killing ability of diabetes disease which needs early prognosis of the disease so as to reduce the risk involved. This also they believe will aid the choice of diagnosis technique for prediction. They intended to compare the accuracies of diabetes diagnosis so as to find the method that produces a more efficient prediction rate of the disease. The choice of techniques made are support vector machines, decision trees, and logistic regression for the classification of pima indian diabetes datasets. The result showed that support vector machine had an accuracy rate of 50%, decision tree 74.87% and logistic regression 77.99%. They intend in future to apply the compared techniques on attributes that were not considered for a larger number of instances.

4.20 Muthuraman and Sankaran (2014) - A framework for personalized decision support system for the healthcare application.

The authors were motivated to carry out the research work by the intention to enhance the treatment quality and to check the time and cost consumption of the healthcare system. They also wanted to improve the healthcare system quality so as to adapt to semantic system for easy understanding by machines and men. They intended to present a framework for personalized decision support system. They constructed framework using fuzzy decision tree and fuzzy rules from fuzzy decision tree. The system triggers the Semantic Web Rule Language that produced a procedure of the treatment. They food consumption database was used for finding the iodine measure, carbohydrate measure, protein measure and fat measure in food item. The framework consisted of fuzzy rule generation and diagnosis, rule execution and ontology. The result showed that the relationship richness of 0.95, and defined more knowledge when compared to existing T2FO ontology. The proposed FCO ontology returns 1 showing that the entities are strongly related. The research work was did not consider the drug and treatment prescription.

4.21 Nakhal and Nouira, (2012) - Development of Ontology for the Representation of Adverse Drug Events of Diabetes Disease.

They presented an adverse drug event ontology of diabetes disease. This included the terms that were relative to the diabetes ADE. It is a formal terms and concept representation that are defined in a given language describing the logical relationships existing between them. The ontology serve to understand the ADE domain. It allows users to develop preventive ADE system and facilitated the extraction of the knowledge. The expense cost was not put into consideration

4.22 Pradhan et al. (2012) - Design of classifier for detection of diabetes using neural network and fuzzy k-nearest neighbor algorithm.

They were motivated by growth of vitally fatal diseases in the world which necessitates designing classifier for detecting diabetes mellitus with optimal cost and precise performance in the age. They intended to detect and diagnose diabetes early and design a cost efficient, convenient and accurate classifier. They made use of neural network and fuzzy k-nearest neighbor algorithm for the design of classifiers. The learning ability of neural network which it does dynamically was employed for detecting the presence of diabetes. But due to its lack of remarkable accuracy, the fuzzy system was then used to complement this. Therefore, rules are

being generated by the fuzzy system which was then controlled by the neural network. The inclusion of the k-NN algorithm was to find the k nearest neighbor amidst the data. The result from the analysis with the use of WEKA showed that the training set provided an accuracy of 100% compared to 10 fold CV which gave 73.0469% using 768 records of PID. Also, with the use of 392-records of PID on removal of records with missing values gave a training set accuracy of 100% and 10 fold CV of 74.2347%. The research work was not specific on the diabetes type that the approach can be effectively implemented upon and did not consider the diabetes diagnosis features necessary.

4.23 Rabina and Chopra (2016). Diabetes Prediction by Supervised and Unsupervised Learning with Feature Selection.

They were motivated by the various factors which required investigation so as to diagnose diabetic patient which could make it difficult for physician. They thought it therefore to carry out a technique that was profitable for categorizing patients that are diabetic with the use of soft computing. They intended to find an approach that was better on datasets of diabetes as well as employ feature selection technique that will reduce feature and complexity of process. They carried out the research making use of WEKA application on the following techniques: Bayes Network, Naïve Bayes, Logistics, Multilayer perception, SGD and SMO. The result showed that the logistics technique had the highest accuracy with 77.7% against Bayes Network's75%, Naïve Bayes' 75.5%, Multilayer perception's 76.5%, SGD's76.7% and SMO's 76%. The result also showed that decision trees have higher potential advantage over neural networks. The research was not able to clearly denote what diabetes type was considered and neglected stating explicitly what features they were concerned with.

4.24 Rahimi et al. (2014) - Validating an ontology-based algorithm to identify patients with Type 2 Diabetes Mellitus in electronic health records.

The authors presented a diabetes mellitus ontology-based algorithm to query semantic protocol and RDF Query Language (SPARQL). The structured fields in the ePBRN data repository was iteratively tested and refined. The completeness was good enough in terms of accuracy. The approach was consistent with the use of uniform data type. The accuracy of the system could be compromised. The approach did not consider prescription of medication.

4.25 Ribeiro et al. (2015) - Diabetes classification using a redundancy reduction preprocessor.

They were motivated by the need to provide an accurate automated screening which is increasingly important due to the wide spread of diabetes disease so as to make the patient benefit significantly from it. They intended to propose a classification methodology that was based on efficient coding of input that will reduce redundancy. They also intended proposing an information theoretic approach for extracting features. They employed a method that uses independent component analysis decomposition for higher order statistic information about input data. They employed algorithms such as FastICA, JADE and INFOMAX. They also performed classification test using noninvasive and invasive indicators based on one class support vector machine. The result showed that the All(FastICA) had a 98.47% accuracy, 6f(FastICA) had 98.28% accuracy, 6f(JADE) had 99.57% accuracy and 6g(InfoMAX) had 99.37% accuracy. The accuracy of the two databases were 99.81% for the Brazilian database against 97.01% for the African-American database. They features were not explicitly stated and the diabetes type put into consideration in the scenarios were not clear. There was also an absence of an efficient knowledge management in the approach.

4.26 Shetty and Joshi (2016) - A Tool for Diabetes Prediction and Monitoring Using Data Mining Technique.

They were motivated by the need of analysis of data with different aspects and the aggregation into information that could be useful. They intended to develop a tool that would predict and monitor diabetes with the use of data mining technique. They also intended to find out a pattern that was new and useful in the provision of information that was useful and meaningful for users who want to know their diabetes state. The research was implemented using ID3 classification algorithm which was used in identifying the disease and applied to the model for prediction. The algorithm was used in generating decision tree from the dataset which accepted only categorical attributes for the building of the model. The evaluation result showed that the method had a 55% sensitivity, 22% specificity, 94% accuracy and error rate of 6%. The method could consider additional features for ascertaining higher level of accuracy to the model.

4.27 Soliman and AboElhamd (2014). Classification of Diabetes Mellitus using Modified

Particle Swarm Optimization and Least Squares Support Vector Machine.
They were motivated by the major health problem which diabetes mellitus is all over the world and several number of classification algorithm applied which needs to be effectively chosen. Also, the willingness to find an adequate treatment of the disease by blood pressure control and lifestyle factor. They intended to propose an approach that will classify diabetes mellitus type 2 patients. They made use of a hybrid algorithm of modified particle swarm optimization and least squares support vector machine. The support vector machine was used for finding hyper plane, which separated various classes while the fast convergence ability of the particle swarm optimization algorithm was adopted. The experimental result of the technique showed that the proposed algorithm was superior to other techniques which gave an average accuracy of 97.833%. The research work was centered on just diabetes type 2 neglecting type 1 and genital diabetes. The work could further be tested on other chronic diseases.

4.28 Sreedevi and Padmavathamma (2015) - A Threshold Genetic Algorithm for Diagnosis of Diabetes using Minkowski Distance Method.
They were motivated to carry out the research work based on the quick rise of diabetes across the globe which necessitated for the early detection of the disease so as to avoid its inception by taking preventive measures. The second motivation for embarking on the research was how vital diagnosis have played in the treatment of diabetes to avoid risk and cost complications. They intended to propose a Threshold Genetic Algorithm for the diagnosis of diabetes with the use of Minkowski Distance Method. They made use of Minikowski Distance method using PIMA Indian diabetes dataset from UCI repository, University of California as an effective tool for accuracy improvement. There were eight attributes considered in the datasets which are the number of times pregnant, concentration of plasma glucose, diastolic BP, triceps skin fold thickness, scrum insulin, body mass index, diabetes pre degree function and ages. The Minikowski Distance method was employed for the calculation of individuals' fitness while Tournament selection method for the process of selection. The result showed that amidst the distance methods implemented, Minkowski function had an a accuracy of 72.214% compared to Stoean fitness function with 70.305%, Manhattan function 60.031%, Euclidean function 70.076%, and Chebychev function 70.763%. This made the more accurate than the others. The research work was not specific on the diabetes type that the approach can be effectively implemented upon. Also, the features and variables considered for the diagnosis were not explicitly stated.

4.29 Thiyagarajan et al. (2016) - A Survey on Diabetes Mellitus Prediction Using Machine Learning Techniques.
They were motivated growing interest of researchers to set up medical system which can screen great number of people for diseases that could threaten their lives. They intended to carry out a survey on machine learning techniques that have been employed in the prediction of diabetes mellitus. They also intended to propose an effective machine learning algorithm for classification so as to find the hyper-plane that was optimal which divides the various classes. They survey literatures between 2009 and 2015. Several machine learning techniques include PCGM algorithm, improved association rule mining, computational intelligent technique, pre-eclampsia prediction, MPSO-LSSVM algorithm and FP-growth algorithm. The investigation was done based on the performances of the techniques. They tried describing a machine learning approach to predict diabetes levels. The survey took several method of classification and ensemble them to give a new model in seeking a better result in terms of accuracy. The research work is intended to be extended for the conclusion of diabetes based on the information gathering from several locale around the world and providing more precise and general prescient model.

4.30 Vasant et al. (2015) -DIAB: An Ontology of Type 2 Diabetes Stages and Associated Phenotypes.
They presented a process for generating ontology through the use of text mining and review of expert and the resulting ontology of disease-phenotype association using terms from mouse and human phenotype ontologies. The process provided a pragmatic and rapid method to extract information. The text mining was discovered to be a useful tool in building ontologies. The process has been successful in performing disease-phenotype association in different disease areas. The process did not consider the modification of input vocabularies to improve recall. There is no complete explicit representation of T2D phenotype with the disease

4.31 Villarreal et al. (2014) - Mobile and ubiquitous Architecture for the Medical Control of

Chronic Disease through the use of intelligent devices: Using the architecture for patients with diabetes.

The authors presented a mobile monitoring application to allow patients monitor chronic diabetes diseases using mobile device. Ontologies was used to classify the medical elements. The process also included the distribution of the devices in layers which allowed the generation of final applications distributed in a medical context. The final inclusion was the mobipatterns that defines the schema of the control module. The application had high level of simplicity and heterogeneity. It made use of the inclusion of biometric which could be extensible. The application had high response time. The medication prescription was not included in the ontology. Access control measure was not put in place to restrict who can include new disease information.

4.32 Zhang et al. (2015) - An Hl7 Rim-Driven, Ontology-based Approach to Healthcare Knowledge Base Development.

The research work was motivated by the significance of the clinical decision support system knowledge base as a bottleneck in determining the success of the application. This as stated in the work could be affected by the lack of effective model for knowledge representation. They intended to present a novel approach which could tackle ineffective knowledge representation model by developing a healthcare knowledge base through the use of semantic knowledge for exchanging, sharing, retrieval and integration of electronic health information. They constructed a semantic healthcare knowledge ontology based on High Level Seven International (HL7) reference information model for the development of the recognized healthcare workflow with the class diagram and the semantic health expression repository was built in Jena rule format and simple protocol protocol and resource description framework query language for the extension of the ontology with dynamic decision logic. The result showed that 130 classes comprising of 6 top-level classes and 124 subclasses, 196 properties and 126 rules were created in the knowledge base. The semantic interoperability between the clinical decision support system and health information system were facilitated through the unified representation formalism of both patient data and domain knowledge. The research work did not cater for the maintenance and extension based on other case studies. They intend to further the work by investigating knowledge base evaluation methods and integrating machine learning techniques for automatically acquiring knowledge and managing close-loop knowledge.

5. Result and Discussion

The result of the systematic review shown in Table 3 gives a summary of the studies qualities per discovered initiative. The main contributions, in terms of the diabetes diagnosis management approach, diabetes mellitus type considered and limitations by each selected initiative is shown in Table 4.

As seen in Table 3, there are new techniques, methodologies, and process which attempt to facilitate the diagnosis management of diabetes in patients. Notwithstanding, few of the approaches have been able to consider the three major types in their diagnosis as well as include medical recommendation to treat the disease. More consideration have been put into physical exercises and feeding. The approaches considered more in diagnosis are artificial intelligence techniques such as fuzzy logic, expert systems, KNN classifiers and ontology. These features can be used as basis for techniques/ frameworks/ process/ methodology, or as extensions to those that already exist. Figure 1 shows the chart of the diabetes type that were addressed by some of the literatures as some did not state what type were focused on in their research works. Table 5 presents a summary of the comparison of initiatives with the intention of carrying out an analysis on the selected initiatives using an analytical framework based on the following criteria:

- *Physical control recommendation*: This has to do with if the initiative considered recommending physical activities such as bodily routine exercises to tackle the diabetes disease in a patient.
- *Nutritional control recommendation*: This is based on any nutritional measure such as type of meal, fruits or drink to be taken to treat a diabetes situation.
- *Drug prescription recommendation*: This is concerned with the consideration of returning a feedback on what type of drug a diabetic patient who has been diagnose should take.

The type of initiative that considers any of these will be labelled as C while those that did not consider any of these will be stated as NC in the table.

Table 3: Summary of the quantity of studies per initiative.

Types of initiative	Number of studies	Initiatives
Techniques	10	4.1, 4.3, 4.6, 4.9, 4.10, 4.17, 4.23,4.25, 4.26, 4.29
Framework	4	4.4, 4.14, 4.20, 4.31
Process	5	4.2, 4.5, 4.15, 4.21, 4.30
Methodology	6	4.7, 4.11, 4.16, 4.18, 4.28, 4.21
Others	7	4.8, 4.12, 4.13, 4.19, 4.22, 4.24, 4.27
Total	32	

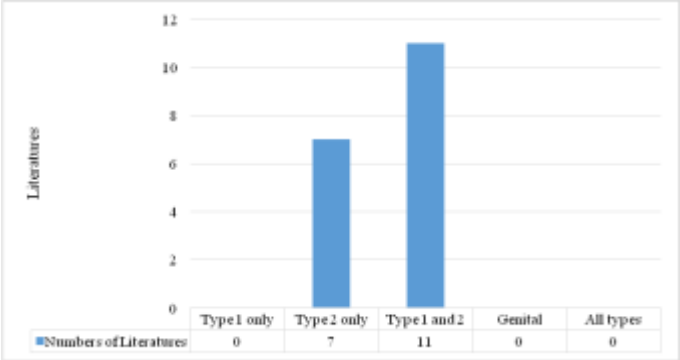

Figure 1: A chart showing the number of literatures that addressed each diabetes type(s)

Table 4: Summary of the contributions and diabetes type considered

Authors	Approach	Diabetes type(s) addressed	Main contribution
Ahmed (2016a)	Data mining	Type 2	▪ Improved accuracy ▪ Determining the best data mining technique
Ahmed (2016b)	Data mining	Type 2	▪ Diet recommendation ▪ Blood glucose control
Ali et al. (2014)	Boosting ensemble technique	Type 1 and 2	▪ Efficient accuracy ▪ Data management, learning and prediction integration.
Buranarach *et al.* (2011)	Ontology		▪ Improved clarity rate ▪ Ontology-based clinical reminder system
Chen and Bau (2013)	Fuzzy logic and ontology	Type 1 and 2	▪ Optimized assessment and management ▪ Computerization of key concepts and relationships.
Chen et al. (2010)	Case Based Reasoning (CBR)	Type 2	▪ Handled insufficiency of cases ▪ Successful storage of solution of patient problems
Cole-Lewis et al. (2015)	Scenario-based appraoch		▪ High level completeness and accuracy ▪ Implicit knowledge capturing of practice diabetes education for reuse
El-Sappagh and Ali (2016)	Ontology	Type 1 & 2	▪ Centered on diagnosis of patients who likely had diabetes using various key attributes.
El-Sappagh et al. (2014a)	CBR		▪ Help facilitate semantic case retrieval ▪ Ease in relationship modeling
El-Sappagh et al. (2014a)	CBR		▪ Standardization of data ▪ Employed intensive case based reasoning

Hayuhardhika et al. (2013)	Ontology and Tree Similarity Algorithm	Type 1 and 2	▪ High level of consistency
Hempo et al. (2015)	Ontology	Type 1 and 2	▪ Considered patient with high precision value ▪ Enablement of semantic recommendation
Kalpana and Kumar (2011)	Fuzzy verdict mechanism	Type 1 and 2	▪ High accuracy ▪ Large scale diabetes knowledge based system with description ad support
Karegowda et al. (2011)	Genetic algorithm + neural network		▪ High level of accuracy ▪ Finding an efficient feature classification method
Khanna and Agarwal (2013)	Data mining	Type 1 and 2	▪ Classification of diabetes patient based on behaviour ▪ High level of accuracy, specificity and sensitivity
Kumar and Sreejith (2016)	Data mining	Type 2	▪ Detection of artificial neural network as the best data mining technique for handling diabetes diagnosis
Lee and Wang (2011)	Fuzzy logic + ontology	Type 1 and 2	▪ Modeling of diabetes knowledge and fuzzy expert system
Mukherjee et al. (2015)	Support Vector Machine, decision trees and logistic regression		▪ Classification of diabetes data set ▪ Accuracies comparison of diabetes diagnosis methods
Muthuraman and Sankaran (2014)	Fuzzy decision tree and fuzzy rules		▪ Improvement of healthcare system quality for adaptation of semantic system. ▪ Framework construction for personalized decision support system.
Nakhal and Nouira (2012)	Ontology	Type 1 and 2	▪ Development of ontology for representing Adverse Drug Events of diabetes disease.
Pradhan et al. (2012)	Neural network + fuzzy k-nearest neighbor	Type 1 and 2	▪ Classifier design for diabetes detection diabetes
Rabina and Chopra (2016)	Bayes network, logistic, multilayer perception	Type 1 and 2	▪ Patient categorization ▪ Finding best appraoch for diabetes dataset
Rahimi et al. (2014)	SPARQL	Type 2	▪ Validation of ontology-based algorithm to identify patient
Ribeiro et al. (2015)	FastICA, JADE and INFOMAX		▪ Reduction of redundancy ▪ Diabetes classification
Shetty and Joshi (2016)	ID3 Classification (Data mining)	Type 1 and 2	▪ Development of tool for predicting and monitoring diabetes
Soliman and AboElhand (2014)	Modified Particle Swarm Optimization + Support Vector Machine	Type 2	▪ Diabetes Mellitus classification ▪ Locating adequate treatment of disease by blood glucose control

Sreedevi and Padmavathamma (2015)	Minkowski Distance method		▪ Finding how vital giagnosis have helped in treating diabetes
Thiyagarajan et al. (2016)	Machine learning	Type 1 and 2	▪ Survey on machine learning techniques employed in diabetes mellitus prediction
Vasant et al. (2015)	Ontology	Type 2	▪ Ontology generation through text mining. ▪ Information extraction using pragmatic and rapid method
Villarreal et al. (2014)	Mobile + Ontology	Type 1 and 2	▪ Mobile pattern ontology and architecture ▪ Mobile based with high response time.

Table 5: Comparison of diabetes control measure addressed by initiatives

Authors	Physical control recommendation	Nutritional control recommendation	Drug prescription recommendation
Ahmed (2016a)	NC	NC	NC
Ahmed (2016b)	NC	NC	C
Ali et al. (2014)	NC	C	NC
Buranarach *et al.* (2011)	NC	NC	NC
Chen and Bau (2013)	NC	NC	NC
Chen et al. (2010)	C	C	NC
Cole-Lewis et al. (2015)	NC	NC	NC
El-Sappagh and Ali (2016)	NC	NC	NC
El-Sappagh et al. (2014a)	NC	NC	NC
El-Sappagh et al. (2014a)	NC	NC	NC
Hayuhardhika et al. (2013)	NC	NC	NC
Hempo et al. (2015)	C	C	NC
Kalpana and Kumar (2011)	NC	NC	NC
Karegowda et al. (2011)	C	NC	NC
Khanna and Agarwal (2013)	NC	NC	NC
Kumar and Sreejith (2016)	NC	NC	NC
Lee and Wang (2011)	C	C	NC
Mukherjee et al. (2015)	C	NC	C
Muthuraman and Sankaran (2014)	NC	NC	NC
Nakhal and Nouira (2012)	C	C	NC
Pradhan et al. (2012)	NC	NC	C
Rabina and Chopra (2016)	NC	NC	NC
Rahimi et al. (2014)	NC	NC	NC
Ribeiro et al. (2015)	NC	NC	NC
Shetty and Joshi (2016)	NC	NC	NC
Soliman and AboElhand (2014)	C	NC	NC
Sreedevi and Padmavathamma (2015)	NC	NC	NC
Thiyagarajan et al. (2016)	C	NC	NC
Vasant et al. (2015)	NC	NC	NC
Villarreal et al. (2014)	C	NC	C
Zhang et al. (2015)	NC	NC	C

International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 6 Issue 9 September 2017, Page No. 22398-22315
Index Copernicus value (2015): 58.10 DOI: 10.18535/ijecs/v6i9.03

The summary from Table 4 shows that the approaches have been centered more on ontology and data mining techniques. Also, diabetes type 1 and type 2 collectively have been of more consideration. Form those of the research work which made known the diabetes type addressed, none catered for the genital diabetes type which is beginning to show forth today. Seven (7) of the approaches addressed diabetes type 2 alone, while fourteen (14) of the approaches addressed diabetes type 1 and 2 collectively as shown in Figure 1. Eleven (11) of the literatures either did not consider diabetes directly or did not state the diabetes type addressed. From table 5, it can be seen that only nine (9) of the literatures considered recommending physical control in form of body exercise routine to patients to address the disease. Only five (5) returned a nutritional recommendation feedback on what kind of meal should be taken by patient to tackle the disease. Five (5) of the literatures as well considered the drug prescription section of the diagnosis management in their research work. The analysis performed on Table 5 will aid researchers to suggest the technique to be adopted based on the criterion that were defined in the table as well as address the limitations. These suggestions were deduced from the attempt to be general and cover the commonly employed choices as regards diabetes diagnosis management in making decision of a high level abstraction.

This review give results that are consistent about diabetes diagnosis management which cannot be rejected being conducted in a systematic and unbiased manner. This will also give other professionals a means of duplicating the same protocol so as to judge the adequacy of the results obtained. This systematic review of diabetes diagnosis approach does not consist of simple arrangement of data that relates to already know or published issues, but have been carried out based on a formal and controlled process in conducting this type of investigation (based on systematic reviews guidelines proposed by Kitchenham [3] and Biochini [39]. Finally, systematic reviews provides more benefits than drawbacks than traditional reviews. Hence, we have presented an evaluation of diabetes diagnosis that is fair through the use of auditable and rigorous methodology.

6. Conclusion

It is very crucial to deal with diagnosis management of diabetes mellitus at all forms. Diagnosing this disease efficiently is crucial due to its high rate at which human beings are affected. Various approaches employed have not addressed the entire diabetes type collectively which is very necessary. Researchers in this field therefore need to discover a suitable approach that will efficiently diagnose any diabetes type and also make recommendation on its control in terms of physical, nutritional and drug prescription. This work makes contribution by making an inference on making available to researchers a summarized details of existing information about diabetes diagnosis approaches in a thorough and unbiased manner, so as to make a provision of context that could be used to operate. Also by comparing its systematic approach to traditional reviews based on the reliability of information obtained. The review was done based on contribution, diabetes type(s) considered, and control recommendation considered. We hope that our categorization and review of the publications will aid researchers in accessing information in the area of diabetes diagnosis and treatment.

References

1. World Health Organization (WHO) (1999). Definition, Diagnosis, and classification of diabetes mellitus and its complications, part 1. WHO/NCD/NCS/99.2
2. H.P. Rang, M.M. Dale (2007). Rang and Dale's pharmacology, 6th ed. Elsevier ltd, UK. p. 402.
3. Kitchenham 2007, Guideline for performing Systematic Literature Reviews in Software Engineering, Version 2.3. 2007, University of Keele (Software Engineering Group,School of Computer Science and Mathematics) and Durham (Department of Computer Science).
4. B. Hempo, N. Arch-int, , S. Arch-int, & C. Pattarapongsin, (2015). Personalized care recommendation approach for diabetes patients using ontology and swrl. In

Information Science and Applications (pp. 959-966). Springer Berlin Heidelberg.

5. T. M. Ahmed, (2016a). Using Data Mining To Develop Model For Classifying Diabetic Patient Control Level Based On Historical Medical Records. Journal of Theoretical and Applied Information Technology, 87(2), 316.
6. D. Vasant, F. Neff, P. Gormanns, N. Conte, A. Fritsche, H. Staiger., & P. Robinson (2015). DIAB: an ontology of type 2 diabetes stages and associated phenotypes. Phenotype Day at ISMB, 2015, 24-27.
7. Y. F. Zhang, Y. Wang, P. F. Li., & J. S. Li (2015). An Hl7 Rim-Driven, Ontology-based Approach to Healthcare Knowledge Base Development.
8. N. Chalortham, M. Buranarach & T. Supnithi, (2009, November). Ontology development for type II diabetes mellitus clinical support system. In 4th International Conference on Knowledge Information and Creativity Support Systems.
9. T. M. Ahmed, (2016b). Developing a Predicted Model for Diabetes Type 2 Treatment Plans By Using Data Mining. Journal of Theoretical and Applied Information Technology, 90(2), 181.
10. R. Ali, M. H. Siddiqi, M. Idris, B. H. Kang & S. Lee, (2014, December). Prediction of diabetes mellitus based on boosting ensemble modeling. In International Conference on Ubiquitous Computing and Ambient Intelligence (pp. 25-28). Springer International Publishing.
11. M. Buranarach, N. Chalortham, Y. M., Thein, & T. Supnithi (2011). Design and implementation of an ontology-based clinical reminder system to support chronic disease healthcare. IEICE transactions on information and systems, 94(3), 432-439.
12. R. C., Chen & C. T. Bau (2013). An ontological approach for guideline-based decision support system. International Journal of Computer, Consumer and Control (IJ3C), 2(3), 27-34.
13. J.X., Chen, S.L. Su, and C.H., Chang, 2010, July. Diabetes care decision support system. In *Industrial and Information Systems (IIS), 2010 2nd International Conference on* (Vol. 1, pp. 323-326). IEEE.
14. H. J., Cole-Lewis, A. M., Smaldone, P. R., Davidson, , R., Kukafka, J. N., Tobin, A., Cassells, & L. Mamykina, (2016). Participatory approach to the development of a knowledge base for problem-solving in diabetes self-management. International Journal of Medical Informatics, 85(1), 96-103.
15. S., El-Sappagh, & F. Ali, (2016). DDO: A Diabetes Mellitus Diagnosis Ontology. In Applied Informatics (Vol. 3, No. 1, p. 5). Springer Berlin Heidelberg.
16. S., El-Sappagh, S., El-Masri, M., Elmogy, & A. M. Riad, (2014a). A Diabetes Diagnostic Domain Ontology for CBR System from The Conceptual Model of SNOMED CT. In Engineering and Technology (ICET), 2014 International Conference on (pp. 1-7). IEEE.
17. S. El-Sappagh, M., Elmogy, A. M., Riad, H., Zaghloul, & F. Badria, (2014b). A Proposed SNOMED CT Ontology-Based Encoding Methodology for Diabetes Diagnosis Case-Base. In Computer Engineering & Systems (ICCES), 2014 9th International Conference on (pp. 184-191). IEEE.
18. W., Hayuhardhika, N., Putra, R., Sarno, & M. Sidiq, (2013). Weighted Ontology And Weighted Tree Similarity Algorithm For Diagnosing Diabetes Mellitus. In Computer, Control, Informatics and Its Applications (IC3INA), 2013 International Conference on (pp. 267-272). IEEE.
19. M., Kalpana, & A. S. Kumar, (2011). Fuzzy expert system for diabetes using fuzzy verdict mechanism. International Journal of Advanced Networking and Applications, 3(2), 1128.
20. A. G., Karegowda, A. S., Manjunath, & M. A. Jayaram, (2011). Application of genetic algorithm optimized neural network connection weights for medical diagnosis of pima Indians diabetes. International Journal on Soft Computing, 2(2), 15-23.
21. S., Khanna, & S. Agarwal, (2013). An Integrated Approach towards the prediction of Likelihood of Diabetes. In Machine Intelligence and Research Advancement (ICMIRA), 2013 International Conference on (pp. 294-298). IEEE.
22. B.S. Kumar and Sreejith R. (2016). A Survey on Identification of Diabetes Risk Using Machine Learning Approaches. International Journal of innovative Research in Computer and Communication Engineering. Vol. 4, Issue 9, pp. 16752 – 16756. September 2016.

23. V., Kumar, & L. Velide, (2014). A Data Mining Approach for Prediction and Treatment of Diabetes Disease.
24. C. S., Lee, & M. H. Wang, (2011). A fuzzy expert system for diabetes decision support application. IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics), 41(1), 139-153.
25. S., Mukherjee, M., Thirugnanam, R., Mangayarkarasi, & T. Tamizharasi, (2015). A Review of Softcomputing Methods for Diabetes. International Journal, 5(2).
26. T., Muthuraman, & G. Sankaran, (2014). A framework for personalized decision support system for the healthcare application.
27. Z., Nakhla, & K. Nouira, (2012). Development of Ontology for the Representation of Adverse Drug Events of Diabetes Disease. Development, 42(20).
28. M., Pradhan, K., Kohale, P., Naikade, A., Pachore, & E. Palwe, (2012). Design of classifier for detection of diabetes using neural network and fuzzy k-nearest neighbor algorithm. International Journal of Computational Engineering Research, 2(5), 1384-1387.
29. E., Rabina, & A. Chopra, (2016). Diabetes Prediction By Supervised And Unsupervised Learning With Feature Selection.
30. A., Rahimi, S.T., Liaw, J., Taggart, P. Ray, and H., Yu, 2014. Validating an ontology-based algorithm to identify patients with type 2 diabetes mellitus in electronic health records. International journal of medical informatics, 83(10), pp.768-778.
31. Á. C., Ribeiro, A. K., Barros, E., Santana, & J. C. Príncipe, (2015). Diabetes classification using a redundancy reduction preprocessor. Research on Biomedical Engineering, 31(2), 97-106.
32. S. P., Shetty, & S. Joshi, (2016). A Tool for Diabetes Prediction and Monitoring Using Data Mining Technique. International Journal of Information Technology and Computer Science (IJITCS), 8(11), 26.
33. O. S., Soliman, & E. AboElhamd, (2014). Classification of Diabetes Mellitus using Modified Particle Swarm Optimization and Least Squares Support Vector Machine. arXiv preprint arXiv:1405.0549.
34. E., Sreedevi, & M. Padmavathamma, (2015). A Threshold Genetic Algorithm for Diagnosis of Diabetes using Minkowski Distance Method. International Journal of Innovative Research in Science, Engineering and technology (IJIRSET). Vol. 4, Issue 7, July 2015.
35. F. G., Sumaiya, A., Geetha (2016) Domain Independent Model for Data Prediction and Visualization, International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 0882. Volume 5, Issue 4, April 2016
36. C., Thiyagarajan, K. A., Kumar, & Bharathi, A. (2016). A Survey on Diabetes Mellitus Prediction Using Machine Learning Techniques. International Journal of Applied Engineering Research, 11(3), 1810-1814.
37. B., Biochini, P.G., Miaan, A.C.C., Natali, G.H, Travassos, Systematic review in software Engineering and Computer Science, 2005

Authors Profile

Folashade Mercy Okikiola received B.Sc in Computer Science from University of Ado, Ekiti State, Nigeria in 2002 . and M.Tech. degrees in Computer Science from Federal University of Technology, Akure, Ondo State, Nigeria in 2009. Currently running her Ph.D. in Computer Science from Federal University of Technology Akure, Ondo State. She is a Certified Oracle Programmer (OCA,SQL & OCP). She is a member of Nigeria Computer Society (NCS).She has written many scholarly papers in both local and international Journals and has authored and co-authored many text books in computer science. She has her research interest in information systems, information security and big data technology

Abiodun Muyideen Mustapha received the B.Sc. and M.Sc. degrees in Computer Science from Federal University of Agriculture, Abeokuta, Ogun State, Nigeria in 2013 and 2017, respectively. He is a graduate member of the Computer Professionals of Nigeria (CPN) which is a professional body. He has presented papers in conference and published in both local and international journals. He has his research interest in requirements engineering, cloud computing, pattern recognition and information systems.

Oluwatoyin Abigaill Akinade received her B.Tech in Computer Engineering from Ladoke Akintola University Of Technology Ogbomoso, Osun State, Nigeria in 2004 and M.Sc. degree in Computer Science from University of Ibadan, Oyo State, Nigeria in 2011. She is a member of Nigeria Computer Society (NCS).She has written many scholarly papers in both local and international Journals and has authored and co-authored many text books in computer science. She has her research interest in Telemedicine

Elizabeth Oluwatoyin Adeleye received Higher National Diplomal in Computer Science from Yaba College of Technology, Lagos state , PGD in Computer Science from Federal University of Agriculture, Abeokuta, Ogun State, Nigeria in 1998 and 2012 respectively. She is currently running a M.Sc .degree programme in Computer Science at Babcock University, Illisan, Ogun State, Nigeria. She is a member of Nigeria Computer Society (NCS) and Computer Professionals of Nigeria (CPN). She has written many scholarly papers in both local and international Journals.

Christiana Yetunde Alonge received B.Sc in Computer Science from Ondo State University Ekiti State, Nigeria in 1996 and PGD Education from Bayero University, Kano State 2007. Currently, running M.Sc .degrees in Computer Science from Federal University of Agriculture, Abeokuta, Ogun State Nigeria . She is a member of Nigeria Computer Society (NCS). She has written many scholarly papers in conference proceedings in computer science. She has her research interest in Cloud computing and requirements engineering.