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WEB-BASED MEDICAL EXPERT SYSTEM FOR DIAGNOSING KIDNEY DISEASES: THE SYSTEMATIC LITERATURE REVIEW

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Abstract

The kidneys play a vital role in filtering toxins from the blood, producing hormones, and maintaining metabolic processes in the body. However, kidney diseases, including kidney stones, kidney infections, and kidney failure, are increasingly prevalent due to poor lifestyle choices. Expert systems, designed to simulate the decision-making capabilities of specialists, are gaining prominence in diagnosing various diseases, including kidney disorders. This study employs a Systematic Literature Review (SLR) methodology to analyze eight recent articles on web-based expert systems for kidney disease diagnosis. The review examines various expert system approaches, including Certainty Factor, Dempster Shafer, and Forward Chaining, and their effectiveness in diagnosing conditions like kidney stones, acute kidney failure, and chronic kidney disease. The results reveal that while these systems offer reliable diagnoses and are accessible across multiple platforms, there is a need for further research in expanding the range of diagnosable diseases and refining diagnostic criteria. Suggestions for future work include incorporating user-specific data, such as gender and lifestyle, and exploring alternative diagnostic approaches like fuzzy logic systems. This study contributes valuable insights into the development of more comprehensive and accessible web-based expert systems for kidney disease diagnosis, which could support healthcare practitioners and patients alike in the timely detection and management of kidney-related conditions.

Keywords: ***Systematic literature study, Web, Medical expert system, Kidney diseases.***

INTRODUCTION

The kidneys filter the blood of toxic compounds which are then excreted through urine and play a role in the synthesis of various hormones, such as erythropoietin which stimulates the production of red blood cells, as well as vitamin D which plays a role in maintaining bone health and regulating blood pressure (Harahap et al. 2022). The kidneys play a crucial role in the body's metabolic processes. However, due to the busyness of daily life, we often forget to properly maintain them. Unhealthy eating patterns, inadequate consumption of fiber and water, and the intake of high calorie processed foods and drinks can unintentionally increase the strain on the kidneys. This impacts various processes, including filtration, reabsorption, and the processing of nutrients transported to the kidneys via the bloodstream (Donaldo and Rasiban 2022). Several types of kidney diseases include kidney stones, nephritis, and renal failure (Sari, Defit, and Nurcahyo 2020). Kidney disease is a condition that necessitates the expertise of a specialist for both diagnosis and prevention, as it can rapidly impact the human body, especially in adults and the elderly. However, specialists face challenges in providing constant care for patients with this condition due to limitations in time and available resources (Pulungan and Medelfii 2020).

An expert system is a computer program that replicates the knowledge and decision-making of specialists to solve specific problems, widely used in fields like education, industry, and healthcare, including for diagnosing conditions (Sulardi and Witanti 2020). The rapid advancement of Information and Communication Technology (ICT) has facilitated human life, with web-based applications being favored for their cross-platform compatibility and ease of use (Budiman, Ahdan, and Aziz 2021). Web-based expert systems will make it easier for users to access expert information in a lightweight, easy, fast, and accessible manner anytime and anywhere. However, not all expert system research implements it in a web-based form, and some are not even developed

as applications, making them difficult to use. This study employs the Systematic Literature Review (SLR) method to systematically gather, assess, and synthesize relevant scientific data, aiming to offer a thorough understanding of the studied diseases through documented information over a defined timeframe. This study also contributes by summarizing and providing further understanding of existing web-based expert system research with certain limitations, so that it can serve as a reference in developing future web-based expert system research, especially for kidney disease diagnosis.

METHOD

This research uses SLR to evaluate web-based expert system research articles for kidney disease diagnosis with the following steps.

Research Question

A research question articulates the central focus of the study, guiding the research process and establishing its scope and objectives (Lestari et al. 2023). Some of the research questions used in this study include:

RQ1. What expert system method approach was chosen by the research to be reviewed?

RQ2. What web application development approach was chosen by the research to be reviewed, e.g. programming language?

RQ3. What are the kidney diseases that can be identified by the expert system in the study?

RQ4. What are the results of developing a web-based expert system for diagnosing kidney disease?

Search Process

This stage is the stage of searching for articles to review. Articles were searched using a browser and Google Scholar with the keywords “sistem pakar penyakit ginjal web” in Bahasa Indonesia with years from 2020. Articles were searched only up to the fifth page of the search results.

Inclusion and Exclusion Criteria

After obtaining the results of the search process, each article was given certain restrictions using inclusion and exclusion criteria. The inclusion and exclusion criteria used are as follows:

Inclusion Criteria:

a. The articles search used the Google Scholar search engine.
b. Article publication is carried out from 2020.
c. The articles concentrate on the development of a web-based expert system for the diagnosis of kidney disease in general.

Exclusion Criteria:

a. The article does not discuss a web-based expert system for diagnosing kidney disease.
b. The article is not eligible for the assigned keywords.

Data Collection

Data were collected by observing search results on Google Scholar and literature review of articles that met the inclusion criteria. After collecting data, the data is analyzed to gain understanding, knowledge, and information, especially regarding the research results of developing a web-based expert system to diagnose kidney disease.

Quality Assessment

Then the articles were analyzed by quality assessment so that the information written was in accordance with the scope of this research. Some quality assessment questions in this study are as follows:

QA1. Does the research to be reviewed been published since 2020?

QA2. Does the research to be reviewed discuss an expert system for diagnosing kidney disease in general?

QA3. Does the research to be reviewed discuss implementing the web for its expert system application?

Then the answer to the quality assessment question used is Y (yes) which means the article matches the quality assessment.

RESULTS AND DISCUSSION

Search Process Results

The article search process is carried out with keywords and years of publication that have been determined on Google Scholar. The search process results are shown in Figure 1. Searching up to the fifth page, 50 journal articles were found.

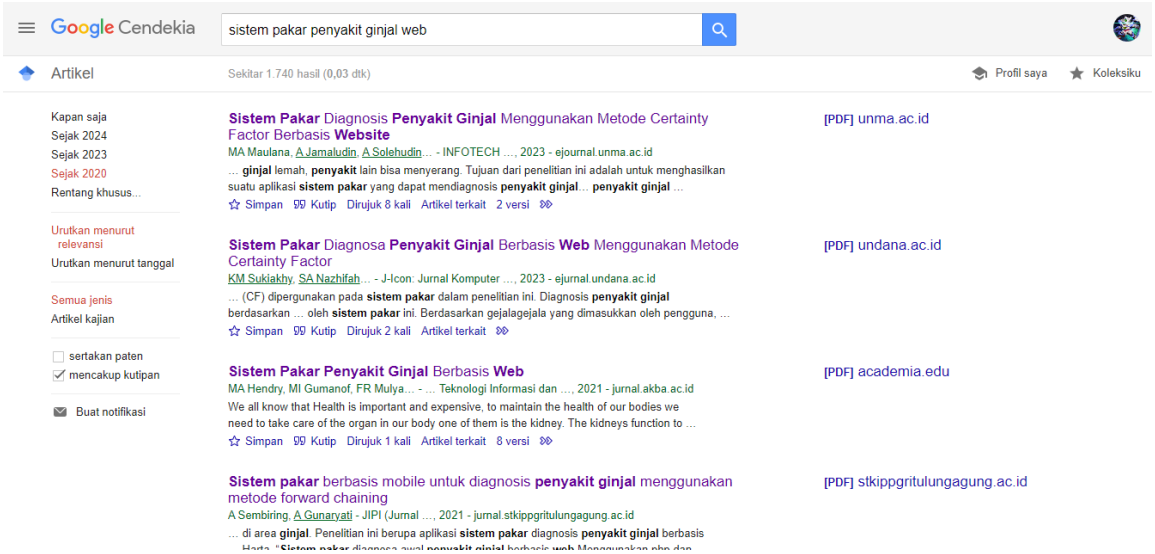

Figure 1. The search process results

Inclusion and Exclusion Criteria and Quality Assessment Results

Of the 50 articles found, only 8 met the inclusion and quality assessment criteria. The quality assessment results of the eight articles are described in Table 1.

Table 1. Quality Assessment Results

No.	Author	Title	Year Published	QA1	QA2	QA3
1	Jeffry, Syahrul Usman	PENERAPAN METODE CERTAINTY FACTOR DAN FORWARD CHAINING PADA SISTEM PAKAR UNTUK MENDIAGNOSA PENYAKIT GINJAL (Jeffry and Syahrul Usman 2020)	2020	Y	Y	Y
2	Eka Fitriani, Iqbal Kamil Siregar, Yori Apridonal M	EXPERT SYSTEM FORWARD CHAINING METHOD DIAGNOSA PADA PENYAKIT GINJAL (Fitriani, Kamil Siregar, and Apridonal M 2024)	2024	Y	Y	Y
3	Mukhroji,	Perancangan Aplikasi Sistem Pakar	2022	Y	Y	Y

No.	Author	Title	Year Published	QA1	QA2	QA3
	Ismuhadi	Doagnosa Awal Penyakit Batu Ginjal Berbasis Web Dengan Menggunakan Metode Forward Chaining (Mukhroji and Ismuhadi 2022)				
4	Yonathan, Benisius	PERANCANGAN SISTEM PAKAR DIAGNOSIS PENYAKIT GINJAL MENGGUNAKAN METODE DEMPSTER-SHAFER BERBASIS WEBSITE (Yonathan and Benisius 2020)	2020	Y	Y	Y
5	Yulia, Arif Rahman Hakim, Sasa Ani Arnomo	DIAGNOSA PENYAKIT GINJAL BERBASIS WEB MENGGUNAKAN METODE FORWARD CHAINING (Yulia, Rahman Hakim, and Ani Arnomo 2024)	2024	Y	Y	Y
6	Kikye Martiwi Sukiakhy, Sri Azizah Nazhifah, Junidar	SISTEM PAKAR DIAGNOSIS PENYAKIT GINJAL BERBASIS WEB MENGGUNAKAN METODE CERTAINTY FACTOR (Sukiakhy, Nazhifah, and Junidar 2023)	2023	Y	Y	Y
7	Muhammad Adrian Maulana, Asep Jamaludin, Arip Solehudin, Apriade Voutama	SISTEM PAKAR DIAGNOSIS PENYAKIT GINJAL MENGGUNAKAN METODE CERTAINTY FACTOR BERBASIS WEBSITE (Maulana et al. 2023)	2023	Y	Y	Y
8	Sri Wahyuni, Jeperson Hutahaean, Cecep Maulana	Penerapan Metode Metode Dempster Shafer Untuk Mendiagnosa Penyakit Ginjal Berbasis Web (Wahyuni, Hutahaean, and Maulana 2022)	2022	Y	Y	Y

Result Discussions

Research Questions (RQ1, RQ2, RQ3 and RQ4) are clarified and discussed in this section.

RQ1. What expert system method approach was chosen by the research to be reviewed?

From the eight articles that met the quality assessment, the description of the selected expert system approach is described in Table 2.

Table 2. The description of the selected expert system approach

No.	Methods	Total
1	Certainty Factor	3
2	Dempster Shafer	2
3	Forward Chaining	4

From Table 2, eight articles found that there are three approaches chosen, namely Certainty Factor, Dempster Shafer, and Forward Chaining. There is one article that combines the Certainty Factor method to get the certainty score and Forward Chaining for inference (Jeffry and Syahrul Usman 2020). It can be concluded that the Certainty Factor, Dempster Shafer, and Forward Chaining methods are still trending as approaches to developing expert systems. There should be other alternative approaches to develop expert systems to diagnose kidney disease, for example fuzzy-based expert systems.

RQ2. What web application development approach was chosen by the research to be reviewed, e.g. programming language?

From the eight articles that met the quality assessment, the description of the selected web application development approach is described in Table 3.

Table 3. The description of the selected expert system approach

No.	Programming Language	Total
1	Native PHP	5
2	CodeIgniter Framework	2
3	Not mentioned	1

From Table 3, it can be concluded that the PHP programming language is still the main choice of researchers to develop web-based expert systems for diagnosing kidney disease. One study did not explicitly mention the programming language used in developing its expert system (Fitriani, Kamil Siregar, and Apridonal M 2024). The future suggestion is to explicitly write down the programming language used in software development research. Then use other PHP frameworks such as Laravel as an alternative to CodeIgniter and develop natively. Other web programming languages should also be considered for developing expert systems, one of which is JavaScript and its frameworks.

RQ3. What are the kidney diseases that can be identified by the expert system in the study?

From the eight articles that met the quality assessment, the kidney diseases that can be identified by the expert systems are described in Table 4.

Table 4. The kidney diseases that can be identified by the expert systems

No.	Kidney Diseases	Total
1	Kidney infection	3
2	Kidney stones	4
3	Polycystic kidney disease	2
4	Kidney failure	1
5	Acute kidney failure	4
6	Chronic kidney disease	4
7	Kidney cancer	1
8	Pyelonephritis	1
9	Nephrotic Syndrome	1
10	Hydronephrosis	1
11	Bladder cancer	1
12	Tubulointerstitial nephritis	1
13	Cystitis	1
14	Urinary Tract Infection (UTI)	2
15	Glomerulonephritis	1
16	Not mentioned in detail.	2

Based on the data presented in Table 4, the primary kidney diseases targeted for expert system development include kidney stones, acute kidney failure, and chronic kidney disease, each of which is addressed by four studies. In contrast, bladder diseases appear to receive less focus, with fewer studies specifically targeting these conditions. Additionally, two studies (Fitriani, Kamil Siregar, and Apridonal M 2024; Yulia, Rahman Hakim, and Ani Arnomo 2024) did not specify the diseases that their expert systems were designed to diagnose, indicating a need for greater detail on the specific conditions addressed by these systems. Notably, kidney cancer were each discussed in only one study (Jeffry and Syahrul Usman 2020), suggesting that further exploration is needed to develop expert systems capable of diagnosing these two kidney diseases.

RQ4. What are the results of developing a web-based expert system for diagnosing kidney disease?

In general, the eight studies yield consistent findings, indicating that the expert systems are capable of providing accurate diagnoses for kidney diseases. Furthermore, these expert systems are easily accessible by various user groups, as they are web-based. One study offers several suggestions for future research (Sukiakhy, Nazhifah, and Junidar 2023), including the addition of kidney disease symptoms to enhance diagnostic specificity, the inclusion of a broader range of kidney diseases that can be identified, and the incorporation of user information such as gender and lifestyle as input data for more personalized diagnoses.

CLOSING

Conclusion

This study has systematically reviewed recent research on web-based expert systems for diagnosing kidney diseases. The findings indicate that kidney stones, acute kidney failure, and chronic kidney disease are the most commonly addressed conditions, with a majority of expert systems employing methods such as Certainty Factor, Dempster Shafer, and Forward Chaining. These systems are accessible via web platforms, making them easy to use and available to a broad audience. While the existing research demonstrates that these systems are capable of providing accurate diagnoses, there remains a need for further exploration in certain areas, such as the diagnosis of kidney cancer and the incorporation of a wider range of kidney diseases. Additionally, future studies could benefit from integrating more detailed diagnostic criteria and user-specific input data, such as gender and lifestyle, to improve the precision of diagnoses.

Suggestions

Based on the findings of this study, several suggestions for future research can be made. First, researchers should explore alternative methods beyond Certainty Factor, Dempster Shafer, and Forward Chaining, such as fuzzy logic systems, to enhance the adaptability and accuracy of expert systems. Second, the scope of kidney diseases diagnosable by expert systems should be expanded, particularly for conditions like kidney cancer and kidney failure, which have been underrepresented in current studies. Furthermore, detailed descriptions of the web application development process, including the specific programming languages and frameworks used, should be explicitly stated in future studies to aid reproducibility and development. Lastly, incorporating user-specific factors, such as gender and lifestyle, as part of the diagnostic process could enhance the system's personalization and overall effectiveness.

REFERENCES

Budiman, Arief, Syaiful Ahdan, and Muhammad Aziz. 2021. "ANALISIS CELAH KEAMANAN APLIKASI WEB E-LEARNING UNIVERSITAS ABC DENGAN VULNERABILITY ASSESMENT." *Jurnal Komputasi* 9 (2): 361–67. https://doi.org/10.23960/komputasi.v9i2.2800.

Donaldo, Evan, and Rasiban. 2022. "Klasifikasi Sistem Pakar Mendiagnosa Penyakit Batu Ginjal Dengan Metode Forward Chaining." *Pendidikan Dan Konseling* 4:1059–65.

Fitriani, Eka, Iqbal Kamil Siregar, and Yori Apridonal M. 2024. "EXPERT SYSTEM FORWARD CHAINING METHOD DIAGNOSA PADA PENYAKIT GINJAL." *Journal of Computer* 4 (3): 329–36. https://doi.org/https://doi.org/10.33330/j-com.v4i3.3429.

Harahap, F. A. A., R. M. Sinaga, K. Arifin, and K. S. 2022. "Implementasi Algoritma Convolutional Neural Network Untuk Mendeteksi Penyakit Ginjal Implementation of Convolutional Neural Network for Detecting Kidney Disease." *Teknologi Informasi, Komputer Dan Aplikasinya (JTIKA)* 4 (2): 212–19. http://jtika.if.unram.ac.id/index.php/JTIKA/.

Jeffry, and Syahrul Usman. 2020. "Penerapan Metode Certainty Factor Dan Forward Chaining

Pada Sistem Pakar Untuk Mendiagnosa Penyakit Ginjal." *Indonesian Journal of Intellectual Publication* 1 (1): 21–32. https://doi.org/10.51577/ijipublication.v1i1.35.

Lestari, Alin, Halim Wijaya, Nanang Selamet Riyadi, and Perani Rosyani. 2023. "Systematic Literature Review: Sistem Pakar Diagnosis Penyakit Pada Manusia Menggunakan Metode Backward Channing." *BIIKMA : Buletin Ilmiah Ilmu Komputer Dan Multimedia* 1 (1): 71–77. https://scholar.google.com/.

Maulana, Muhammad Adrian, Asep Jamaludin, Arip Solehudin, and Apriade Voutama. 2023. "Sistem Pakar Diagnosis Penyakit Ginjal Menggunakan Metode Certainty Factor Berbasis Website." *INFOTECH Journal* 9 (2): 431–41. https://doi.org/10.31949/infotech.v9i2.6389.

Mukhroji, Mukhroji, and Ismuhadi Ismuhadi. 2022. "Perancangan Aplikasi Sistem Pakar Doagnosa Awal Penyakit Batu Ginjal Berbasis Web Dengan Menggunakan Metode Forward Chaining." *Jurnal Ilmiah Informatika* 10 (01): 15–19. https://doi.org/10.33884/jif.v10i01.4513.

Pulungan, Wahyu Alfandry, and Dwini Medelfii. 2020. "Sistem Pakar Menentukan Penyakit Ginjal Dengan Metode Forward Chaining." *Ultima InfoSys : Jurnal Ilmu Sistem Informasi* 11 (1): 27–32. https://doi.org/10.31937/si.v9i1.1369.

Sari, Meilinda, Sarjon Defit, and Gunadi Widi Nurcahyo. 2020. "Sistem Pakar Deteksi Penyakit Pada Anak Menggunakan Metode Forward Chaining." *Jurnal Sistim Informasi Dan Teknologi* 2:130–35. https://doi.org/10.37034/jsisfotek.v2i4.34.

Sukiakhy, Kikye Martiwi, Sri Azizah Nazhifah, and Junidar Junidar. 2023. "Sistem Pakar Diagnosa Penyakit Ginjal Berbasis Web Menggunakan Metode Certainty Factor." *Jurnal Komputer Dan Informatika* 11 (1): 117–25. https://doi.org/10.35508/jicon.v11i1.9931.

Sulardi, Naftali, and Arita Witanti. 2020. "Sistem Pakar Untuk Diagnosis Penyakit Anemia Menggunakan Teorema Bayes." *Jurnal Teknik Informatika (Jutif)* 1 (1): 19–24. https://doi.org/10.20884/1.jutif.2020.1.1.12.

Wahyuni, Sri, Jeperson Hutahaean, and Cecep Maulana. 2022. "Penerapan Metode Metode Dempster Shafer Untuk Mendiagnosa Penyakit Ginjal Berbasis Web." *Building of Informatics, Technology and Science (BITS)* 4 (2): 915–23. https://doi.org/10.47065/bits.v4i2.2166.

Yonathan, and Benisius. 2020. "Perancangan Sistem Pakar Diagnosis Penyakit Ginjal Menggunakan Metode Dempster-Shafer Berbasis Website." *Journal of Information System, Informatics and Computing* 4 (1): 107–15. http://journal.stmikjayakarta.ac.id/index.php/jisicom/article/view/215%0Ahttps://journal.stmikjayakarta.ac.id/index.php/jisicom/article/download/215/170.

Yulia, Arif Rahman Hakim, and Sasa Ani Arnomo. 2024. "DIAGNOSA PENYAKIT GINJAL BERBASIS WEB MENGGUNAKAN METODE FORWARD CHAINING." *Jurnal Ilmu Komputer Dan Sistem Informasi* 1 (1): 43–51.