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Contraceptives Informatics Expert System Model (COINEX)

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Abstract: *Despite widespread awareness of contraceptive methods and their effectiveness, their utilization remains low, which is attributed in part to misconceptions and inadequate recommendations. Studies have shown that not all contraceptives have side effects, and only a few women who use contraceptives have discomfort. A lack of adequate recommendations, counsel and perceptions are mitigating the willingness to use contraceptives. The increase in the Nigerian population growth rate calls for prompt and adequate responses to regulate birth control. This study addresses this gap by developing a rule-based contraceptive informatics expert system. Primary data on contraceptive discomfort were collected, and knowledge from various sources, including human experts and medical websites, was extracted. Feature engineering was employed to select relevant variables for model development. The system, implemented using Java programming, provides user-friendly interfaces and accurately displays contraceptive discomfort based on patient blood type. Our findings suggest that an expert system has the potential to increase willingness to use contraceptives. We recommend the adoption of technology-aided tools by governments to provide precise and accurate contraceptive recommendations.*

Keywords: expert system and contraceptive

1. Introduction

The rapid population growth of a country such as Nigeria, whose population is over 200 million, calls for concern. It was believed that more people imply greater productivity and security since more workers or labourers working efficiently would be expected to vastly improve productivity and the overall output of the nation [26]. [26], for example, stated that as the global fertility rate continues to outweigh the mortality rate, and currently, with almost 7 billion people, global natural resources are being placed under considerable strain. This, in turn, gives rise to negative consequences through the different aspects of human life that are being hampered, especially in developing nations such as Nigeria [16]. Nigeria is one of the fastest-growing countries in the world, with a population growth rate of approximately 2.44% as of 2016 according to the Central Bank of Nigeria; it is the most populous country in Africa, is endowed with a wide range of natural resources, and accounts for one in five of the people of Sub-Saharan Africa. According to the National Population Commission as of 2016, Nigeria's population was 182.2 million, while the population growth was estimated to be 206 million in 2020[28].

Birth control is imperative for achieving rapid population growth, as has been experienced in Nigeria and other developing countries in recent years. Birth control can be achieved using either natural methods or contraception methods [17]. The contraception methods used are hormonal-based. There are various types of contraception, including oral pills, injections, diaphragms, implants, intrauterine contraception, etc. The use of modern-day contraception requires the expertise of medical professionals, doctors and midwives in counselling and administering most contraceptives. These methods seem to be promising and a suitable way of preventing unwanted pregnancy [17].

Not all contraceptive methods have side effects, and most women who use contraceptive methods do not experience any discomfort. However, despite widespread awareness of the effectiveness of contraceptive methods for birth control, the number of women who practice birth control through the use of contraceptive methods is less than the number of women who do not use any contraceptives.

If there is widespread awareness and people are indeed aware of numerous contraceptive methods and their effectiveness, why are most couples not using them? To answer this question, we attempted to unravel the factors responsible for couples' unwillingness to use contraceptives, with the aim of using the findings to construct an expert system model for contraceptives. It is believed that if there is proper guidance and recommendations that an expert system is capable of providing, couples will do away with negative perceptions of contraceptives, which are spread by a few women who experience discomfort in the use of some contraceptives, which makes it look as if contraceptive usage is not good.

Our expert system provides right and appropriate recommendations for contraceptive methods, minimized if not eliminating the fear of the unknown and inconvenience experienced by women by the right suggestion for the best contraceptive method. This will encourage more women to use contraception for family planning. It will assist in keeping records and statistics of contraceptive methods administered. This information will help greatly in decision-making by stakeholders. In addition, medical practitioners can use the system as a guide for recommending and administering contraceptives, thereby helping the government achieve awareness/campaign on family planning. Tremendous contributions to the health area have been made by the expert system over the last ten years. Expert systems will continue to play an increasingly important role in the health field [1].

2. Expert system (ES)

Expert systems are computer programs that are derived from a branch of computer science research called artificial intelligence (AI) [1]. The scientific goal of AI is to comprehend intelligence by building software that reveals intelligent comportment. AI deals with the perceptions and approaches of figurative inference, or reasoning, by a PC and how the knowledge that can be used to create those inferences will be embodied in the machine [19].
ES aims to mimic the decision-making abilities of a human expert in a specific domain or field. They utilize a knowledge base consisting of rules, facts, and heuristics to provide advice, recommendations, or solutions to complex problems.
Expert or knowledge-based systems are the most common types of AI systems in routine clinical use. They contain medical knowledge, usually about a very specifically defined task, and can reason with data from individual patients to come up with reasoned conclusions [24]. We must note that systematic and responsible observations are very important factors for the adoption of family planning (FP) methods. This remark is especially important when the collection of data and chart interpretation are realized automatically using a PC system. The computer system can fulfil the following expectations concerning the two main inconveniences of NFP methods: the necessity of documenting daily observations and good knowledge about the rules of fertility and infertility. These abovementioned inconveniences can be realized using well-designed ES with a clear and friendly graphical interface [27]. The explanation, fast response, steady, unemotional, and complete response at all times, intelligent tutor, and intelligent database increase. The first implementations of the algorithms concern the basic situations in the woman's life only; of great importance is the development of a rule set to ensure safe and clinically relevant alerts and instructions [18].
Expert system approach

Expert Systems (ES): ES rely on explicit knowledge encoded by human experts in the form of rules, if-then statements, or decision trees. They use logical reasoning and inference mechanisms to interpret and apply this knowledge to new situations or problems.

Integration machine and expert system

Expert systems can utilize ML techniques for tasks such as data preprocessing, feature selection, or improving the accuracy of their decision-making processes.

Considering a medical diagnosis system, ML algorithms can be trained on historical patient data to recognize patterns in symptoms and diagnoses. These learned patterns can then be integrated into an expert system that provides diagnostic recommendations based on a patient's symptoms and medical history.

3. Brief review of expert systems in health

[4] presented an expert system for diagnosing feeding problems in infants and children, and the expert system was found to be a helpful methodology. The authors believed that their expert system was the initial step in attaining good performance in a real-world application. It was developed to aid parents in diagnosing these problems and receiving recommendations on how to address infants and children.

[8] addressed genital problems and injuries that mostly occur as the result of recreational activities (such as basketball, football, hooky, and biking), work-related tasks (such as contact with irritating chemicals), downhill droppings, and sexual activities. They used the SL5 Object expert system language to develop this expert system. Additionally, [10]. presented an expert system that diagnoses genital problems in infants, which is one of the most common problems that requires quick intervention in the newborn stage.

[11] designed an expert system to aid users in obtaining an accurate diagnosis of nausea and vomiting in infants and children (e.g., gastroesophageal reflux, gastroenteritis, systemic infection, bowel obstruction, tumors, bleeding disease, tonsillitis, and hepatitis pharynx). Additionally, this expert system offers information about the disease and how to address it. The SL5 Object Expert System language was used for development.

[6] proposed an expert system that can be used to positively diagnose low back pain concentration. This system asks for symptoms, and finally, the patient can pick the illness producing these symptoms and recommend the appropriate treatment. [14] used an expert system to diagnose eighteen-foot problems in all phases of human life, beginning with the baby and progressing to the adult stage, through an examination with yes/no questions. The expert system asks the end user to select the right answer on every screen. Later, the expert system provides diagnoses and recommendations to the user.

[9] The knowledge-based system can diagnose seven neck diseases of different phases of human life beginning by asking the user many questions according to their pain symptoms. SL5 Object language, a rule-based language, was used in designing and implementing the knowledge-based system for neck disease diagnosis.

[13] An expert system for shoulder problem diagnosis was designed and implemented using the CLIPS language, which was developed by NASA's Johnson Space Center in 1996. [15] designed an expert system to diagnose several urinary diseases (pyelonephritis, kidney stones, bladder infection, prostatitis, urethritis, gonorrhoea, interstitial cystitis, stress incontinence, and trauma in the kidney or bladder). A brief introduction to the disease was given, the cause of the disease was outlined, and proper treatment of the disease whenever possible was provided. SL5 Object language was used for designing this expert system

In [12], an expert system asked the user to answer questions about the symptoms of the patient and provided some information about the disease and advice about how to address the baby. The SL5 Object Expert System Language was used to develop the expert system.

[7]. The researchers presented an expert system for male infertility diagnosis that helps men explore problems related to infertility and infertility diseases, such as azoospermia and O.T.A., which are characterized by oligo-terato-astheno-spermia, aspergillaemia and sexually transmitted disease. This expert system for male infertility diagnosis used 5th generation language called the SL5 Object language [2]. for its design and development.

[3] presented the design of an expert system that provides patients with a background for suitable diagnosis of a few eye diseases. The CLIPS language was used as a tool for developing the expert system. A preliminary evaluation of the expert system was performed, and the outcome was positive.

[5] addresses the design of a prototype expert system that assists patients in diagnosing their diseases and offers them suitable advice. The knowledge management used in the expert system was discussed. The main objective of this research was to identify a suitable language for representing a user's medical history and current situation in a knowledge base for expert systems to carry out consultations effectively. Rules were used to capture the knowledge. The expert system was implemented using CLIPS (C Language Integrated Production System) with the Java Interface.

[17] carried out a study with the aim of developing a medical factor-based mobile application model for contraceptive implants. K-nearest neighbor (KNN) and support vector machine (SVM) techniques were used for the prediction of discomfort and blood type. Their model was tested by the use of the Predict function. The experimental results showed that the prediction accuracy of the KNN model was 85.72%, and that of the SVM model was 92.2%. SVM outperformed KNN. Therefore, they concluded that the model can be used to choose the right contraceptive that is friendly to one blood type. They then implemented a prediction mobile application of the tested model frontend in an Android built-in with Java as the programming language.

Therefore, this study adopted a decision tree integrated with an expert system. Decision was used to build the model, and the expert system was then implemented using the decision tree model results. Thus, our system is a rule-based system.

4. Methodology

To build our contraceptive expert system, a structured methodology was followed from problem identification to inference engine and testing, as described in the following sections.

4.1 Problem identification

Our concern lies in the low utilization of contraceptives among women, despite their awareness of the effectiveness of these methods for family planning. Additionally, there is a lack of information regarding specific discomfort associated with each contraceptive method. To address this issue and better understand the negative perceptions surrounding contraceptive methods, we conducted a study in collaboration with the family planning units of five selected primary healthcare centers in the Yola North Local Government Area of Adamawa State.

These centers were chosen because they are among the few large primary healthcare centers, and the researchers' proximity to the centers facilitated monitoring and contributions to providing family planning support, ensuring good population representation.

4.2 Knowledge Acquisition

Researchers first observed relevant document records on contraceptives with the aim of examining records of conditions and factors considered in administering contraceptives to women. Interviews were conducted with 200 participants from the five selected primary healthcare centers after they had been administered contraceptives. These methods were chosen due to the small population size of participants.

4.3 Procedure for knowledge acquisition

Researchers liaised with selected centers, holding meetings at each center to brief heads of family planning units on the aims and objectives of the research and their role in gathering relevant and reliable data. Modalities for collecting data were agreed upon, including convincing women to participate, conducting all stated tests for volunteer participants, and administering contraceptives. During administration, family planning units conducted pregnancy tests, measured blood pressure, and recorded relevant data on the VDCF.

The VDEF is the tool researchers used to collect data on volunteers' discomfort as a result of the use of contraceptives. The VDEF consists of several columns. The columns include the blood group and type of contraceptive administered to the volunteer, and the other columns are for discomfort. The discomforts included headache, fever, weight loss, weight gain, increased apatite, loss of appetite, etc. The data were collected from the knowledge base for the system.

4.4 Knowledge Representation

4.4.1 Data Cleaning

The collected data were cleaned to ensure that they were accurate, complete, and consistent. We removed duplicates, handled missing values, and resolved inconsistencies.

4.4.2 Feature Engineering

Discomfort based on blood type in contraceptive methods was identified and regarded as relevant features used in the rules of the expert system. These discomforts include dizziness, weight gain, increased appetite, unusual menstruation, and fever, among others. These are transformed into meaningful features that capture the relevant aspects of the problem domain.

4.4.3 Inference Engine Development

The inference engine is the backbone of the expert system. It is responsible for reasoning and making deductions based on the acquired knowledge. This involves implementing algorithms to perform rule firing, which refers to the process by which rules are applied based on the conditions specified in the rules.

We defined and implemented the system antecedent and consequent of our model. The antecedent is the "IF statements" rule that specifies the conditions that must be satisfied for the rule action to be taken. Consequent is the "THEN". This part of the rule specifies the action or conclusion that should be taken if the conditions specified in the antecedent are met.

When the system receives input data, the inference engine of the rule-based system evaluates the antecedents of all the rules to determine which rules are "firable" based on the current state of the system.

Once the applicable rules are identified, the inference engine fires these rules, executing the actions specified in their consequents. This process of rule firing leads to the generation of new information, the modification of system state, or the triggering of further rules in a chain reaction.

Rule firing is typically performed iteratively, with the system evaluating the applicability of rules and firing them in a sequential and parallel manner until a predefined termination condition is met.

4.4.3 Rule Validation

Our expert system model was evaluated for the effectiveness and correctness of the rules by testing against known cases.

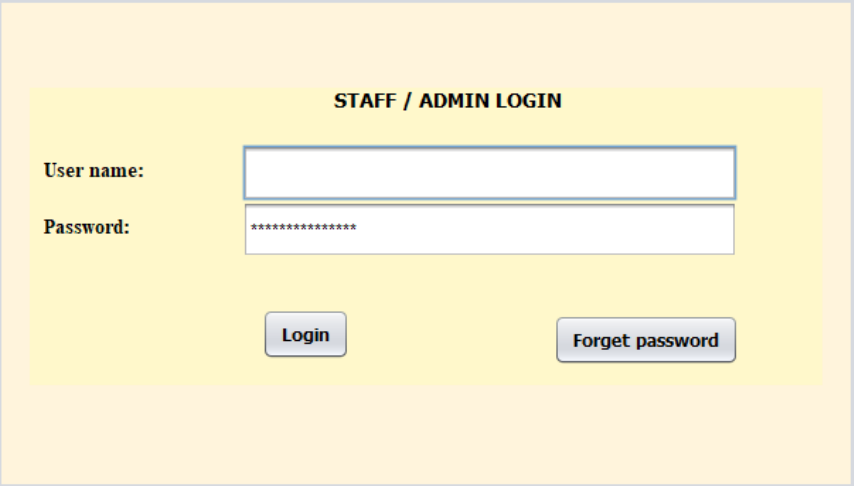
5. Implementation

One of the objectives of this research is to develop COINEX, a system designed to provide reliable recommendations on contraceptives and anticipate possible inconveniences. In line with these objectives, the research utilized the results to implement the system. The implementation involved employing a rule-based technique. The system's knowledge base was built using MySQL and hosted on a WAMP server. It is a window-based system, with the front end developed using Java.

The system comprises two views: the admin view and the user view. Below are the implemented front-end views of the system.

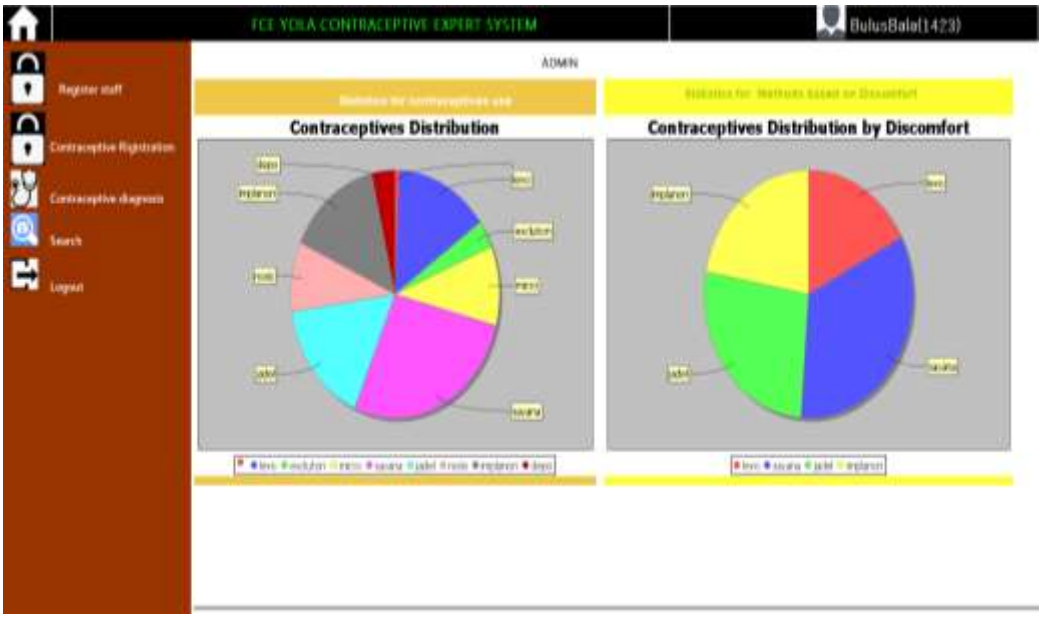
5.1 Login View

This is the view accessible to either the admin or other staff members responsible for managing the system. It features a simple, user-friendly interface with two input fields: one for the username and the other for the password, as depicted in Figure 1 below. Users are required to enter their authentication details into these input fields. Upon successful authentication, either the admin or user dashboard will open, depending on the credentials provided.



5.2 Admin/Admin Dashboard

The admin serves as the primary user of the system and is responsible for granting access and privileges to other users. Admin officers register new users and issue access credentials. These credentials are then used by the users to access the system's functionalities. The admin dashboard, depicted in Figure 2 below, provides access to various functions.



From the administrative dashboard, the administrative officer can view contraceptive statistics, including usage and associated discomfort, presented in a pie chart. The contraceptive distribution section provides statistics on all contraceptive methods used, categorized by whether discomfort was reported. Additionally, the contraceptive distribution by discomfort section presents statistics

on methods based on women's reported discomfort. Other functions that the admin can perform include "contraceptive registration," "contraceptive diagnosis," and "reset user password."

5.5 CONTRACEPTIVE DIGNOSIS

This interface enables both the admin and other users to utilize the system for prediction and recommendation purposes. It primarily serves women experiencing discomfort as a result of any contraceptive method administered to them. Users can utilize this interface to determine a woman's blood type if she is unaware, simply by inputting her experience.

Additionally, this interface allows users to inform clients about the potential discomfort associated with each method and recommend the best method based on the woman's blood group. Users can simply enter the blood group in a search box. Figure 4 illustrates the contraceptive diagnosis.

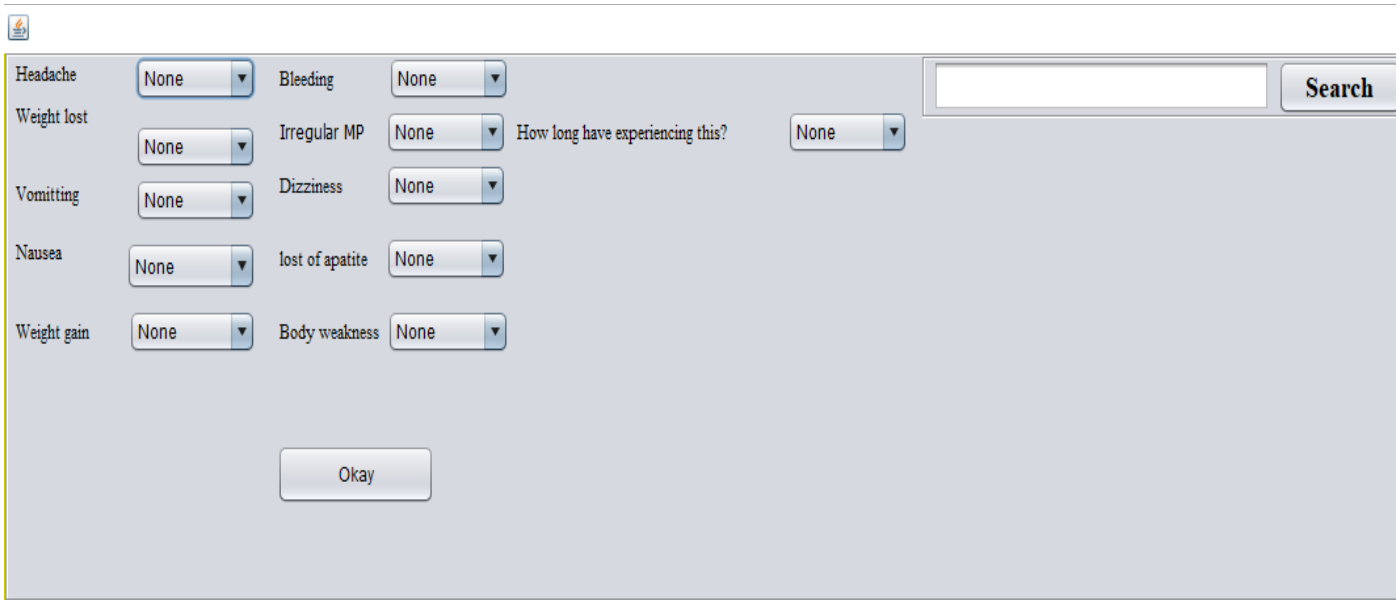


Figure 4: Contraceptive diagnosis

6. Conclusion

Our research aimed to develop an expert system that provides recommendations on various contraceptive methods. For those who experience discomfort, the nature of discomfort varies across different methods and blood types. Women with similar blood types tend to experience similar discomfort. Consequently, the expert system COINEX is constructed based on the insights derived from the study. COINEX, the developed expert system, is designed to align with these findings by offering dependable recommendations for contraceptive use.

5. Recommendations Based on Findings:

- ✓ Tailored Recommendations: Healthcare providers should prioritize personalized contraceptive recommendations, taking into account individual factors such as blood type, to minimize discomfort and improve user satisfaction. This can enhance the effectiveness and acceptability of contraceptive methods among women.
- ✓ Accessibility and Affordability: Efforts should be made to ensure the accessibility and affordability of modern contraceptive methods, particularly for marginalized and underserved communities. This includes improving access to healthcare facilities offering contraceptive services and subsidizing costs where necessary.
- ✓ Continuous Monitoring and Evaluation: Healthcare systems should establish mechanisms for continuous monitoring and evaluation of contraceptive usage, including tracking discomforts and side effects experienced by women. These data can inform ongoing improvements in contraceptive services and guide future research initiatives.
- ✓ Research and Development: Further research and development efforts should focus on refining contraceptive methods to minimize discomfort and side effects while maximizing effectiveness. This may involve exploring innovative technologies and formulations tailored to individual needs, including considerations based on blood type.

Reference

[1] Abu-Nasser, B. S. and S. S. Abu-Naser (2018). "Rule-Based System for Watermelon Diseases and Treatment." International Journal of Academic Information Systems Research (IJAISR) 2(7): 1-7.
[2] Abu-Nasser, B. S. and S. S. Abu-Naser (2018). "Cognitive System for Helping Farmers in Diagnosing Watermelon Diseases." International Journal of Academic Information Systems Research (IJAISR) 2(7): 1-7.
[3] Abu-Naser, S. S. (2015). "Sl5 Object: Simpler Level 5 Object Expert System Language." International Journal of Soft Computing, Mathematics and Control (IJSCMC) 4(4): 25-37.
[4] Abu-Naser, S. S. and A. Z. A. Ola (2008). "An Expert System For Diagnosing Eye Diseases Using CLIPS." Journal of Theoretical and Applied Information Technology 4(10).
[5] Abu-Naser, S. S. and Alawar, M. W. (2016). An expert system for feeding problems in infants and children. International Journal of Medicine Research, 1(2), 79-82.
[6] Abu-Naser, S., Al-Dahdooh, R., Mushtaha, A. and El-Naffar, M. (2010). Knowledge management in ESMDA: expert system for medical diagnostic assistance. AIML Journal, 10(1), 31-40.
[7] Abu-Naser, S. S. and Al-Bayed, M. H. (2016). Detecting Health Problems Related to Addiction of Video Game Playing
[8] Abu-Naser, S. S. and AlDahdooh, R. M. (2016). Lower Back Pain Expert System Diagnosis And Treatment. Journal of Multidisciplinary Engineering Science Studies (JMESS), 2(4), 441-446.
[9] Abu-Naser, S. S. and Alhabbash, M. I. (2016). Male Infertility Expert system Diagnoses and Treatment. American Journal of Innovative Research and Applied Sciences, 2(4).
[10] Abu-Naser, S. S. and Al-Hanjori, M. M. (2016). An expert system for men genital problems diagnosis and treatment. International Journal of Medicine Research, 1(2), 83-86.
[11] Abu-Naser, S. S. and ALmursheidi, S. H. (2016). A Knowledge Based System for Neck Pain Diagnosis. Worldwide Journal of Multidisciplinary Research and Development (WWJMRD), 2(4), 12-18.
[12] Abu-Naser, S. S. and El Haddad, I. A. (2016). An Expert System for Genital Problems in Infants. EUROPEAN ACADEMIC RESEARCH, 4(10).
[13] Abu-Naser, S. S. and El-Najjar, A. E. A. (2016). An expert system for nausea and vomiting problems in infants and children. International Journal of Medicine Research, 1(2), 114-117.
[14] Abu-Naser, S. S. and Hamed, M. A. (2016). An Expert System for Mouth Problems in Infants and Children. Journal of Multidisciplinary Engineering Science Studies (JMESS), 2(4), 468-476.
[15] Abu-Naser, S. S. and Hilles, M. M. (2016). An expert system for shoulder problems using CLIPS. Worldwide Journal of Multidisciplinary Research and Development, 2(5), 1-8.
[16] Abu-Naser, S. S. and Mahdi, A. O. (2016). A proposed Expert System for Foot Diseases Diagnosis. American Journal of Innovative Research and Applied Sciences, 2(4), 155-168.
[17] Abu-Naser, S. S. and Shaath, M. Z. (2016). Expert system urination problems diagnosis. Worldwide Journal of Multidisciplinary Research and Development, 2(5), 9-19.
[18] Adedoyin, T. A. (2021). AN ANALYSIS ON THE IMPACT OF POPULATION GROWTH ON THE ECONOMY OF NIGERIA International Journal of New Economics and Social Sciences № 2(14)2021
[19] Bala, P.B., and Yusuf, M. M. (2023). Medical Factors-Based Mobile Application for Choosing Contraceptives: A Data Mining Approach. American Journal of Data Mining and Knowledge Discovery. Vol. 8, No. 1, pp. 1-10. doi:0.11648/j.ajdmkd.20230801.11
[20] Emily, S., Kevin, J. Leonard, J. A. Cafazzo, J.B., Caterina, M.and Heather, J. (2012). Developing healthcare rule-based expert systems: Case study of a heart failure telemonitoring system. International Journal of Medical Informatics, 81(8), Pg 556-565, ISSN 1386-5056, https://doi.org/10.1016/j.ijmedinf.2012.03.001.
[21] Gath, S. J., and Kulkarni, R. V. (2012). Review: Expert System for Diagnosis of Myocardial Infarction, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 3 (6), 2012,5315- 5321
[22] Hassan, R., Al-Insaif, S., Hossain, M. I., and Kamruzzaman, J. (2020). A Machine Learning Approach for Prediction of Pregnancy Outcome following IVF Treatment. Neural Computing and Applications DOI: 10.1007/s00521-018-3693-9.
[23] Haq, I., Hossain, I., Rahman, M., Methun, I. H, Talukder, A., Jakaria Habib, J and Hossain, S., (2022). Contraceptive Practice among Ever-Married Women in Bangladesh: A Hierarchical Machine Learning Classification Approach. DOI: http://dx.doi.org/10.5772/intechopen.103187
[24] Jothi, N. and Husain, W. (2015). Data mining in healthcare: A review. Procedia Comput. Sci. 2015; 72: 306–313. doi: 10.1016/j.12.145. [CrossRef] [Google Scholar].
[25] Mitra, S. (1994). Fuzzy MLP Based Expert System For Medical Diagnosis. Fuzzy Set and Systems, 65:285- 296.
[26] Russell, S., and Norvig, P. (2002). Artificial Intelligence: A Modern Approach, Prentice Hall, Englewood Cliffs, NJ, Second Edition. ISBN 0-13-103805-2.
[27] Tartiyus, E.H., Dauda, M.I., and Peter, A (2015). Impact of Population Growth on Economic Growth in Nigeria (1980-2010). IOSR Journal of Humanities and Social Science (IOSRJHSS), Volume 20, Issue 4, Ver. V, PP 115-123

[28] Urbaniak, A. (1996). Expert system for diagnosing women's menstrual cycle using the natural family planning method Presented at the 17th IFIP Conference on System ModeUing and Optimization.
[29] World Population Data Sheet (WPDS) (2015). Washington: Population Reference Bureau, 1-3.