Volume. 5 Number. 2
Period: July – December 2021; page 40-47
p-ISSN : 2580-1112; e-ISSN : 2655-6669

journal homepage: https://ejournal.akperfatmawati.ac.id
DOI : 10.46749/jiko.v5i2.70

Jurnal Ilmiah Keperawatan Orthopedi (JIKO)
Article history:
Received: October 12, 2021
Revised: February 11, 2022
Accepted: February 13, 2022

Breast Cancer Risk Analysis Using Fuzzy Inference System with the Mamdani Model: Literature Review

Siti Utami Dewi, Rr. Tutik Sri Haryati
Faculty of Nursing, University of Indonesia, Depok, Indonesia
Email: utamidewi1701@gmail.com

Abstract

Breast cancer is one of the most common cancer causes of death in sufferers. Breast cancer is the second leading cause of death for Indonesian women. For this reason, a device that can identify the risk of breast cancer is needed. The fuzzy method with the Mamdani model is one method that has been widely used in software development to determine the level of breast cancer risk. Purpose: To know the software development of the Fuzzy Inference System Method with the Mamdani model to identify the level of breast cancer risk. Methods: This research is a literature study with the data collection process through the PubMed, Science Direct, ProQuest, and Google Scholar databases. The criteria for the articles used are 2010-2021 publications. Results: Based on a review of 10 journals using the Fuzzy Inference System (FIS) Mamdani model can provide effective results to identify risks for people who have the possibility of developing breast cancer. Conclusion: The fuzzy expert system using the Mamdani method can be applied to the problem domain of breast cancer diagnosis with a fairly good level of accuracy to be able to overcome the inequality of mammography results.

Keywords: Fuzzy Inference System, Breast Cancer, Mamdani Model.

Introduction

Cancer is a chronic disease whose incidence is increasing. Cancer occurs a lot in developing countries and Indonesia is one of the developing countries which currently has a lot of people suffering from cancer. The World Health Organization (WHO) (2010) estimates that cancer cases will continue to increase and are predicted to reach 21.4 million cases by 2030 and two-thirds of these cases are in developing countries such as Indonesia. In Indonesia, based on the results of the 2013 Basic Health Research survey, the prevalence of tumor or cancer reached 1.4 per mile (Kemenkes RI, 2013).

Breast cancer (breast cancer) is one type of malignant cancer, where cells form in breast tissue, and is the most common type of cancer besides skin cancer and ranks second (after lung cancer) the type of cancer that causes death (Harbeck et al, 2019). Every year thousands of people die from cancer due to limited medical resources and the inability of society to use available information resources effectively.

Today, most people with cancer come to the hospital when the disease is in a developmental stage because the disease was not diagnosed earlier, and treatments at this stage tend to be ineffective. One important issue is to focus on early diagnosis of cancer,

because the earlier cancer is diagnosed, the greater the likelihood that the treatment provided will be successful (Wang, 2017). In making a diagnosis of breast cancer, a doctor uses several clinical symptoms to determine the risk of breast cancer suffered by a patient.

However, doctors have difficulty in determining the risk status of breast cancer. This research has been previously conducted by Saleh, et al (2011), where in his research he implemented a fuzzy decision support system in the management of breast cancer using the Mamdani inference method.

One method of breast cancer screening is mammography. Mammography is a breast cancer screening method that can identify cancer several years before the physical symptoms of the disease appear. However, mammography results are often interpreted as inconclusive. For that we need a device that can identify whether a patient's mammography results belong to a benign class, which does not have breast cancer or a malignant class that leads to breast cancer (Keles, Keles, and Yavuz, 2011).

Expert systems as one of the techniques of artificial intelligence (artificial intelligence) is a technology based on knowledge, facts, and reasoning, can be used to solve various problems in various disciplines including the problem of early detection in the health sector. Several studies using expert systems as a support for diagnosis have been carried out by several previous researchers. The fuzzy method is one method that has been widely used in software development to determine the level of breast cancer risk (Kusumadewi & Purnomo, 2010). In addition, the need for software to determine the level of breast cancer risk is still very much needed.

One method of fuzzy inference is Mamdani. Mamdani uses the min-max operator in the process of implication and rule composition, so it is often referred to as the min-max method.

According to Mamdani (1974 in Shoumi & Syulistyo, 2021), the use of the Mamdani Fuzzy Inference System (FIS) model can provide effective results depending on uncertain verbal knowledge, such as human logic. While the Mamdani fuzzy inference system is the most used method, where the output membership function is a fuzzy set that needs to be defuzzified for each output variable. The purpose of developing a breast cancer analysis system is to identify risks for people who have the possibility of developing breast cancer and make an early diagnosis by applying the Mamdani Fuzzy Inference System model. The most efficient way and one of the ways of protection against breast cancer is early diagnosis. So, with the development of this system, it is hoped that it will enable people to take preventive measures against cancer risk.

Efforts are being made to analyze the risk of breast cancer as an initial diagnostic step by implementing the Mamdani Fuzzy Inference System model to analyze the risk of breast cancer in a person, where the system will be developed using the Fuzzy Toolbox in MATLAB. Therefore, it is necessary to summarize the literature that aims to identify the risk analysis related to Breast Cancer using the Fuzzy Inference System with the Mamdani Model.

Method

The method used in writing this article is a literature review, which is a study used to analyze the literature that has been selected from various sources and produce a conclusion. This

literature begins by reviewing articles identified through the PubMed database, Science Direct, ProQuest, Scopus, and Google Scholar. The keywords used for the search were Breast Cancer, Fuzzy Inference System and Mamdani Model, the search for supporting articles was limited to 2010 – 2021. In principle, this literature review is a research method carried out by summarizing the results of primary research articles as a goal to present data more comprehensively and balanced.

Results

The focus of this literature review is to determine the risk of breast cancer using the Fuzzy Inference System with the Mamdani model. The results of a review of 10 journals show that in general, discussing the use of a fuzzy system is one method that has been widely used in the development of software for the diagnosis of a disease.

The mamdani model is expected to produce an appropriate classification of the level of danger of breast cancer or tumors with input in the form of mammographic data sets, to produce the right diagnosis for breast cancer. The list of journals that researchers found and analyzed in this literature review study is in table 1.

Table.1 Details of journal results Main choices for literature review

No	Author/Year	Title	Method	Results
1	Alshalaa A Shleeg, Issmail M. Ellabib (2013)	Comparison of Mamdani and Sugeno Fuzzy Inference Systems for the Breast Cancer Risk	Analysis of the basic differences between Mamdani type FIS and Sugeno type	Shows a comparison of the performance of the two systems and the advantages of using the Mamdani type and the Sugeno type
2	Alireza Atashi Najmeh Nazeri Ebrahim Abbasi Sara Dorri Mohsen Alijani Z (2017)	Breast Cancer Risk Assessment Using Adaptive Neuro-Fuzzy Inference System (ANFIS) and Subtractive Clustering Algorithm	The risk factors are classified into three priorities according to their level of importance, then fuzzified and substractive clustering method is used.	The desired fuzzy function is defined for the variables, and the model is trained with the combined dataset. The test was carried out first with 30% of the dataset, and then with real data obtained from real clinical data (BCRC), while the precision model for the above steps was 81% (sensitivity = 85.1%, specificity = 74.5%) and 84.5% (sensitivity = 89.3%, specificity = 79.9%) respectively
3	R. Khezri R Hoesseini M. Mazinani (2014)	A Fuzzy Rule-based Expert System for the Prognosis of the Risk of Development of the Breast Cancer	Most presented to assess the risk of stage of cancer development, are using unbiased input variables in the prognostic process; that is, this model has the potential to predict risk of developing breast cancer even in healthy women. Furthermore, the fuzzy expert system is evaluated on real datasets	Performance results on real datasets reveal the superiority of fuzzy expert systems in prognostication of processes with an average accuracy of 95%, compared to other related work.

No	Author/Year	Title	Method	Results
			and system results are compared.	
4	B, Haznedar MT. Arslan A Kalinli (2018)	Using adaptive Neuro-Fuzzy Inference System for Classification of Microarray Gene Expression Cancer Profiles	This study proposes artificial intelligence Adaptive neuro-fuzzy inference system (ANFIS) method, to classify cancer gene expression profiles. (Experimental studies)	The findings obtained by the proposed ANFIS approach are compared with the results of statistical methods such as Naïve Bayes and Supporting Vector Machines. In conclusion, although the highest average classification performance achieved by ANFIS was 95.56%, the highest performance achieved by statistical method was found to be 87.65%.
5	M. Brudget O A Oludele Okolie S.O Omotosho O. J (2018)	Design and implementation of a mobile based fuzzy expert system for pre breast cancer growth prognosis	Fuzzy inference approach is used to formulate membership functions. The Mamdani approach is used for system design. Using random sampling.	The results show that the facts obtained from the experts serve as the range values for the 12 input fuzzification risk factors and thus, 36 rules are generated. These rules are used for system development. The developed MFES recorded an accuracy of 96%.
6	Mei-Ling Huang Yung-Hsiang Hung Wen-Ming Lee R. K. Li Tzu-Hao Wang (2012)	Usage of Case-Based Reasoning, Neural Network and Adaptive Neuro-Fuzzy Inference System Classification Techniques in Breast Cancer Dataset Classification diagnosis	Study Experiment: comparing the particle swam optimizer (SPO), based on artificial neural network (ANN), adaptive neuro-fuzzy inference system (ANFIS), and case-based reasoning (CBR) classifier with logistic regression models and decision tree models.	Experimental results show that, the best CBR-based classification accuracy is 83.60%, and the classification accuracy of PSO and ANFIS-based ANN classifier is 91.10% and 92.80%, respectively
7	Gisele Helena B. M Joaquim Cezar F. (2015)	Computer-aided diagnosis system based on fuzzy logic for breast cancer categorization	A malignancy value was determined for each image descriptor, according to the BI RADS standard. When analyzing contours, for example, our method considers feature matching and linguistic variables. Next, we create a fuzzy inference system. Membership generation function is performed by the Fuzzy Omega algorithm, which is based on the statistical analysis of Data set. This algorithm maps the distribution of different classes in a set.	The images are analyzed by a group of doctors and the resulting evaluation is submitted to the Fuzzy Omega algorithm. The results were compared, achieving an accuracy of 76.67% for nodules and 83.34% for calcifications.
8	Glaucia RMA S.	Fuzzy method for	A fuzzy method that	The developed Fuzzy method

No	Author/Year	Title	Method	Results
	Cicilia RM Leite Ana MG Guerreiro Adriao D Dosia N (2012)	pre diagnosis of breast cancer from the Fine Needle Aspirate Analysis	helps in the diagnosis and second opinion of breast cancer, The so-called FNA-Fuzzy Pre-Diagnosis Module (PDM-FNA-Fuzzy), was developed through analysis of smears extracted from breast masses obtained by FNA.	provides pre-diagnosis of breast cancer with 98.59% sensitivity (correct pre-diagnosis of malignancy); and 85.43% specificity (true pre-diagnosis of benign cases).
9	Yilmaz A Ayan K (2011)	Risk Analysis in Breast Cancer Disease by using fuzzy logic and Effects of Stress Level on Cancer Risk	Leading methods and samples have been presented along with fuzzy logic models as a new modality. The reason for selecting the fuzzy logic model in this study is the system uses a fuzzy logic model that provides effective results.	The results of the research; our system will pre-diagnose people who may be at risk of developing cancer by reason of working conditions or standard of living. Therefore, this will allow these people to take precautions against the risk of cancer.
10	Dudek Gabriela Anna S Monika K Aleksandra R Roman T (2012)	Fuzzy Analysis of the Cancer Risk Factor	Mamdani model, implemented in Fuzzy Logic Toolbox in Matlab, used for data analysis. As input to the system genetic, biological (race, age, gender) and behavioral (overweight, alcohol consumption, tobacco smoke) risk factors.	The results obtained indicate that fuzzy logic can be an effective tool in dealing with the problem of breast cancer risk.

Discussion

This literature review identifies 10 articles that mostly discuss fuzzy models that have been applied in various fields, one of which is in the process of medical diagnosis. Development of a fuzzy decision support system to identify breast cancer risk status in situations of data diversity and uncertainty. This system can help specialist doctors for breast cancer treatment. In this development the membership function, input variable, output variable and rule base are based on data from research conducted by Saleh et al (2011).

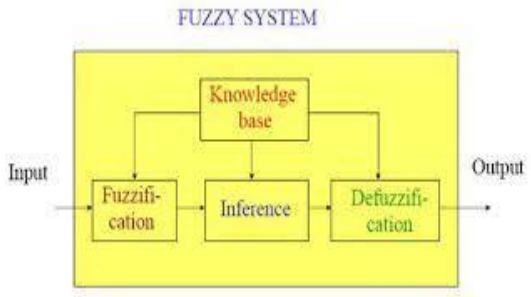

Figure 1. Fuzzy Logic System Structure Khezri et al, (2014)

In the research of Shoumi & Sulistyo, (2021) succeeded in implementing a breast cancer risk analysis system using the Fuzzy Inference System (FIS) mamdani model. The system developed in this

study can be used to check the early diagnosis of breast cancer risk with 6 input variables in the form of gender, age, menstrual age, delivery age, menopause age, and genetic status. 85%, for further development can be added several input variables with other important factors that can affect the risk of breast cancer, such as race, Body Mass Index (BMI), and duration of breastfeeding. This is in line with Normalisa's research, (2018) the implementation of the Fuzzy Inference system (FIS) with the Mamdani method is applied by identifying the input parameters in the fuzzification process then these parameters are entered in the rules formed from the inference process after which the defuzzification process is carried out. Namely calculating the rules and data samples with the Mamdani formula to get the detection results.

According to Alshalaa et al, (2013) describes the two most used fuzzy inference systems to evaluate breast cancer risk. It can be concluded that the Mamdani type FIS and Sugeno type FIS perform very similarly, but the Sugeno type FIS allows risk evaluation to work at its full capacity with smooth operational performance. Although the design of both systems is the same, but the output membership function of the Sugeno Type can only be constant or linear and the sharp output is generated in different ways for the two FIS. The Sugeno FIS type also has the advantage that it can be integrated with neural networks and genetic algorithms or other optimization techniques so that the system can adapt to system characteristics efficiently.

In the research of Dudek et al, (2012) said that the Mamdani model, implemented in the Fuzzy Logic Toolbox in Matlab, was used for data analysis. As input to the system of genetic, biological (race, age, gender) and behavioral (overweight, alcohol consumption, tobacco smoke) risk factors. The results obtained indicate that fuzzy logic can be an effective tool in dealing with the problem of breast cancer risk.

The fuzzy method is one method that has been widely used in the development of software for the diagnosis of a disease. In addition, the need for software for breast cancer diagnosis is still very much needed. A Mamdani fuzzy expert system was developed, with a problem domain in the form of breast cancer diagnosis. The Mamdani method is expected to produce an appropriate classification of the level of danger in breast tumors with input in the form of mammographic data sets, to produce the right diagnosis for breast cancer.

Conclusion

Based on the analysis of the articles that have been carried out, it can be concluded that the fuzzy expert system using the mamdani method can be applied to the problem domain of breast cancer diagnosis with a fairly good level of accuracy to be able to overcome the inequality of mammography results. The fuzzy inference system can be applied to determine the risk of breast cancer through rules made in everyday language, with the system being able to quickly find out a person's risk of breast cancer based on the factors they experience.

Acknowledgement

The authors express their infinite gratitude to the Faculty of Nursing, University of Indonesia for the opportunity to facilitate the authors to complete this literature review.

Bibliography

Atashi, A., Nazeri, N., Abbasi, E., Dorri, S., & Alijani-Z, M. (2017). *Breast Cancer Risk Assessment Using adaptive neuro-fuzzy inference system (ANFIS) and*

Subtractive Clustering Algorithm. *Multidisciplinary Cancer Investigation*, *1*(2), 20–26. https://doi.org/10.21859/mci-01029

Bridget O, M. (2018). *Design and Implementation of a Mobile Based Fuzzy Expert System for Pre Breast Cancer Growth Prognosis*. International Journal of Advanced Research in Computer Science, *9*(3), 258–279. https://doi.org/10.26483/ijarcs.v9i3.6116

Dudek, G., Strzelewicz, A., Krasowska, M., Rybak, A., & Turczyn, R. (2012). *Fuzzy analysis of the cancer risk factor*. Acta Physica Polonica B, 43(5), 947–959. https://doi.org/10.5506/APhysPolB.43.947

Haznedar B., Arslan, M.T., & Kalinli A. (2018). *Using Adaptive Neuro-Fuzzy Inference System for Classification of Microarray Gene Expression Cancer Profiles*. Tamap Journal of Engineering, 2018(1). https://doi.org/10.29371/2018.3.29

Harbeck, Nadia & Penault-Llorca, Frédérique & Cortes, Javier & Gnant, Michael & Houssami, Nehmat & Poortmans, Philip & Ruddy, Kathryn & Tsang, Janice & Cardoso, Fatima. (2019). *Breast cancer*. Nature Reviews Disease Primers. 5. 10.1038/s41572-019-0111-2.

Huang, M. L., Hung, Y. H., Lee, W. M., Li, R. K., & Wang, T. H. (2012). *Usage of case-based reasoning, neural network and adaptive neuro-fuzzy inference system classification techniques in breast cancer dataset classification diagnosis*. Journal of Medical Systems, *36*(2), 407–414. https://doi.org/10.1007/s10916-010-9485-0

Keles, A., A. Keles, and U. Yavuz. (2011). *Expert system based on neuro-fuzzy rules for diagnosis breast cancer*. [doi: 10.1016/j.eswa.2010.10.061]. Expert Systems with Applications, 38(5), 5719-5726.

Kemenkes RI. (2013). *Riset Kesehatan Dasar;* RISKESDAS. Jakarta: Balitbang Kemenkes RI

Khezri, R., Hosseini, R., Mazinani, M. (2014). *A fuzzy Rule-based Expert System for the Risk of Development of the Breast Cancer*. International Journal of Engineering. Vol.27, No.10

Kusumadewi, Sri dan Purnomo Hari. (2010). *Aplikasi Logika Fuzzy*, Cetakan Pertama, Yogyakarta: Graham Ilmu

Miranda, G. H. B., & Felipe, J. C. (2015). *Computer-aided diagnosis system based on fuzzy logic for breast cancer categorization*. Computers in Biology and Medicine, *64*, 334–346. https://doi.org/10.1016/j.compbiomed.2014.10.006

Normalisa, N. (2018). *Fuzzy Inference System dengan Metode Mamdani untuk Prediksi Kanker Payudara*. Jurnal Teknologi Sistem Informasi Dan Aplikasi, *1*(1), 37. https://doi.org/10.32493/jtsi.v1i1.1951

Saleh, A.A.E., Sherif E.B., Ahmed A.E.A., March. (2011)., *A Fuzzy Decision Support System for Management of Breast Cancer*, International Journal of Advanced Computer Science and Applications,Vol. 2, No.3.

Wang, Lulu. (2017). *Early Diagnosis of Breast Cancer*. Sensors. 17. 1572. 10.3390/s17071572.

Shleeg, A. A., & Ellabib, I. M. (2013).

Comparison of Mamdani and Sugeno Fuzzy Interference Systems for the Breast Cancer Risk. International Journal of Computer, Electrical, Automation, Control and Information Engineering, 7(10), 1343–1347.

Shoumi, MN, Syulistyo. (2021). *Analisis resiko kanker payudara (Breast Cancer) menggunakan fuzzy Inference system (FIS) model Mamdani*. Jurnal Informasi Interaktif Vol. 6 No.1

Sizilio, G. R. M. A., Leite, C. R. M., Guerreiro, A. M. G., & Neto, A. D. D. (2012). *Fuzzy method for pre-diagnosis of breast cancer from the Fine Needle Aspirate analysis*. BioMedical Engineering *Online*, *11*, 1–22. https://doi.org/10.1186/1475-925X-11-83

Yilmaz, A., & Ayan, K. (2011). *Risk analysis in breast cancer disease by using fuzzy logic and effects of stress level on cancer risk*. *Scientific Research and Essays*, *6*(24), 5179–5191. https://doi.org/10.5897/SRE11.840