CERTAINTY FACTORS FOR DETECTING PREECLAMPSIA RISK BASED ON PREGNANCY TRIMESTER: A LITERATURE REVIEW

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ABSTRACT

Preeclampsia is a leading cause of maternal and fetal death. Early detection of the risk of preeclampsia is essential. This study aims to analyze the application of the Certainty Factor method in an expert system for early detection of preeclampsia risk, identify preeclampsia symptoms based on trimester of pregnancy, and develop recommendations for developing a knowledge base that matches the characteristics of preeclampsia symptoms. The study used a literature review method through article searches in the Scopus and Google Scholar databases, a selection process based on inclusion and exclusion criteria, extraction, descriptive analysis, and synthesis of eligible articles. The analysis focused on the application of the Certainty Factor method, knowledge sources, symptoms used, inference techniques, diagnostic results, and the characteristics of preeclampsia symptoms in each trimester of pregnancy. The results show that the Certainty Factor method has been widely applied in expert systems to support early detection of preeclampsia and other pregnancy-related diseases through rule-based reasoning and diagnostic confidence level calculations. Research still uses a static knowledge base without considering changes in symptom characteristics according to gestational age. It is proposed that the development of a knowledge base structured by trimester of pregnancy aims to improve inference accuracy and reduce misinterpretation of symptoms.

KEYWORDS Certainty Factor, Expert System, Risk Preeclampsia, Knowledge Base, Pregnancy Trimester

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INTRODUCTION

Preeclampsia is a condition characterized by hypertension that develops after 20 weeks of gestation and is accompanied by proteinuria; it can progress to eclampsia. Preeclampsia remains the leading cause of maternal and infant mortality worldwide. Ten million women experience preeclampsia, which leads to other complications such as hemorrhage, cesarean delivery, low birth weight, and maternal and infant mortality. Hemorrhage remains the leading cause of maternal mortality, followed by preeclampsia. Eighty percent of maternal deaths are caused by hypertension and preeclampsia. Preeclampsia is a primary target for reducing maternal mortality rates by the Indonesian government. The maternal mortality rate in Indonesia is reported to be 305 per 100,000 live births. Morocco and Nigeria have reported that preeclampsia and eclampsia contribute to maternal and infant mortality(Akbar et al., 2025; Gayatri et al., 2022; Oumbarek et al., 2025; Pribadi, 2021). Based on these trends, there is a need to utilize information systems, such as expert systems, to aid in the detection of preeclampsia risk

An expert system was developed to help healthcare professionals detect the risk of preeclampsia earlier. The expert system utilizes various algorithms to analyze and predict the risk of preeclampsia. The benefits for healthcare professionals include early detection, prevention of complications in mothers and fetuses, and improved accuracy and efficiency in their work (Puspita et al., 2026; Rahman et al., 2023). One of the methods used for disease diagnosis in expert systems is the certainty factor.

The certainty factor (CF) is a method used in expert systems to address uncertainty in diagnosis. By combining expert judgment and symptom data, the CF provides a quick and accurate diagnosis(Tarigan, 2021). However, there are still some limitations to the application of the CF in dynamic health conditions such as preeclampsia.

A trimester-based expert system for preeclampsia has unique characteristics that influence diagnostic outcomes. Differences in the management of the same symptoms across different trimesters affect diagnostic needs. A trimester-based approach enables the expert system to provide follow-up care to patients and identify risks(Lyu et al., 2025).

Based on the description, it is necessary to conduct a study to analyze the application of the Certainty Factor method in an expert system to support early detection of preeclampsia risk, identify preeclampsia symptoms based on trimester of pregnancy, and compile recommendations for developing a knowledge base that is in accordance with the characteristics of preeclampsia symptoms.

RESEARCH METHOD

This research is a literature review involving the analysis and evaluation of various literature sources relevant to the research topic. The main objective of this study is to analyze the application of the Certainty Factor method in an expert system for detecting the risk of preeclampsia and to identify preeclampsia symptoms based on trimester as the basis for developing an expert system knowledge base. The literature review was conducted by synthesizing various research results to answer the research questions (a) to identify studies that use the Certainty Factor method for the diagnosis or detection of preeclampsia during pregnancy; (b) to analyze the application of the Certainty Factor method in expert systems for preeclampsia detection; (c) to identify symptoms of preeclampsia in the first, second, and third trimesters based on the literature, and (d) to formulate recommendations for the future development of an expert system for preeclampsia detection.

Data collection was conducted in June 2026 through searches on Scopus and Google Scholar using the keywords “Certainty Factor” AND “preeclampsia”; “Certainty Factor” AND “pregnancy”; “preeclampsia symptoms” AND “trimester.” Inclusion criteria were journal articles or research proceedings available in full text, written in Indonesian or English, published between 2021 and 2026, discussing the application of the Certainty Factor method in expert systems for the diagnosis of preeclampsia or the detection of other pregnancy-related conditions, as well as articles discussing preeclampsia symptoms based on the trimester of pregnancy. Exclusion criteria include duplicate articles, articles available only as abstracts, undergraduate theses, master’s theses, doctoral dissertations, books, non-research publications, articles not available in full text, articles in languages other than Indonesian or English, and articles irrelevant to the search topic. The article selection process is presented in Figure 1.

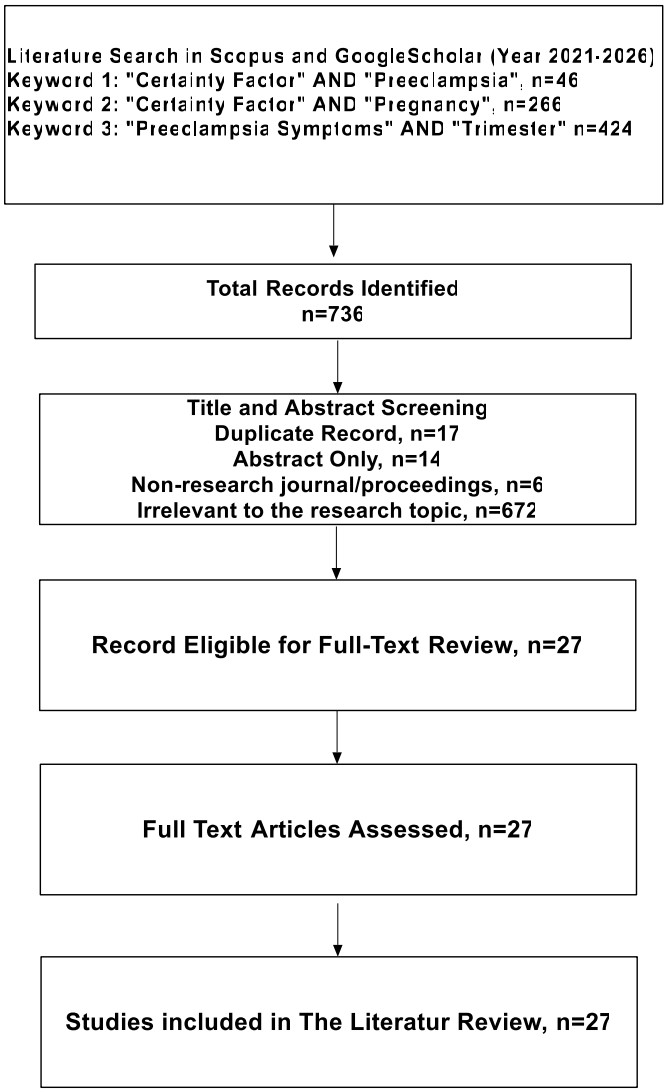


Figure 1. Article Selection Process

Twenty seven selected articles will be analyzed to extract information regarding the author’s name, year of publication, type of publication, research objectives, the

pregnancy related disease or condition discussed, implementation of the Certainty Factor method, inference techniques used, the knowledge base or symptoms used as diagnostic parameters, system platform, validation methods, research results, and study limitations. Information on clinical symptoms of preeclampsia in each trimester of pregnancy was extracted from articles identified using the search terms “preeclampsia symptoms” AND “trimester.”

The extracted data were then analyzed descriptively by grouping the articles into three topics: the application of the Certainty Factor method in the diagnosis of preeclampsia, the application of the Certainty Factor method in an expert system for pregnancy related diseases, and symptoms of preeclampsia based on the trimester of pregnancy. The analysis was conducted by comparing the results of the method’s application, the knowledge base, the symptoms used, the inference techniques, the validation methods, the results, and the limitations of each study.

The synthesis phase was used to synthesize the results of the analysis in order to identify the application of the Certainty Factor method, developments in expert system research in the field of pregnancy, the consistency of preeclampsia symptoms based on clinical literature, and research gaps. The results of this synthesis served as the basis for formulating the discussion and providing recommendations for the development of a Certainty Factor based expert system for the early detection of preeclampsia, with a knowledge base tailored to each trimester of pregnancy.

RESULT AND DISCUSSION

Result

Peer-Reviewed Articles

Table1. Articles Reviewed

No	Title	Author	Year
1	Sistem Peringatan Awal Resiko Preeklampsia Pada Kehamilan Menggunakan Metoda Certainty Factor	Fitrilina, M. Albbi, Indra Agustian, Afriyastuti Herawati, Nikki Aldi Massardi	2021
2	Sistem Pakar Deteksi Dini Penyakit Preeklamsia Pada Ibu Hamil Menggunakan Metode Certainty Factor	Nur Wachid Adi Prasetya, Linda Perdana Wanti, Laura Sari, Lina Puspitasari	2022
3	Sistem Deteksi Dini Penyakit Preeklampsia Melalui Perubahan Warna Urine Berdasarkan Protein Dengan Menggunakan Metode Naïve Bayes Classifier	Fakhrul Allaam, Barlian Henryranu Prasetio, Rizal Maulana	2023
4	Pregnancy Disease Diagnostic Expert System With Certainty Factor Method	Embun Fajar Wati, Elvi Sunita Perangin-Angin, Budi Sudrajat	2021
5	Pre-Eclampsia Diagnosis Expert System Using Fuzzy Inference System Mamdani	Siprianus Septian Manek; Grandianus Seda Mada; Yoseph P.K. Kelen	2023
6	Penerapan Metode Certainty Factor Untuk Mendiagnosa Penyakit Preekslamsia Pada Ibu Hamil Dengan Menggunakan Bahasa Pemrograman Python	Kharis Hudaiby Hanif, Novita Ranti Muntiari, Putri Ananda Ramadhani	2022
7	Expert System Of Preeclampsia Diagnosis Using Certainty Factor Method	Kiki Dea Ananda Tarigan, Magdalena Simanjuntak, Yani Maulita	2024
8	Expert System Implementation Using Certainty Factor Method For Early Pregnancy Disease Detection	Nanda Syarla Hariyanti, Afina Lina Nurlaili, Firza Prima Aditiawan	2026
9	Expert System For Early Detection Of High-Risk Pregnancy Conditions Using Certainty Factor And Forward Chaining Methods	Febria Dwi Vadlisky, Hamdani Hamdani, Fahrul Agus	2025

No	Title	Author	Year
10	Application Of Forward Chaining And Rule-Based Reasoning Methods To Design An Expert System For Pregnant Women Disease Diagnosis In A Private Hospital	Abdul Tahir,Donny Hendriyanto, Ana Faizah, Jamil Anshory, Rofiq Harun	2024
11	Sistem Pakar Diagnosis Penyakit Berdasarkan Keluhan Saat Kehamilan Menggunakan Metode Forward Chaining Dan Certainty Factor (Studi Kasus : Klinik Alqila)	Ryan Ramadhan, Asep Jamaludin, Arip Solehudin	2023
12	Sistem Pakar Deteksi Dini Masalah Kesehatan Pada Ibu Hamil Berbasis Web: Literature Review	Zufar Abyan Handito,Aridhanyati Arifin	2023
13	Sistem Pakar Diagnosis Penyakit Gangguan Kehamilan Menggunakan Metode Forward Chaining Dan Certainty Factor Berbasis Web	Shinta Siti Sundari, Sarmidi, Ai Fitri Nuraropah	2021
14	Sistem Pakar Diagnostik Dini Risiko Preeklampsia Pada Ibu Hamil Berbasis Certainty Factor	Tar Muhammad Raja Gunung, Alyiza Dwi Ningtyas, Dinda Dian Meidita, Manutur Pandapotan Siregar, Vicky Rolando	2026
15	Sistem Cerdas Kesehatan Ibu Hamil Menggunakan Metode Certainty Factor	Nurhayati, Siti Farida, Dwi Lestari Mukti Palupi	2021
16	Penerapan Sistem Pakar Untuk Mendeteksi Dini Masalah Kesehatan Ibu Hamil: Systematic Literature Review	Melinia Betha Nureza, Aridhanyati Arifin	2023
17	Penerapan Sistem Pakar Diagnosa Sectio Caesarea Pada Ibu Hamil Berbasis Android Dengan Menggunakan Metode Certainty Factor	Rici Surya Ardani Diningrat, Murni Marbun	2022
18	Implementasi Certainty Factor Dalam Mendiagnosa Penyakit Hamil Anggur (Mola Hidatidosa)	Erika Fahmi Ginting	2025
19	Analisis Hemoroid Pada Ibu Hamil Dengan Sistem Certainty Factor	Indri Damayani, Rizaldi, Sudarmin	2025
20	Sistim Pakar Diagnosis Gangguan Pada Kehamilan Trimester Pertama Menggunakan Metode Certainty Factor Berbasis Web	Sebastianus Adi Santoso Mola , Diana Inda Carmilla Tokan , Tiwuk Widiastuti	2023
21	Preeclampsia And Eclampsia-Specific Maternal Mortality In Bangladesh : Levels, Trends, Timing And Care-Seeking Practices	Shusmita Khan, Abu Bakkar Siddique, Sabrina Jabeen, Aniqa Tasnim Hossain, M Moinuddin Haider, Fatema Tuz Zohora, Md Mahabubur Rahman, Shams El Arifeen, Ahmed Ehsanur Rahman, Kanta Jamil	2023
22	Midwifery Care For Pregnant Women In Trimester III With Pre-Eclampsia At RSUD Dr H. Moch. Ansari Saleh Banjarmasin	Noor Latifah, Ika Avrilina Haryono1, Fitri Yuliana	2023
23	Preeclampsia In Saudi Arabia: A Systematic Review And Meta-Analysis Of Prevalence, Risk Factors, Awareness, And Outcomes	Rwdyn R. Nujoom , Raghad B. Babader, Albatul A. Aloufi , Mohammed Malibary , Nouf H. Alshareef , Fatema M. Shoaib , Afrah Almteri , Leen S. Al Maqwashi , Maria D. Alrafi	2025
24	Preeclampsia 2.0: The Urgent Need For New Thinking	Berthold Huppertz	2026
25	Practical Considerations Concerning Preeclampsia Subgroups	Peter Tamas, Balint Farkas ,Jozsef Betlehem	2025
26	Isolated Sixth Nerve Palsy As The First Manifestation Of Preeclampsia	Sneha Annie Sebastian, Karanbir Singh , Inderbir Padda	2023

No	Title	Author	Year
27	Pregnant Women Behaviours In Early Detection Of Preeclampsia Warning Signs Based On Health Belief Model: A Structural Equal Modelling Analysis	Dwi Rukma Santi , Dewi Retno Suminar, Shrimarti Rukmini Devy, Mahmudah	2022

Studies Using the Certainty Factor Method for the Diagnosis or Detection of Preeclampsia in Pregnancy

Based on the reviewed articles, the characteristics of expert system studies on preeclampsia detection using the certainty factor focus on the early detection of preeclampsia and other pregnancy related conditions through the identification of symptoms and risk factors(Hariyanti et al., 2026; Ramadhan et al., 2023; Tarigan et al., 2024). The system assists in diagnosis and provides recommendations for the management of preeclampsia(Hanif et al., 2022; Sundari et al., 2021). Additional features for monitoring pregnancy conditions have been added, such as integration with blood pressure monitors and the provision of information on fetal development to improve the effectiveness of early detection (Fitrilina et al., 2021; Nurhayati et al., 2022). Expert systems can identify pregnancy risk factors and improve access to healthcare services through online platforms; these systems aim to reduce diagnostic delays, lower consultation costs, and support efforts to reduce the Maternal Mortality Rate(Gunung et al., 2026; Prasetya et al., 2022; Vadlisky et al., 2025; Wati et al., 2023)

Application of the Certainty Factor Method in an Expert System for Preeclampsia

Based on the articles reviewed, all of them applied the Certainty Factor (CF) method to address uncertainty in the diagnostic process. Expert knowledge is presented in a rule-based format, followed by the calculation of the Measure of Belief (MB), Measure of Disbelief (MD), and Combined CF, which are useful for determining the level of confidence in the diagnostic results. Most studies use a standard formula to calculate the certainty value for a single symptom, namely $CF[H,E] = MB[H,E] - MD[H,E]$. The combined CF is calculated as $CFcombine = CFold + CFsymptom \times (1 - CFold)$ (Diningrat & Marbun, 2022; Gunung et al., 2026; Handito & Arifin, 2023; Hanif et al., 2022; Nureza & Arifin, 2023; Sundari et al., 2021; K. D. A. Tarigan et al., 2024). The knowledge base was derived from the expertise of obstetricians and midwives, as well as medical records obtained through observation and interviews. The summarized symptoms of preeclampsia include hypertension, proteinuria, edema, epigastric pain, visual disturbances, and a history of hypertension (Fitrilina et al., 2021; Nurhayati et al., 2022; Prasetya et al., 2022; Ramadhan et al., 2023; Vadlisky et al., 2025).

Differences in the application of CF result from multiplying expert weights by the User CF; there are combinations of CF with other uncertainty methods, such as Fuzzy Logic and Bayes. These CF combinations impact the system's ability to handle data uncertainty and the inference reasoning process (Fitrilina et al., 2021; Ginting, 2025; Hariyanti et al., 2026; Prasetya et al., 2022; Ramadhan et al., 2023; Tahir et al., 2024). The output of the expert system consists of diagnostic results in the form of CF percentage values and risk level classifications for certain diseases, including preeclampsia, eclampsia, and many other pregnancy related conditions(Fitrilina et al., 2021; Gunung et al., 2026; Hariyanti et al., 2026; Prasetya et al., 2022; K. D. A. Tarigan et al., 2024; Wati et al., 2023). The interpretation scale and threshold range from -1 (definitely not) to 1 (definitely). The risk categories are classified as Low (0–40%), Moderate (41–70%), and High (71–100%); additionally, a specific threshold of 95.62% is used to determine whether an individual falls into the preeclampsia category(Fitrilina et al., 2021; Gunung et al., 2026).

Symptoms of Preeclampsia by Trimester

Based on the reviewed articles, the symptoms of preeclampsia by trimester can be summarized as shown in Table 2.

Table 2: Symptoms of Preeclampsia by Trimester

Trimester	Symptoms/Signs of Preeclampsia	Support Resources
First Trimester (0–13 weeks 6 days)	Hypertension before 20 weeks (requires evaluation because it is generally not preeclampsia, but may be a risk factor), dizziness, nausea, and vomiting	(Huppertz, 2026; Khan et al., 2023; Latifah et al., 2023; K. D. A. Tarigan et al., 2024; Vadlisky et al., 2025)
Second Trimester (14 weeks 0 days – 27 weeks 6 days)	Hypertension (≥140/90 mmHg), proteinuria, edema, severe headache, seizures (eclampsia), visual disturbances, epigastric pain/right upper quadrant pain	(Fitrilina et al., 2021; Hanif et al., 2022; Huppertz, 2026; Khan et al., 2023; Latifah et al., 2023; Nujoom et al., 2025; Prasetya et al., 2022; Ramadhan et al., 2023; Sundari et al., 2021; Tamas et al., 2025; K. D. A. Tarigan et al., 2024; Wati et al., 2023)
Third Trimester (28 weeks 0 days – 42 weeks)	Hypertension, proteinuria, edema, severe headache, visual disturbances, epigastric pain, oliguria, shortness of breath, seizures (eclampsia), intrauterine growth restriction (IUGR), decreased fetal movement	(Fitrilina et al., 2021; Hanif et al., 2022; Khan et al., 2023; Latifah et al., 2023; Nujoom et al., 2025; Prasetya et al., 2022; Ramadhan et al., 2023; Santi et al., 2023; Sebastian et al., 2023; Sundari et al., 2021; Tamas et al., 2025; K. D. A. Tarigan et al., 2024; Vadlisky et al., 2025; Wati et al., 2023)

Preeclampsia usually occurs clinically after 20 weeks of gestation, although symptoms may appear as early as the beginning of pregnancy (Allaam et al., 2023; Santi et al., 2023; K. D. A. Tarigan et al., 2024). In the first trimester, symptoms are dominated by nausea, vomiting, weakness, weight loss, and bleeding, which is generally associated with miscarriage or molar pregnancy(Ginting, 2025; Mola et al., 2023; Nurhayati et al., 2022). In the second trimester, particularly after 20 weeks, characteristic signs of preeclampsia begin to appear, such as hypertension, edema, and sudden weight gain(Hanif et al., 2022; Nurhayati et al., 2022; Vadlisky et al., 2025). By the third trimester, symptoms may become more severe, with complications such as eclampsia, oliguria, shortness of breath, and neck pain(Hariyanti et al., 2026; Latifah et al., 2023; Wati et al., 2023).

Recommendations for Developing an Expert System for Preeclampsia Detection

According to the reviewed articles, existing studies still have limitations, such as focusing on only one disease, requiring manual symptom input, lacking clinical validation, having a static knowledge base and CF values, and lacking transparency in the diagnostic process. In general, these studies suggest the development of an expert system capable of handling various pregnancy complications, the integration of the system with IoT to automatically collect clinical data, and the inclusion of clinical validation(Allaam et al., 2023; Damayani et al., 2025; Fitrilina et al., 2021; Hariyanti et al., 2026; Manek et al., 2023; Sundari et al., 2021).

Discussion

Application of the Certainty Factor Method

The CF method is widely used in expert systems for preeclampsia detection to account for uncertainty in the disease diagnosis process. Research studies apply expert CF to symptoms through IF-THEN rules and inferences using forward chaining. The application of CF involves determining CF values using expert and user weights; some studies also combine it with Fuzzy Logic or Bayesian methods to improve diagnostic accuracy.

The reviewed articles rely solely on clinical symptoms to draw conclusions about the disease without considering risk factor recommendations such as those in the WHO guidelines, which include taking into account symptoms and past medical history (WHO, 2011). It is necessary to incorporate preeclampsia risk factors into the CF knowledge base to improve the expert system's ability to perform early detection.

Implementation of the Expert System Knowledge Base

According to the reviewed articles, the knowledge base was compiled based on the expertise of obstetricians and medical literature. The symptoms used as the primary indicators of preeclampsia are hypertension, proteinuria, edema, severe headaches, visual disturbances, and epigastric pain.

These findings are consistent with WHO guidelines, which state that hypertension occurring after 20 weeks of gestation is the primary sign of preeclampsia. The WHO also emphasizes the need to consider pregnancy risk factors as part of early detection(WHO, 2011). The knowledge base must include symptoms, risk factors, and preventive measures in accordance with clinical guidelines.

Analysis of Preeclampsia Symptoms by Trimester

Based on the reviewed articles, evidence shows that preeclampsia develops in accordance with gestational age. Symptoms in the first trimester, such as nausea, vomiting, fatigue, and weight loss, are often considered normal physical changes associated with pregnancy. In the second trimester, at a gestational age of more than 20 weeks, symptoms such as hypertension, proteinuria, edema, severe headaches, visual disturbances, and epigastric pain begin to appear. Symptoms of preeclampsia become more severe in the third trimester, including shortness of breath, impaired fetal growth, and even eclampsia.

The study findings are consistent with WHO guidelines, which state that symptoms in the first trimester are still considered a risk factor(WHO, 2011). Gestational age, expressed in trimesters, is an important variable used in formulating the rules for the expert system.

Research Gaps and Recommendations for Development

Based on the reviewed articles, expert systems still use a static knowledge base and rely on manual symptom input. The expert systems in the reviewed studies do not yet provide clinical recommendations. A pregnant woman at risk for preeclampsia requires low-dose aspirin before 20 weeks of gestation (WHO, 2011).

The recommended development of an expert system should integrate risk factors, prevention recommendations, clinical validation, and integration with other technologies such as the Internet of Things (IoT) and machine learning, so that the expert system serves not only as a diagnostic tool but more as a clinical decision support system.

Implementation of a Trimester-Based Knowledge Base

Based on the reviewed articles, the expert system developed still uses a single knowledge base for the entire pregnancy period, whereas the characteristics of preeclampsia can change depending on the gestational age. This leads to symptoms being misinterpreted and considered common complaints in early pregnancy, when in fact they are signs of a medical condition.

The WHO states that preeclampsia can be diagnosed after 20 weeks of gestation, and prevention can begin as early as the start of the first trimester at 12 weeks of gestation (WHO, 2011).

There is a need to develop an expert system with a trimester-based knowledge base capable of distinguishing between physiological and pathological symptoms. The developed expert system is capable of adjusting inferences based on gestational age. A knowledge base organized by trimester provides an approach that more accurately reflects the clinical conditions of pregnant women. With a knowledge base organized by trimester, it is possible to distinguish common physiological symptoms, such as typical pregnancy complaints, from pathological symptoms indicative of preeclampsia. Inference rules and CF weights can be adjusted based on gestational age, thereby strengthening the reasoning process. The trimester-based knowledge base is expected to improve accuracy, reduce false positives and false negatives in search results, and enhance the quality of the preeclampsia detection expert system compared to the use of a static knowledge base.

CONCLUSION

This literature review analyzes 27 journal articles and conference proceedings that discuss the application of the Certainty Factor method in expert systems for diagnosing pregnancy related conditions and in studies of preeclampsia symptoms. The results show that the Certainty Factor method has been widely applied in expert systems for the early detection of preeclampsia and other pregnancy related conditions, and is capable of presenting the expert's level of confidence in a diagnosis and supporting decision-making through rule-based reasoning.

The results indicate that most studies still use a single knowledge base applicable to the entire pregnancy without considering differences in symptom characteristics across each trimester. Clinical reviews indicate that the manifestation of preeclampsia evolves according to gestational age, with differences in symptoms and dominant risk factors observed in the first, second, and third trimesters. This suggests that the knowledge bases currently used in expert systems do not adequately reflect the clinical progression of preeclampsia throughout pregnancy.

This study identified a research gap, namely the suboptimal application of a knowledge base structured by trimester in a Certainty Factor-based expert system. Expert system development should utilize separate knowledge bases based on trimesters, with Certainty Factor rules and weights adjusted to reflect changes in symptoms at each stage of pregnancy. This approach is expected to improve the accuracy of early detection of preeclampsia risk and reduce misinterpretation of symptoms.

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REFERENCES

Akbar, M. I. A., Gumilar, K. E., Aziz, M. A., Pribadi, A., Bachnas, M. A., Aryanda, R. A., & Dekker, G. (2025). Maternal death associated with preeclampsia in Indonesia. *Pregnancy Hypertension*, *42*(November), 101400. https://doi.org/10.1016/j.preghy.2025.101400

Allaam, F., Prasetio, B. H., & Maulana, R. (2023). Sistem Deteksi Dini Penyakit Preeklampsia Melalui Perubahan Warna Urine Berdasarkan Protein dengan

Menggunakan Metode Naive Bayes Classifier. *Jurnal Teknologi Informasi dan Ilmu Komputer*, *10*(4), 807–814. https://doi.org/10.25126/jtiik.20241046908

Damayani, I., Sudarmin, S., & Piliang, R. (2025). Analisis Hemoroid Pada Ibu Hamil Dengan Sistem Certainty Factor. *Jurnal Sistem Informasi dan Informatika (Simika)*, *8*(2), 236–247. https://ejournal.lppm-unbaja.ac.id/index.php/jsii/article/view/3973

Diningrat, R. S. A., & Marbun, M. (2022). PENERAPAN SISTEM PAKAR DIAGNOSA SECTIO CAESAREA PADA IBU HAMIL BERBASIS ANDROID DENGAN MENGGUNAKAN METODE CERTAINTY FACTOR. *Jurnal Sistem Informasi Kaputama (JSIK)*, *6*(1), 7–14. https://jurnal.kaputama.ac.id/index.php/JSIK/article/view/174

Fitrilina, Albbi, M., Agustian, I., Herawati, A., & Massardi, N. A. (2021). Sistem Peringatan Awal Resiko Preeklampsia Pada Kehamilan Menggunakan Metoda Certainty Factor. *Jurnal Nasional Teknik Elektro*, *10*(1), 45–54. https://doi.org/10.25077/jnte.v10n1.896.2021

Gayatri, M., Indriani, A., Akingbade, O., Mulyadi, J., Fathiyah, N., Pirade, R. A., Indrawan, I. W. A., Wardani, D. S., & Sutrisno, S. (2022). Verbal Autopsy of Preeclampsia-related Maternal Death in Jember District, Indonesia: A Case Control Study. *Bahrain Medical Bulletin*, *44*(4), 1172–1176. https://www.bahrainmedicalbulletin.com/DECEMBER_2022/BMB-22-295.pdf

Ginting, E. F. (2025). Implementasi Certainty Factor Dalam Mendiagnosa Penyakit Hamil Anggur (Mola hidatidosa). *Jurnal SAINTIKOM (Jurnal Sains Manajemen Informatika dan Komputer)*, *24*(2), 181–192. https://doi.org/10.53513/jis.v24i2.12200

Gunung, T. M. R., Ningtyas, A. D., Meidita, D. D., Siregar, M. P., & Rolando, V. (2026). Sistem Pakar Diagnostik Dini Risiko Preeklampsia pada Ibu Hamil Berbasis Certainty Factor. *Jurnal Rekayasa Teknologi Informasi (JURTI)*, *10*(2), 196–205. https://e-journals.unmul.ac.id/index.php/INF/article/view/26860

Handito, Z., & Arifin, A. (2023). Sistem Pakar Deteksi Dini Masalah Kesehatan pada Ibu Hamil Berbasis Web: Literature Review. *Automata*, *4*(1), 1–4. https://journal.uii.ac.id/AUTOMATA/article/view/26234

Hanif, K. H., Muntiari, N. R., & Ramadhani, P. A. (2022). Penerapan Metode Certainty Factor untuk Mendiagnosa Penyakit Preekslamsia pada Ibu Hamil dengan Menggunakan Bahasa Pemrograman Python. *Insect (Informatics and Security): Jurnal Teknik Informatika*, *7*(2), 63–71. https://doi.org/10.33506/insect.v7i2.1818

Hariyanti, N. S., Nurlaili, A. L., & Aditiawan, F. P. (2026). Expert System Implementation Using Certainty Factor Method for Early Pregnancy Disease Detection. *Journal bit-Tech*, *8*(3), 1–11. https://doi.org/10.32877/bt.v8i3.3366

Huppertz, B. (2026). Preeclampsia 2.0: The urgent need for new thinking. *Journal of Reproductive Immunology*, *173*(August 2025), 104820. https://doi.org/10.1016/j.jri.2025.104820

Khan, S., Siddique, A. B., Jabeen, S., Hossain, A. T., Haider, M. M., Zohora, F. T., Rahman, M. M., El Arifeen, S., Rahman, A. E., & Jamil, K. (2023). Preeclampsia and eclampsia-specific maternal mortality in Bangladesh: Levels, trends, timing, and care-seeking practices. *Journal of Global Health*, *13*, 1–12. https://doi.org/10.7189/JOGH.13.07003

Latifah, N., Haryono, I., & Yuliana, F. (2023). Midwifery Care for Pregnant Women in Trimester III with Pre-eclampsia at RSUD Dr H. Moch. Ansari Saleh Banjarmasin. *International Student Conference of Global Multidisciplinary Collaboration (INTEGRATION)*, *1*(1), 114–119. https://ocs.unism.ac.id/index.php/integration/article/view/1001

Lyu, G., Liao, R., Jiang, Q., He, X., & Weng, Z. (2025). Chinese Expert Consensus on ultrasound anatomical examination of fetuses at 11 + 0 to 13 + 6 weeks of gestation based on the Delphi method. *Archives of Gynecology and Obstetrics*, *312*(6), 1937–1954. https://doi.org/10.1007/s00404-025-08231-z

Manek, S. S., Mada, G. S., & Kelen, Y. P. K. (2023). Pre-Eclampsia Diagnosis Expert System Using Fuzzy Inference System Mamdani. *Jurnal Techno Nusa Mandiri*, *20*(2), 80–88. https://doi.org/10.33480/techno.v20i2.4622

Mola, S. A. S., Tokan, D. I. C., & Widiastuti, T. (2023). Sistim Pakar Diagnosis Gangguan Pada Kehamilan Trimester Pertama Menggunakan Metode Certainty Factor Berbasis Web. *Jurnal Dialektika Informatika (Detika)*, *4*(1), 13–18. https://doi.org/10.24176/detika.v4i1.11427

Nujoom, R. R., Babader, R. B., Aloufi, A. A., Malibary, M., Alshareef, N. H., Shoaib, F. M., Almteri, A., Al Maqwashi, L. S., & Alrafi, M. D. (2025). Preeclampsia in Saudi Arabia: A Systematic Review and Meta-Analysis of Prevalence, Risk Factors, Awareness, and Outcomes. *Cureus*, *17*(12), 1–18. https://doi.org/10.7759/cureus.98969

Nureza, M. B., & Arifin, A. (2023). Penerapan Sistem Pakar untuk Mendeteksi Dini Masalah Kesehatan Ibu Hamil: Systematic Literature Review. *Jurnal Minfo Polgan*, *12*(1), 797–803. https://doi.org/10.33395/jmp.v12i1.12497

Nurhayati, N., Farida, S., & Palupi, D. L. M. (2022). Sistem Cerdas Kesehatan Ibu Hamil Menggunakan Metode Certainty Factor. *Prosiding Seminar Nasional Teknologi Informasi dan Bisnis (SENATIB) 2022*, 228–235. https://ojs.udb.ac.id/index.php/Senatib/article/view/1891/1481

Oumbarek, K., Lkoul, A., Mahlaq, S., El Hilali, S., Sbai Idrissi, K., & Obtel, M. (2025). Factors associated with maternal death from severe preeclampsia in the post-pandemic era: a cross-sectional study from Southern Morocco. *BMC Pregnancy and Childbirth*, *25*(1), 1–9. https://doi.org/10.1186/s12884-025-08139-1

Prasetya, N. W. A., Wanti, L. P., Sari, L., & Puspitasari, L. (2022). Sistem Pakar Deteksi Dini Penyakit Preeklamsia pada Ibu Hamil Menggunakan Metode Certainty Factor. *Infotekmesin*, *13*(1), 168–177. https://doi.org/10.35970/infotekmesin.v13i1.1050

Pribadi, A. (2021). Zero mother mortality preeclampsia program: Opportunity for a rapid acceleration in the decline of maternal mortality rate in Indonesia. *International Journal of Women's Health and Reproduction Sciences*, *9*(3), 160–163. https://doi.org/10.15296/ijwhr.2021.30

Puspita, S., Yanto, G., Turaina, R., & Putri, N. E. (2026). Early Prediction of Preeclampsia Using Ensemble Machine. *Telehealth and Medicine Today*, *11*(1), 1–13. https://telehealthandmedicinetoday.com/index.php/journal/article/view/663

Rahman, R. T. A., Lakulu, M. M., & Panessai, I. Y. (2023). Advancing Preeclampsia Prediction with Machine Learning: A Comprehensive Systematic Literature Review. *International Journal of Intelligent Systems and Applications in Engineering*, *11*(3), 13–23. https://ijisae.org/index.php/IJISAE/article/view/3138

Ramadhan, R., Jamaludin, A., & Solehudin, A. (2023). Sistem Pakar Diagnosis Penyakit Berdasarkan Keluhan Saat Kehamilan Menggunakan Metode Forward Chaining Dan Certainty Factor (Studi Kasus : Klinik Alqila). *INFOTECH journal*, *9*(2), 418–430. https://doi.org/10.31949/infotech.v9i2.6320

Santi, D. R., Suminar, D. R., Devy, S. R., & Mahmudah. (2023). Pregnant women behaviours in early detection of preeclampsia warning signs based on health belief model: A structural equal modelling analysis. *Pharmacy Education*, *23*(4), 76–81. https://doi.org/10.46542/pe.2023.234.7681

Sebastian, S. A., Singh, K., & Padda, I. (2023). Isolated sixth nerve palsy as the first

manifestation of preeclampsia. *Radiology Case Reports*, *18*(4), 1411–1414. https://doi.org/10.1016/j.radcr.2023.01.012

Sundari, S. S., Sarmidi, S., & Nuraropah, A. F. (2021). Sistem Pakar Diagnosis Penyakit Gangguan Kehamilan Menggunakan Metode Forward Chaining Dan Certainty Factor Berbasis Web. *It (Informatic Technique) Journal*, *9*(2), 164. https://doi.org/10.22303/it.9.2.2021.164-175

Tahir, A., Hendriyanto, D., Faizah, A., Anshory, J., & Harun, R. (2024). Application of Forward Chaining and Rule-Based Reasoning Methods to Design an Expert System for Pregnant Women Disease Diagnosis in a Private Hospital. *Jurnal Informasi dan Teknologi*, *6*, 93–98. https://doi.org/10.60083/jidt.v6i1.480

Tamas, P., Farkas, B., & Betlehem, J. (2025). Practical Considerations Concerning Preeclampsia Subgroups. *Journal of Clinical Medicine*, *14*(7), 1–13. https://doi.org/10.3390/jcm14072498

Tarigan, E. B. (2021). Expert System for Diagnosis of Pests and Diseases of Citrus Plants using the Certainty Factor Method (Case Study in Deram Village, Karo Regency). *International Journal of Basic and Applied Science*, *10*(1), 9–15. https://doi.org/https://doi.org/10.35335/ijobas.v10i1.1

Tarigan, K. D. A., Simanjuntak, M., & Maulita, Y. (2024). Expert System of Preeclampsia Diagnosis Using Certainty Factor Method. *Journal of Mathematics and Technology (MATECH)*, *3*(2), 169–179. https://doi.org/10.63893/matech.v3i2.176

Vadlisky, F. D., Hamdani, H., & Agus, F. (2025). Expert System for Early Detection of High-Risk Pregnancy Conditions Using Certainty Factor and Forward Chaining Methods. *JCSE Journal of Computer Science an Engineering*, *6*(1), 1. https://icsejournal.com/index.php/JCSE/article/view/826

Wati, E. F., Sunita Perangin-Angin, E., & Sudrajat, B. (2023). Pregnancy Disease Diagnostic Expert System With Certainty Factor Method. *International Journal of Information System & Technology*, *6*(158), 754–760. https://ijistech.org/ijistech/index.php/ijistech/article/view/292

WHO. (2011). WHO recommendations for Prevention and treatment of pre-eclampsia and eclampsia. In *WHO* (Vol. 97). WHO.

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