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Innovation Article

Mobile application for early detection of non-communicable diseases

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A B S T R A C T

Background: The number of deaths and illnesses caused by Non-communicable diseases (NCDs) is increasing. One of the leading causes of NCDs is the behavior or patterns of people's daily habits. In the absence of a system that is used to detect NCDs with a behavioral approach, it is essential to research and create an application system for the early detection of NCDs.

Purpose: This study aims to produce a system for the early detection of NCDs in pregnant women and provide recommendations based on an expert system.

Method: This study employed Research & Development consisting of 4 stages, namely Literature Study, Development Stage, Validity Expert, and Trial.

Results: This application has features that the public can use to detect NCDs independently. Users can perform early detection independently as needed; all user detection history data will be recorded in the detection history menu. In addition, users get health information through the health article menu. The results of trials conducted on pregnant women found that this application system was more effective than the manual. A mobile application can also increase the speed of diagnosis to 42%.

Conclusion: This application is helpful for health workers and the public in conducting early detection of NCDs and providing education. This early detection application will make it easier for users to know their condition based on their behavior and make it easier for health workers to detect early and control the user's condition even from a distance.

INTRODUCTION

Indonesia faces a double burden of communicable and Non-communicable diseases (NCDs). NCDs prevention and control is still limited to a risk factor approach, and there is no NCDs detection service in the community. Public awareness is needed to come to health services to carry out examinations related to NCDs. The weakness of the current examination system is the incompleteness of data on risk factors for NCDs, the absence of a screening model, and the diagnosis of NCDs. The research on making this application can make it easier for the community to detect NCDs and monitor health regularly. This mobile-based application is an expert system-based application that can perform early detection quickly and accurately with a risk factor approach following WHO guidelines.[1–3]

Currently, there is an NCDs risk screening model, and the education provision is carried out but has yet to be completed online.[4] The results of this detection do not accumulate, so analysis cannot be carried out, the findings cannot be reported immediately, and the findings cannot be followed up immediately.[5,6] Various efforts have been made to provide education related to NCDs, one of which is using multimedia. The use of multimedia can increase public knowledge regarding NCDs. This shows that people are more interested in getting information through multimedia.[5–8] In 2020, research makes a website-based NCDs information system. However, there is this research, researchers do not create a system that the wider community can use, and the system is still limited to health workers.[9] So, the researchers suggest making an android-based application that the wider community can use for early detection and health information and be used as a monitoring medium and data storage of medical history.[7]

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Previous researchers created an information system that can be used by cadres for recording and reporting the results of the integrated development post in NCDs. However, this system has yet to detect early detection, and no research or application can detect NCDs early. Hence, researchers need to research to create android-based or mobile applications. The purpose of this study is to develop an application for the early detection of NCDs that can be used as a reminder and early detection independently, self-assessment of NCDs risk factors that can be updated every day by users by filling in data so that it can be used as a medium for monitoring and self-control, health history data that has been inputted, can provide suggestions and recommendations for results based on the data that has been inputted and can function for surveillance and provide information related to NCDs and their risk factors.

METHOD

The development model used in the research consists of a literature study, development stage, validity expert, and trials.[10]

Stage 1 Literature Study

At this stage, the researcher conducted a literature study and collected information data by interviewing the department of health for the prevention and control of NCDs and the maternal and child health section and midwives to obtain potential data and problems in the field as application materials.

Stage 2 Application Development

The results from the initial stage will be used to design a model for the early detection of NCDs based on behavioral and environmental factors based on an information system tailored to the land's needs. Then this early detection design uses an expert system, where the stages consist of planning, analysis, design, implementation, testing, and maintenance stages. Third parties assist researchers in the manufacture of this mobile application. The third party is an Indonesian programmer based in Warsaw, Poland. The system used in this mobile application is an expert system, using a disease algorithm validated by experts (specialist doctors and health services). An expert system is a computer-based system that uses knowledge, facts, and reasoning techniques to solve problems that usually only an expert can solve in the field.[11] Expert systems were presented to help diagnose patients with nine possible symptoms.[12]

Stage 3 Expert Validity

Expert validation tests are carried out by Information Technology (IT) experts, material experts from the field of prevention and control of NCDs at the Health Office, and specialist doctors. Data collection techniques were carried out by distributing questionnaires and then revising the use of the model, if any, according to expert advice. This test is carried out to produce a model that is feasible and ready to be implemented. The validity test is carried out not only related to the content of the material in the application but also related to the use of the system. The application system is tested for effectiveness in terms of usability, speed, suitability, convenience, accuracy, and trustworthiness before the application is used by respondents. This test was carried out by 15 representatives from IT experts, health workers, health offices, and the community.

Stage 4 Application Testing

They test the application using a quasi-experiment with an unequal control group design. The sample consisted of 70 pregnant women who were divided into two groups. The treatment group was detected early using the mobile android-based application, and the control group was detected early using a manual questionnaire. Application testing to test the speed, accuracy, and effectiveness of android-based applications. The sampling technique used was purposive sampling for the sample in Banyumas, and total sampling for the sample from Pemalang Data analysis was conducted using the Chi-Square Test to test the difference in completed between the intervention and control groups. In testing this application, a test is carried out to determine the time it takes for the application system to make detection and diagnosis results in minutes.

RESULTS

Result of The Literature Review

This application is designed to facilitate midwives and patients in the early detection of NCDs. The references included in this application are related to the early detection of blood sugar risk factors, early detection of breast cancer risk factors, early detection of cervical cancer risk factors, early detection of heart disease risk factors, early detection of preeclampsia risk factors, early detection of hypertension risk factors, “CERDIK” behavior (regular health check-ups, smoking cessation, diligent exercise, balanced healthy diet, adequate rest, and stress management), Diabetes Mellitus Self-Management Behavior, and Self-reporting Questionnaire (SRQ-29).

Results of Application Development

The application can be downloaded at http://sip-tmen.id/. In the application, there are eight features available. Once downloaded, a login page will appear to enter the application (Figure 1). After logging in, a menu page will appear on the application (Figure 3). Figure 2 is the menu for initial registration to create an account so the user can log in. Feature 1 (Figure 3) is a menu where patients can perform early detection of NCDs independently. In this menu, there are several diseases for which early detection is carried out. Patients can choose one disease (Figure 4). After the

patient has selected the appropriate disease category (Figure 4), the screen will display a behavioral early-detection questionnaire (Figure 5). Patients fill out the questionnaire according to the situation; if so, click save answer, and early detection results will appear (Figure 6).

Then feature 2 (Figure 3) contains a history of the patient's. All detection history that has been carried out will be recorded in the early detection history (Figures 7 and 8). Furthermore, feature 3 (Figure 9) is a means of information for users related to NCDs. Users can read health information related to NCDs. Feature 4 (Figure 3), namely the medical history (Figure 10), contains a history of laboratory examinations and anthropometric examinations such as height, weight, and other supporting examinations. Feature 5 (Figure 3) contains a guide for users to use the application, regarding how to use the application. Feature 6 (Figure 8) is for consultation, and the menu will be connected to the Whatsapp of the midwife or the person in charge. Feature 7 (Figure 3) is the user's biodata; in this menu, the user can edit and update the data independently, and finally, Feature 8 (Figure 3), which is to exit the application.

Results of Trial

The trial result found that this application is more effective than the manual system. The trials include data completeness, detection speed, diagnostic speed, and the system's effectiveness. The test results found that the use of this application is more effective in terms of usability, speed, suitability, convenience, accuracy, and trustworthiness. The data in the application is also more complete than the data in the manual. In addition, this application has been proven faster in detecting and diagnosing NCDs than the manual system.

Differences in Detection and Diagnosis Time

The information system for early detection of NCDs using Android can automatically detect NCDs based on the results of the examinations in detail. Table 1 shows that all respondents in the intervention group detected NCDs with an average examination time of 608.57 seconds. Meanwhile, the control group (respondents who received a manual system inspection) with an average time required of 1028.57 seconds. The results showed that respondents in the intervention group experienced a faster examination time than the manual system, which was 42% faster. All respondents in the intervention group detected NCDs with an average duration of diagnosis of 15.14 seconds. Meanwhile, in the manual group, the average time required of 288 seconds. Based on the interpretation of the data, it can be concluded that at the time of diagnosis and detection, the intervention group was better than the manual group.

Table 1. Detection and Diagnosis Speed

Time (second)	Manual	Android
Detection speed	1028.57	608.57
Diagnose speed	288.00	15.14

Expert System Effectiveness

The application was an expert validation test carried out by information technology experts and material experts from the field of NCDs at the health office. The validity test is carried out not only related to the content of the material in the application but also the use of the system. The application system is tested for effectiveness in terms of usability, speed, suitability, convenience, accuracy, and trustworthiness before respondents use the application. This test was carried out by 15 representatives from IT experts, health workers, health offices, and the community. Data on the frequency distribution of the information system effectiveness test can be seen in Table 2.

Based on Table 2, the highest score data on the effectiveness of information systems in terms of speed is 4.67 (93.4%), while the lowest score in terms of accuracy and trust is 4.26 (85.2%). The average score of information system effectiveness is 4.43 (88.63%) in terms of usability, speed, suitability, convenience, accuracy, and trustworthiness. So it can be concluded that the information system for early detection of NCDs in pregnant women is very effective.

Table 2. Effectiveness of the Application System (n=15)

Parameter	Average	Percentage
Utility	4.40	88%
Speed	4.67	93.4%
Suitability	4.40	88%
Convenience	4.60	85.2%
Accuracy	4.26	85.2%
Trust	4.26	92%
Average	4.43	88.63%

DISCUSSION

The features of this application are the feature of early detection of NCDs independently and features of early detection history, health articles, medical history, application usage guide, health consultations, and user biodata. The essence of this application is the menu for early detection of NCDs that can be done independently by the user. After the mother gets information from the application about her health condition, it is hoped that it can change her behavior to pay more attention to her health. The user is looking at the menu for early detection of NCDs, which is expected to be the initial screening when the mother has health problems related to behavioral factors. This early detection can be done at home. There are also educational facilities in the form of health articles that mothers can use to find health information, especially about NCDs. If the early detection results are health problems, the mother can contact the midwife in charge through the consultation menu. The menus in the application are designed in such a way as to make it easier for mothers to receive education and conduct examinations from a distance.

Figure 1. Login

Figure 2. User Registration

Figure 3. Application Feature

Figure 4. Early Detection of NCDs Feature

Figure 5. Early Detection Questionnaire

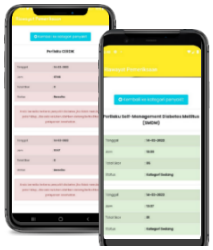

Figure 6. Result Early Detection

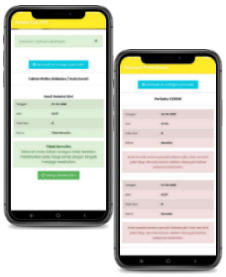

Figure 7. History of Early Detection

Figure 8. Results of Early Detection History

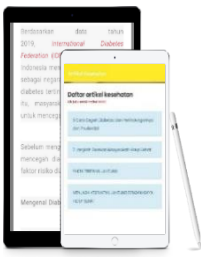

Figure 9. Health Article Feature

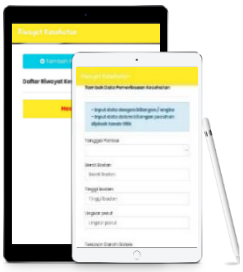

Figure 10. Medical History Feature

Figure 11. Application Guide

Figure 12. Health Consultation Feature

Expert test or feasibility testing is an activity to assess the model's design by presenting several experts such as IT experts, material experts, and health workers (specialist doctors and midwives). This is done so that the results are reliable. Currently, no application can be used to perform early detection of NCDs based on community behavior. The existing application only provides health information related to NCDs. From expert advice, this application can be added to a summary of the results of early detection that shows scoring for the advantages and disadvantages of each item of results obtained, development in the form of machine learning to increase the accuracy of the results, as well as the development of other factors outside of behavior that can affect the occurrence of NCDs.

This study found that all respondents were recorded with complete data as early detection of NCDs by 100%. Village midwives can detect risk factors for NCDs early through antenatal care data reported in the maternal cohort list, a form of national standard. The quality of data recording and reporting is essential to ensure accuracy in detecting NCDs risk factors. Complete data collection by health professionals is significant. However, it is often problematic due to the technical limitations of healthcare institutions, the high cost of medical examinations, or the high risk of harm to the patient's health.[13] Lack of data prevents health workers from making a diagnosis. However, the current recording of risk factors is still incomplete and consistent. This can lead to confusing data interpretation.[14,15]

Data on pregnant women and examination of risk factors and diagnosis of NCDs is more complete with applications that use artificial intelligence-based information systems. Previous study use of information systems can be used as a solution to incomplete data obtained during inspection or reporting so far. Health workers can view patient data anytime and anywhere. This process will support the speed of health workers in making clinical decisions.[20.21] The utilization of information systems can be used as a solution to incomplete data obtained during inspection or reporting.

Health workers can view patient data anytime and anywhere. This process will support the speed of health workers in making clinical decisions. Many African countries have used information systems to overcome the problem of incomplete audit data. With the help of the information system, the data obtained is much more complete and faster, especially from remote areas, making it easier for midwives and health workers to communicate to determine what actions will be taken to overcome health problems that occur.[9,22] In addition, with the information system, health workers get a convenient tool to collect and manage patient data to minimize negative impacts on patients.[18]

A study stated that the use of information systems for early detection of high-risk pregnancies has a faster time than the manual system in reporting carried out.[15] This was also revealed in a previous study which found that seven million people were not diagnosed with hypertension. They did not know that they had risk factors for hypertension.[19] Speed and accuracy in making a diagnosis will reduce the number of patients who do not understand their condition. Patients will be able to understand better and receive the health services provided to them. This shows that it is vital to detect the risk of preeclampsia in pregnant women so that it can be handled more quickly and precisely. A previous study revealed that the time needed by health workers and volunteers is faster with the development of an information system to support clinical decision-making. The speed in reporting the results of the examination to the client will affect the quality of the health service. The information system also provides convenience in terms of accessing patient data faster.[15]

The system effectiveness test results obtained a value of 4.43 (88.63%) in terms of usability, speed, suitability, convenience, accuracy, and trustworthiness. So it can be concluded that the information system for early detection of NCDs using an expert system-based information system in caring for pregnant women is very effective. The highest score is in terms of speed, then below in terms of confidence. This shows that the midwife feels helped by the existence of this information system. In addition, the midwife found it easy to use this system because the instructions for filling in the data were well provided. The lowest score for information system effectiveness is in terms of the trust. This is because trust influences consumer intentions and behavior in making online transactions or not doing so. Abbas states that trust refers to the belief that a health profession performs its performance on health service technology. Trust reflects a belief system that results in behavior change. A system will build trust in the minds of individuals if it can perform the expected function and bring about change, and can motivate individuals to have a positive evaluation of the use of the system. A positive attitude is likely a collection of beliefs about the system. The more positive the individual's intention towards using health care technology, the higher the likelihood that technology users will perform this behavior.[20,21]

The information system is a solution to the many problems that exist in health services, such as the lack of available resources, the length of the reporting process, the length of the administrative process, the incompleteness of the existing data, the delay in establishing a diagnosis and providing treatment, the long distance to go to the health service, the high-cost transportation to health services.[16,22,23] Application of a web-based expert system can facilitate the patients and prospective patients to perform a physical examination of the symptoms he was experiencing. Doctors and specialists with access to an admin can view patient data indicated on the admin page, making it easier for subsequent patient management.[25]

CONCLUSIONS AND RECOMMENDATION

An application of an early detection system for NCDs in pregnant women based on an expert system has been created. This application can detect NCDs accurately, accompanied by recommendations according to the risks experienced. As a future promotive effort, this application will be disseminated to the public with cross-sectoral collaboration for the early detection of NCDs independently.

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