



DESIGN AND DEVELOP AN EARLY DETECTION SYSTEM APPLICATION TO MONITOR KIDNEY HEALTH IN PREGNANT WOMEN

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ABSTRACT

Pregnancy is a physiological process that can become pathological if not well monitored. Kidney disease will increase the risk during pregnancy, namely preeclampsia, fetal growth restriction, and loss of maternal kidney function. Chronic kidney disease in pregnant women often goes undiagnosed. Kidney disease problems detected will worsen if not examined at the early signs and symptoms or delaying treatment for kidney disease. This study proves the effectiveness and accuracy of early detection systems for kidney health in pregnant women. In the design of this application, exploratory data analysis (EDA) and data visualization techniques are used, which will provide deeper insight into the distribution, trends and relationships between variables in the data which includes data on pregnant women, perceived symptoms and laboratory examination. From the results of the design of this early detection system application, it shows perfect performance of the model on the overall dataset with precision, recall, and F1-score scores all reaching 1.00 or 100% accuracy. The developed classification model shows outstanding performance. This success can be attributed to the selection of relevant features, effective data preprocessing, and the selection of the appropriate classification model.

Keywords: exploratory data analysis; knowledge based system; kidney; pregnant women

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INTRODUCTION

Pregnancy is a physiological process that can become pathological if not monitored properly. Pregnancy causes various symptoms, especially in the third trimester, one of which is frequent urination. If you don't get proper treatment, urinary tract infections will occur.(Tyastuti, 2016)Therefore, in order to minimize future risks, all pregnant women are considered at risk so that all safe midwifery services must be available.(Kasmiyati et al, 2023) The kidneys are one of the important organs in the human body and function to filter metabolic waste from the blood and then dispose of it in the form of urine. However, changes in certain conditions in the body can affect the condition of the kidneys, causing a decrease in he function of these organs and triggering chronic kidney disease.(Kemenkes, 2023) Chronic kidney disease is the failure of kidney function to maintain metabolism and fluid and electrolyte balance due to progressive destruction of kidney structures with manifestations of accumulation of metabolic waste (uremic toxins) in the blood. Chronic kidney disease is kidney damage for more than 3 months based on findings of abnormal structure or function.(Sardjito, 2023)

As we age, kidney function decreases. This process occurs especially after the age of 40 years because some nephrons are damaged. Age factors and chronic diseases such as high blood pressure or diabetes can damage the kidneys permanently.(Verdiansah, 2016)In addition, an inactive lifestyle and a diet that is high in fat and carbohydrates, and low in fiber, causes fat accumulation and excess weight, which in turn can disrupt blood circulation and cause fat to build up in the blood vessels.(Arsita, 2017). The kidneys are very dependent on blood circulation to carry out their main function as filters of blood from the body's metabolic waste.(Irawati et al., 2023) In pregnant women, the kidneys experience physiological adaptations during pregnancy. Pregnant women will experience glomerular hyperfiltration of up to around 40-60 percent in the second trimester(Kusumawati & Wijayanti, 2019). This situation occurs due to a decrease in oncotic pressure. In normal pregnancy, there is an increase in effective renal plasma flow (ERPF). In pregnant women with preeclampsia, the glomerular filtration rate (GFR) of the kidneys decreases compared to women with normal pregnancies.(Mussap & Noto, 2020) (Intan & Ismiyatun, 2020). Hemodynamic mechanisms and changes in renal structure including disturbances in endothelial and podocyte biology have been proposed as mechanisms for hypofiltration in preeclampsia.(SERANG, 2020) (Wiguna & Sudhana, 2019)

Glomerular filtration rate (GFR) is one of the parameters to determine kidney function. GFR describes the function of our kidneys and is generally estimated from blood creatinine levels. GFR or GFR (glomerular filtration rate) is the best test to measure the level of kidney function and determine the stage of kidney disease(Veronika & Hartono, 2019). Currently, early detection of kidney health in various countries still uses a laboratory checking system with proteinuria examination, serum urea and creatinine examination and manual calculation of GFR.(Hajia et al., 2017). Handling problems in the current technological era is developing in line with advances in technological devices, especially Android-based applications. Android, which is an open source technology, allows the development of various types of applications, including in the health sector. The development of this health application involves collaboration with relevant experts and references to ensure that the services developed comply with applicable standards.(Gunawan & Saputro, 2018) Previous research was conducted by Rohman Robin, et al in 2017(Rianto & Iswari, 2017)which aims to assist in the process of detecting chronic kidney disease using the C4.5 algorithm. The algorithm succeeded in predicting heart disease, and produced an accuracy of 91.50%.

Another research conducted by Edwin Ariesto in 2018(Malahina, 2018)The results of the function tests and rules can be concluded that in general this system has fulfilled its main objective, namely regarding the Android mobile-based kidney disease detection application. Patients or sufferers can easily operate or diagnose via the application service developed, easily. And the system has been running well and in accordance with the rules regarding kidney disease. Based on the problem above, an Android-based kidney disease detection technique will be developed by applying it to an expert system which uses exploratory data analysis (EDA) techniques and data visualization, which will provide deeper insight into distribution, trends and relationships. between variables in the data containing data on pregnant women, perceived symptoms and laboratory examination results. The aim of this research is to create an Android-based application for an early detection system for kidney health in pregnant women so that it can be easily implemented and implemented in the community as well as providing education to treat existing kidney diseases and the symptoms they suffer from, but does not replace the duties of health workers and doctors. , because the application was developed as an auxiliary medium and treatment must still be carried out or handled by health workers and doctors in their field and with intensive care.

METHOD

In designing the application, use exploratory data analysis (EDA) techniques and data visualization, which will provide deeper insight into the distribution, trends and relationships between variables in the data. By completing the preprocessing stage, the dataset has been prepared for further analysis using Exploratory Data Analysis (EDA) techniques and data visualization, which will provide deeper insight into the distribution, trends and relationships between variables in the data. This method uses an application on Android by entering pregnant women's data such as the mother's age, gestational age, mother's age, symptoms felt by the pregnant woman, blood pressure checks, as well as laboratory tests such as urem, creatinine and maternal urine protein. After all the data is entered, the test results will immediately come out and recommendations will come out. This system makes it easier for health workers to monitor kidney health in pregnant women.

RESULTS

Application Implementation And Detection Test

Data Mining

Data mining is a process that uses statistical techniques, mathematics, artificial intelligence and machine learning to retrieve and recognize information contained in various databases. Data mining is often referred to as Knowledge Discovery in Databases (KDD)(Gorunescu, 2021).

Data Sets

In this research, a dataset was used obtained from The UCI Machine Learning Repository website. This website provides a collection of databases, domain theories, and data generators which are widely used by the machine learning community to carry out analysis of machine learning algorithms. Table 1 presents the dataset used in this research along with the abbreviations used in this article for ease of writing.(Ha et al., 2011)

Data Implementation

This dataset consists of several numeric columns such as Age, Gravida, Para, Abortion, gather age, as well as laboratory examination results (Ureum, Creatinine, Systolic Pressure, Diastolic Pressure). The non-numerical columns that are important to pay attention to are History of previous pregnancies and PU, which provide qualitative information regarding the history of previous pregnancies and proteinuria status, as well as the Results column which shows the risks in the current pregnancy, and Recommendations which provides advice based on the results. When carrying out exploratory data analysis (EDA), focus on several main aspects: - Distribution of Numerical Variables: Review the distribution of age, gestational age, blood pressure, urea, creatinine and other numerical variables. - Relationship Between Variables and Pregnancy Outcomes: Analyze how variables such as age, gestational age, blood pressure, and pregnancy symptoms relate to pregnancy risk (at risk or not at risk). - Patterns in Recommendations: Understand the relationship between characteristics of pregnant women and the types of recommendations given.

GFR calculation on the application

In this application, the use of GFR calculations is in accordance with standards, by entering the formula in the application, early detection of kidney health can be more accurate.(Isro'in & Mas'udah, 2020).

Model evaluation

The model is evaluated using cross-validation with accuracy scores as the main metric. The algorithm with the best performance in each case

Classification of Risk

At this stage, a program trial was carried out using 55 samples of pregnant women to determine the accuracy of the application. On the classification of health risk outcomes for pregnant women. After iterating on various algorithms to evaluate their performance through cross validation. Decision Trees are selected based on the accuracy and ease of interpretation of the model. The final model is trained using the entire dataset and tested using the test subset to obtain accuracy scores, classification reports, and confusion matrices. Models and scalers are saved using joblib for use in real applications.

Table 1.

Test Trial Results - Classification of Risk

Class	Precision	Recall	F1-Score	Support
0	1.00	1.00	1.00	29
1	1.00	1.00	1.00	26
Accuracy			1.00	55
Macro Average	1.00	1.00	1.00	
Weighted Average	1.00	1.00	1.00	

These results show the perfect performance of the applied model, where the model succeeded in classifying all samples correctly both in the test set and the entire dataset. This is shown by the precision, recall and F1-score values which all reached 1.00, indicating that there were no prediction errors for either class 0 or class 1. This is an indicator that the model has very good generalization abilities on the given data.

Classification of Recommendations

At this stage, a program trial was carried out using 55 samples of pregnant women to determine the accuracy of the application. For recommendation classification, a similar analysis was carried out on the target variable "Recommendations_encoded". After pre-processing and initial algorithm evaluation, Gradient Boosting was selected for further tuning using GridSearchCV to find the best hyperparameter combination. The tuned model is then tested to obtain evaluation metrics.

Table 2.

Test Trial Results - Classification of Recommendations

Class	Precision	Recall	F1-Score	Support
0	1.00	1.00	1.00	29
1	1.00	1.00	1.00	22
2	1.00	1.00	1.00	19
3	1.00	1.00	1.00	5
Accuracy			1.00	55
Macro Average	1.00	1.00	1.00	55
Weighted Average	1.00	1.00	1.00	55

Precision, Recall, and F1-Score: Perfect 1.00 for all classes on the entire dataset, which includes 55 samples. Accuracy: 100% on the entire dataset, confirming the general accuracy of the model. These results show the perfect performance of the applied model, where the model succeeded in classifying all samples correctly both in the test set and the entire dataset. This is shown by the precision, recall and F1-score values which all reached 1.00, indicating that there were no prediction errors for either class 0 or class 1. This is an indicator that the model has very good generalization abilities on the given data.

DISCUSSION

Classification Case Analysis of Pregnant Women's Data Using Machine Learning Methods

In this study, we develop and analyze classification models for two different cases using a dataset on pregnant women. The dataset includes a variety of factors that have the potential to influence health recommendations and outcomes. The two cases reviewed were classification based on “results” and classification based on “recommendations”. The analysis process involves applying various machine learning algorithms to determine the best approach to predicting the two target variables

Program Testing and Preprocess Analysis

In this study, we develop and analyze classification models for two different cases using a dataset on pregnant women. The dataset includes a variety of factors that have the potential to influence health recommendations and outcomes. The two cases reviewed were classification based on “results” and classification based on “recommendations”. The analysis process involves applying various machine learning algorithms to determine the best approach to predicting the two target variables. At this stage, a program trial was carried out using 55 samples of pregnant women to determine the accuracy of the application.

CONCLUSION

The design of an early detection system application for monitoring kidney health in pregnant women using exploratory data analysis (EDA) techniques and data visualization was successfully created, with the help of the Weka library in creating the resulting algorithm which can predict the kidney health of pregnant women. Trials were carried out to find out how much accuracy the application could produce. The process of testing classification of risk results is carried out using models and scalars stored using joblib for use in real applications. Meanwhile, for the classification of recommendation results using Gradient Boosting, it was chosen for further tuning using GridSearchCV to find the best combination of hyperparameters. The results of both classifications show perfect performance of the model on the test dataset and overall data with precision, recall and F1-score scores all reaching 1.00 or 100% accuracy. The developed classification model shows excellent performance. This success can be attributed to the selection of relevant features, effective data preprocessing, and selection of appropriate classification models.

REFERENCES

- Arsita, E. (2017). Pendekatan Diagnosis dan Tata Laksana Sindroma Nefrotik. In *Jurnal Kedokteran Meditek* (Vol. 23, Issue 64, pp. 73–82).
- Gorunescu, F. (2021). *Data Mining: Concepts, Models and Techniques*.
- Gunawan, H., & Saputro, A. K. H. (2018). Pemanfaatan Aplikasi Mobile Untuk Mempercepat Pencarian Tempat Indekos Berbasis Android. *Jurnal Muara Sains, Teknologi, Kedokteran Dan Ilmu Kesehatan*, 1(2), 85–96. DOI.10.24912/jmstkik.v1i2.1454
- Ha, J., Kambe, M., & Pe, J. (2011). *Data Mining: Concepts and Techniques*. In *Data Mining: Concepts and Techniques*. <https://doi.org/10.1016/C2009-0-61819-5>
- Hajia, M. A., Mongan, A. E., & Wowor, M. F. (2017). Gambaran Kadar Ureum Serum pada Wanita Hamil Normal. *Jurnal E-Biomedik*, 5(2), 3–7. DOI.10.35790/ebm.5.2.2017.18606
- Intan, P., & Ismiyatun, N. (2020). Deteksi Dini Kehamilan Beresiko. *Jurnal Kesehatan*

- Masyarakat, 8(1), 40–51.
- Irawati, D., Slametiningih, Nugraha, R., Natasha, D., Narawangsa, A., Purwati, N. H., & Handayani, R. (2023). Perubahan Fisik Dan Psikososial Mempengaruhi Kualitas Hidup Pasien Hemodialisis. *Jurnal Ilmiah Keperawatan (Scientific Journal of Nursing)*, 9(1), 96–104. DOI.10.33023/jikep.v9i1.1426
- Isro'in, L., & Mas'udah, A. F. (2020). Pelatihan Penghitungan Glomerulo Filtration Rate (Gfr) on Line Bagi Penderita Diabetes Mellitus Dan Hipertensi. *Adimas : Jurnal Pengabdian Kepada Masyarakat*, 4(1), 35. DOI.10.24269/adi.v4i1.1430
- Kasmiyati dkk. (2023). Asuhan Kehamilan. PT. Literasi Nusantara Abadi Grup.
- Kemenkes. (2023). Fungsi dan Faktor Risiko Ginjal. Kementerian Kesehatan
- Kusumawati, W., & Wijayanti, A. R. (2019). Gambaran Faktor-Faktor Risiko Kejadian Preeklampsia Pada Ibu Bersalin Dengan Preeklampsia (Di RS Aura Syifa Kabupaten Kediri bulan Februari – April tahun 2016). *Jurnal Kebidanan*, 6(2), 139–146. DOI.10.35890/jkdh.v6i2.43
- Malahina, E. A. U. (2018). Sistem Pakar Deteksi Penyakit Ginjal Berbasis Mobile Android. *High Education of Organization Archive Quality: Jurnal Teknologi Informasi*, 10(1), 6–13. DOI.10.52972/hoaq.vol10no1.p6-13
- Mussap, M., & Noto, A. (2020). Renal disorders in pregnancy. *Journal of Laboratory and Precision Medicine*, 5(2). DOI.10.21037/jlpm.2020.02.04
- Rianto, R., & Iswari, N. M. S. (2017). Rancang Bangun Aplikasi Pendeteksi Penyakit Ginjal Kronis dengan Menggunakan Algoritma C4.5. *Jurnal ULTIMATICS*, 9(1), 10–18. DOI.10.31937/ti.v9i1.558
- Sardjito, K. R. (2023). Memahami Organ Ginjal Kita. <https://sardjito.co.id/2022/06/24/memahami-organ-ginjal-kita/>
- SERANG, D. D. R. K. B. (2020). Gangguan Fungsi Ginjal Pada Ibu Hamil Preeklampsia Berat Dengan Dislipidemia Di Rsud Kelas B Serang. *Jurnal Kesehatan Reproduksi*, 11(1), 69–79. DOI.10.22435/kespro.v11i1.2650.69-79
- Tyastuti, S. (2016). Asuhan Kebidanan Kehamilan. Pusdik SDM Kesehatan.
- Verdiansah. (2016). Pemeriksaan Fungsi Ginjal. 43(2), 148–154.
- Veronika, E., & Hartono, B. (2019). Nilai Estimasi Glomerulus Filtration Rate (Gfr) Menggunakan Persamaan Cockcroft and Gault Pada Masyarakat Terpajan Merkuri Di Area Pertambangan Emas Skala Kecil (Pesk) Desa Lebaksitu Kabupaten Lebak Banten. *Jurnal Forum Ilmiah*, 16(2), 130–138.
- Wiguna, P. D. W., & Sudhana, W. (2019). Seorang penderita sindrom nefrotik relaps dengan gambaran histologi minimal change disease (MCD) yang diduga mengalami evolusi menjadi focal segmented glomerulosclerosis (FSGS). *Jurnal Penyakit Dalam Udayana*, 3(1), 18–21. DOI.10.36216/jpd.v3i1.66.