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Non-Communicable Diseases Information System

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ABSTRACT Non-communicable diseases (NCDs) are the leading cause of death worldwide. In Indonesia, NCDs has increased and shifted patterns. Changes in behavior and lifestyle increase the risk of NCDs. Difficulties in monitoring treatment and patient visits are a challenge for health workers. Currently, there is still no integrated information system for patient monitoring. The general objective of this research is to develop an integrated Non-Communicable Disease Information System (NCDSI) in Semarang City. The current study uses the Rapid Application Development (RAD) method with a qualitative approach. RAD is a complete approach model for information system development and covers the entire system life cycle. This research was conducted in three stages: planning and needs analysis, designing, developing, and collecting feedback. During the development and collection of feedback, functionality testing activities are carried out to obtain feedback and evaluation as the system is improved. The research was carried out by the Semarang City Office. The functional test subjects consisted of three agents and five patients with primary hypertension and diabetes mellitus. The results: the planning and needs analysis phases were carried out through thorough interviews with end-users. The system design phase was described through contextual diagrams and database tables, and the development and feedback phase was conducted through the NCDSI functionality test. Conclusion: The developed NCDSI has been integrated and has four user levels (users of the City Health Office, Head of Health Community Center, Cadres, and patients).

INDEX TERMS Non-communicable diseases, NCDs, information system, rapid application development.

I. INTRODUCTION

Non-communicable diseases (NCDs) are the number 1 cause of death in the world and are a challenge in the health sector of the 21st century. The first global target sets a relative reduction of 25% overall mortality from four major NCDs (cardiovascular disease, cancer, diabetes, and chronic respiratory diseases). In 2016, 71% (41 million) of the 57 million deaths were caused by NCDs. The main NCDs that cause deaths include cardiovascular disease (17.9 million deaths, accounting for 44% of all deaths from NCDs and 31% of all global deaths), cancer (9 million deaths, 22% of all deaths from NCDs and 16% of all global deaths), chronic respiratory diseases (3.8 million deaths, 9% of all deaths from NCDs and 7% of all global deaths), and diabetes (1.6 million deaths, 4% of all deaths from NCDs and 3% of all global deaths)[1], [2]

The increasing prevalence of NCDs in various countries prompted the birth of agreements on global strategies for the prevention and control of NCDs. The 2030 SDGs agenda makes NCDs a strategic issue so that it becomes a priority program in various countries. The trend of NCDs in Indonesia has increased and shifted patterns. Changes in patterns are influenced by changing environmental conditions, changes in people's behavior, demographic transitions, technology, economic, and sociocultural influences. Coronary heart disease becomes the highest cause of death, which is followed by cancer and diabetes mellitus with complications. Based on basic health research data (Riskesdas) in 2018 shows that 95.5% of Indonesians consume fewer vegetables and fruits, 33.5% of people do less physical activity, 29.3% of people at productive age have smoking habits, and 31% have central obesity and 21.8% of obesity in adults[3][4].

The burden caused by NCDs has increased, this is in line with the increased risk factors. Some studies state that there is a relationship between changes in behavior and lifestyle to unhealthy behavior patterns such as smoking behavior, wrong and uncontrolled diet, imbalance of physical activity,

stress, drinking alcoholic beverages, and drug use. The development of technology has made it easier for humans to meet their needs. This results in most humans just sitting behind a desk and causing a lack of physical activity[5], [6]. Unbalanced physical activity causes physiological reactions in the body to decrease, triggering the onset of metabolic and cardiovascular diseases such as diabetes mellitus and cardiovascular [7]. Physical activity can improve overall glucose control due to an increase in blood flow which causes the capillary meshes to open so that many insulin receptors and receptors become more active. Physical activity such as gymnastics is useful for improving insulin sensitivity as well as controlling blood sugar levels[8]–[10]. The preliminary study conducted showed that the recording of NCD reporting, especially hypertension and diabetes mellitus, was taken from data from the Puskesmas Management Information System (SIMPUS). The data includes general data, namely the name of the patient, the date of the examination, and the diagnosis of the disease. Until now the system has not been able to support mechanisms that can be used to evaluate the compliance of people with hypertension and diabetes mellitus for treatment and taking medication. As a result of preliminary interviews, officials said they experienced difficulties when conducting regular monitoring of treatment and patient treatment visits. Age factor affects the patient's adherence to treatment. Patient adherence in the treatment of hypertension may lower the risk of cardiovascular disease[11], [12]. Efforts to monitor the state of health of patients with complaints of NCD disease through the use of technology have been developed. The use of the website and android-based applications has shown effective results in improving adherence to taking medications, as well as assisting officers in monitoring the health status of hypertensive patients[13]. Likewise, the use of mobile health that has been carried out in various countries shows that the mobile health application has succeeded in improving the control of *glycemic index* in diabetes mellitus patients and control of blood pressure in hypertensive patients[14]

Previous research has shown that technology-based systems have been used for the treatment of NCDs such as hypertension and diabetes mellitus, but their use is still unable to provide comprehensive services to patients with these diseases. However, several aspects have not been covered in the management of NCD treatment such as how to monitor the regularity of treatment and physical activity. In addition, the current information system has not been integrated with existing systems in health service institutions and still includes general data such as patient names, examination dates, and disease diagnoses. So it is necessary to develop an information system that can support the implementation of integrated management of hypertension and diabetes mellitus. The general objective of this study is to develop an integrated Non-Communicable Disease Information System (SIPTM) in Semarang City.

This research contributes to helping the health office and l to monitor patients with non-communicable diseases.

II. METHODS

This research uses the *Rapid Application Development* (RAD) method with a qualitative approach (FIGURE 1). RAD is a complete model approach to information system development and covers the entire life cycle of the system, from initiation to delivery. RAD has high system quality with fast turnaround time and low cost[15]. RAD emphasizes a short planning process and focuses on the software development process which includes planning and needs assessment, system design, feedback development and *collection*, and product implementation or completion[16].

FIGURE 1. Rapid Application Development Process

A qualitative approach is used to assist the process of identifying planning needs in system development. The *cross-sectional* approach is used as a time approach to data collection. This research was conducted in three stages, namely planning and needs analysis, system design, development, and collection of *feedback*. The implementation stage has not been carried out in this study. At the planning and needs analysis stage, a data collection process is carried out by conducting in-depth interviews with program managers and documentation regarding hypertension and diabetes mellitus data used. This stage will generate data related to the user's wishes in system development. The design stage of the system is carried out by the design of DFD and database tables. The development and feedback collection stage is carried out through function test activities to obtain *feedback* and evaluation as an improvement of the system under development. The research was conducted at the Semarang City Office. The subjects in the function test were 3 officers (from the Semarang City Health Office, Puskesmas, and Kader) and 5 patients with primary hypertension and diabetes mellitus aged 46 to 55 years.

III. RESULTS

The Non-Communicable Disease Information System (SIPTM) was developed with a *platform* website and implemented in Semarang City, Indonesia. SIPTM was developed by the RAD method. The phases of system development with the RAD method are as follows:

A. PLANNING AND NEEDS ASSESSMENT

At this stage, information on the issue of identification and data collection in the form of primary data is obtained directly from users (NCDs management staff of the Semarang City Health Office, puskesmas management staff, and posyandu cadres). Users and teams conduct meetings to identify the goals and needs of the system.

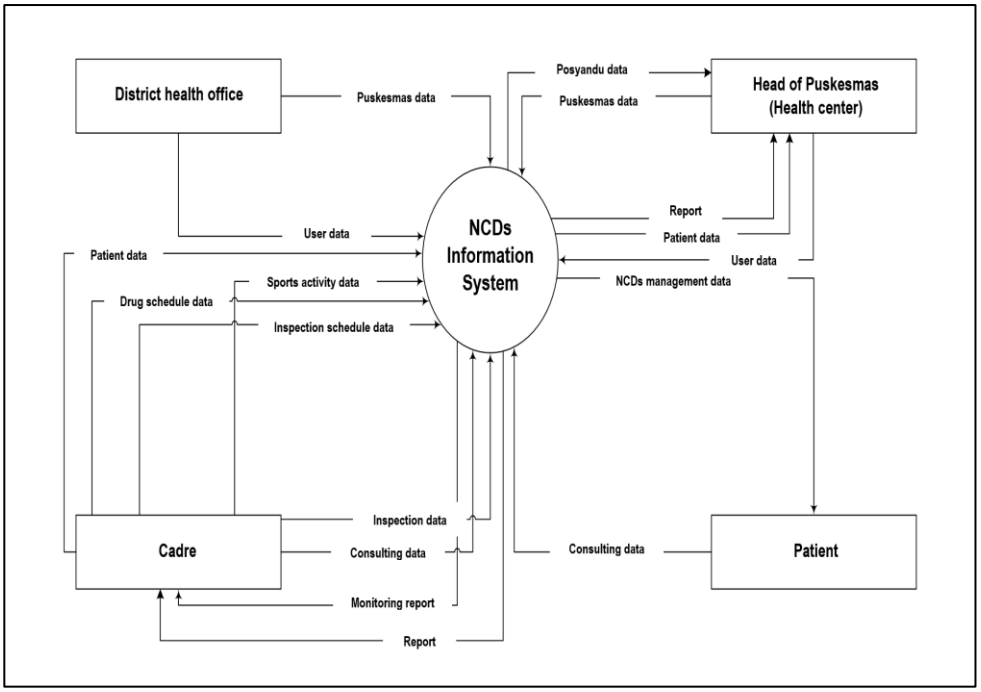

FIGURE 2. **Context Diagram of Non-Communicable Disease Information System**

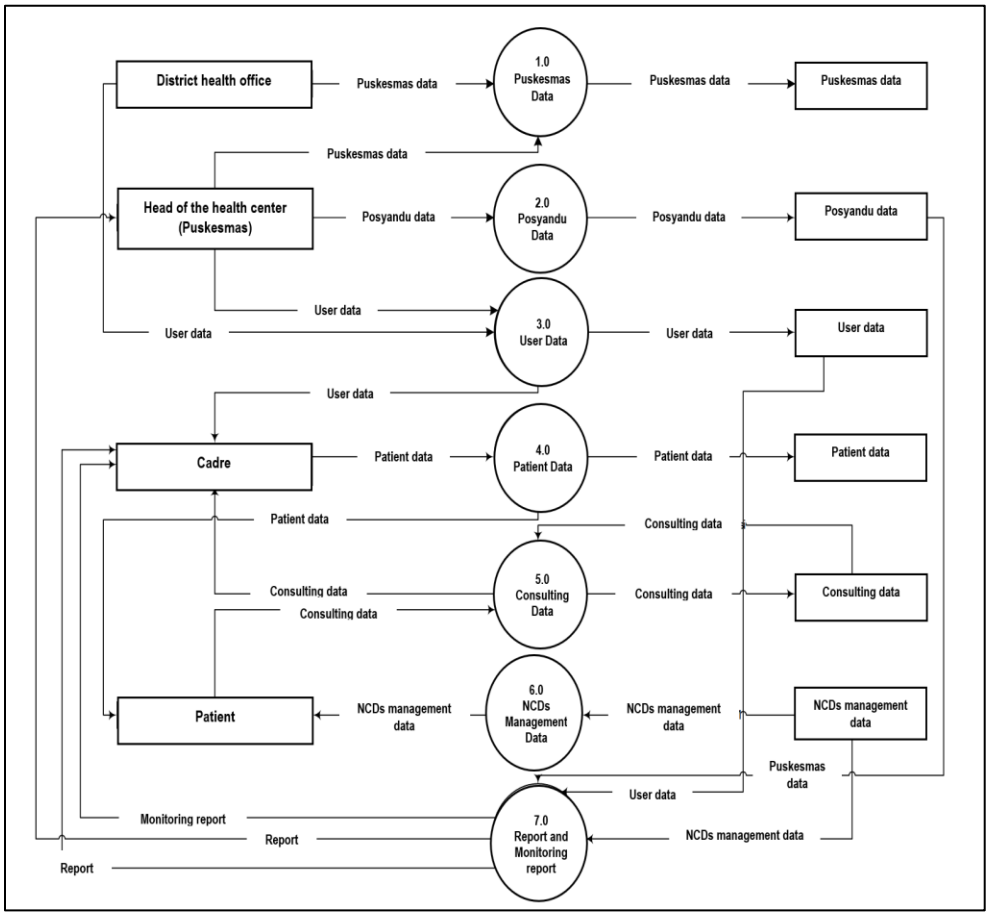

FIGURE 3. **Level 0 Diagram of Non-Communicable Disease Information System**

TABLE 1
TEST FUNCTION

Test ID	Description	Expected results	Test Results	Status
UF1	**Patient Data –User Cadre** Enter your name, NIK, date of birth, gender, occupation, cellphone number, posyandu, family PTM history, own PTM history, and address then press save	The system will store the patient data that has been added	The system stores added patient data	Succeed
UF2	**Patient Data – User Cadre** Leave one of the fields on the form marked with an asterisk (*) and then press save	The system does not store the data that has been filled in the patient data form and will display the message "please fill out this field"	The system does not store data and displays the message "please fill out this field"	Succeed
UF3	**Sports Activities – User Cadre** Click action – click add then enter the activity type, time, start date, and end date, and then hit save	The system will store data on the patient's sports activities that have been added	The system stores data on the patient's added exercise activities	Succeed
UF4	**Sports Activities – User Cadre** Click action – click add then clear one of the columns and then hit save	The system will not save the data that has been filled in the sports activity data form and will display the message "please fill out this field"	The system does not store sports activity data and displays the message "please fill out this field"	Succeed
UF5	**Sports Activities – User Patient** See suggested sports activities	The system will display the type of sports activity suggested for the patient	The system cannot display the type of exercise activity suggested for the patient	Failed/ Error
UF6	**Drug Schedule – User Cadre** Click Action – click add then enter the drug name, dosage, frequency, start date, end date, availability and then press save	The system will store the patient's drug schedule data that has been added	The system stores schedule data of added patient medications	Succeed
UF7	**Drug Schedule– User Cadre** Click action – click add then clear one of the columns and then hit save	The system will not save the data that has been filled in on the drug schedule data form and will display the message "please fill out this field"	The system does not save the drug schedule data and displays the message "please fill out this field"	Succeed
UF8	**Drug Schedule – User Patient** Displays the schedule of medications taken by the patient	The system will display the schedule of medications taken by the patient	The system does not display the schedule of medications taken for the patient	Failed/ Error
UF9	**Check– User Cadre** Click action – click add then enter the date, height, weight, BMI, body fat, belly fat, waist/abdominal circumference, systole, diastole, blood glucose, cholesterol, uric acid, eat saturated fat in 1 week, drink sweet in 1 week, eat/drink addictive substances/preservatives in 1 week, use used cooking in 1 week, exercise in 1 week, smoke, caption then press save	The system will store the patient's examination data that has been added	The system stores the patient examination data that has been added	Succeed
UF10	**Check– User Cadre** Click action – click add then clear the smoking selection field and then hit save	The system will not save the data that has been filled in the check data form and will display the message "Please select an item in the list"	The system does not store inspection data and displays the message "please select an item in the list"	Succeed

TABLE 1
(Continued)

Test ID	Description	Expected results	Test Results	Status
UF11	**Examination _ User Patient** Displaying the results of the patient's examination	The system will display the results of the patient's examination	The system does not display the results of the patient's examination	Failed/ Error
UF12	**Inspection Schedule– User Cadre** Click action – click add then enter the place, check the date then hit save	The system will store the data of the patient's examination schedule that has been added	The system stores data on the patient's examination schedule that has been added	Succeed
UF13	**Inspection Schedule– User Cadre** Click action – click add then clear one of the columns and then hit save	The system will not save the data that has been filled in on the inspection schedule data form and will display the message "please fill out this field"	The system does not store inspection schedule data and displays the message "please fill out this field"	Succeed
UF14	**Examination Schedule – Patient User** View the patient's examination schedule	The system will display the schedule of examinations that the patient must perform	The system does not display the schedule of examinations that the patient must perform	Failed/ Error
UF15	**Report– User Cadre** Select posbindu, period, month	The system will display a table of reports according to the previously selected option	The system displays a table of reports according to the selected option	Succeed

The information needs to be needed by the managing staff include a bar chart of patient data (based on age, gender, history of NCDs in the family, history of NCDs on oneself), patient data, posyandu data, heatlh community center data, and user data; information needs for cadres include diagram bar patient data (based on age, gender, family history of NCDs, history of NCDs on oneself), sports activities, drug schedules, consultations, patient data, examinations, user data, reports, and monitoring reports.

Respondent 1

"*I hope that this system that will be developed (SIPTM) will make it easier for me to find patient data and compile reports*."

Respondent 2

"*After this system was developed, it could help me get patient examination information, monitoring reports, and be able to directly communicate with patients, for example needing consultation*."

Respondent 3

"*NCDs are getting higher cases so my hope is that this system will help us analyze time so that in the future it can be more controlled*."

Cadre 1

" *..... I hope that this system can help me when recording data and reports to puskesmas officers. Klo can be made easy so that we and other users can easily use it*."

B. SYSTEM DESIGN

In the RAD method, system design includes an overview and details of the stem (context diagram), database table design, and user interface design. Based on the context diagram above, it is known that there are four user users in the developed system. First-level user Dinas Kesehatan Kabupaten has a role in creating user data (Kepala Puskesmas) and adding data to health community center. The two user levels of the head of health community center have a role in making user data (Kader), adding puskesmas data, seeing/adding patient data, viewing/adding posyandu data, and making reports. The three levels of Cadre users have a role in adding patient data, increasing drug schedule data, increasing sports activity data, increasing examination schedules, adding examination data, consulting, making reports, and making monitoring reports. DFD can be used to find out the data flow flowing in a system and its implementation. The DFD current in this application can be seen in the FIGURE 2.

FIGURE 3 shows the processes that occur at each user level. First, at the user level of the city/regency health office (Dinas kesehatan kabupaten), there are two processes, namely the process of storing data related to puskesmas data and user data. The second user level is the head of the puskesmas (Kepala puskesmas) which has two data storage processes related to posyandu data and user data. The third user level is a cadre (Kader) that has five data storage processes, namely user data, patient data, consultation data, PTM management data, report data, and monitoring reports. The last level of users is patients (Pasien) who have three processes, namely patient data, consultation data, and PTM management data.

FIGURE 4 shows the relationship schema of the SIPTM database table. Each table represents each interconnected *field*. In the patient data table, seven tables are connected, namely the examination data table, user data table, sports

activity data table, drug schedule data table, consultation data table, examination schedule data table, and report table. Meanwhile, the report table is connected to six tables, namely the consultation data table, the drug schedule data table, the examination schedule data table, the patient data table, the sports activity data table, and the examination data table. The user interface design of SIPTM that is being developed is tailored to the needs of the user. The form of the appearance/*interface* of the City Health Office user includes a login menu, dashboard, and puskesmas data. The form of login display, dashboard, and puskesmas data can be seen in APPENDIX 1, APPENDIX 2, APPENDIX 3, and APPENDIX 4. The second user level is the Head of puskesmas. There is a user screen of the Head of Puskesmas including logins, dashboards, posyandu data, and reports. The shape of the *interface* can be seen in APPENDIX 5, APPENDIX 6, APPENDIX 7, and APPENDIX 8. The third user level is cadres. The user cadre screen includes login, dashboard, patient data, examination, examination schedule, sports activities, drug schedule, consultation, reports, and monitoring reports. The shape of the interface can be seen in APPENDIX 9, APPENDIX 10, APPENDIX 11, APPENDIX 12, APPENDIX 13, APPENDIX 14, APPENDIX 15, APPENDIX 16, APPENDIX 17, and APPENDIX 18. The fourth user level is the patient. The user cadre screen includes login, dashboard, sports activities, drug schedule, examination schedule, examination, health promotion video media, and patient consultation. The shape of the *interface* can be seen in APPENDIX 19, APPENDIX 20, APPENDIX 21, APPENDIX 22, APPENDIX 23, and APPENDIX 24.

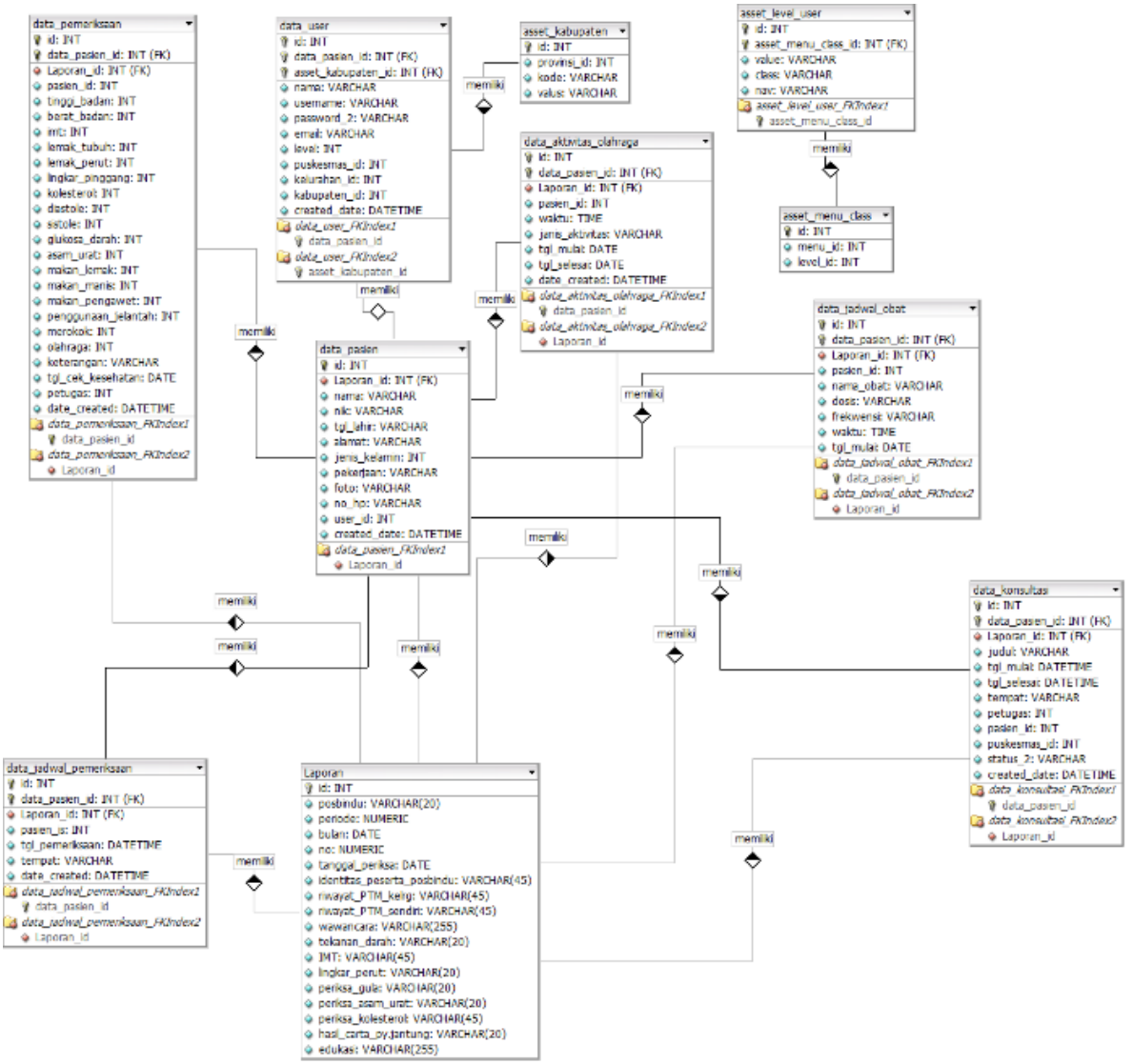

FIGURE 4. Non-Communicable Disease Information System Database Table

C. FEEDBACK DEVELOPMENT

At this stage, *feedback* collection is carried out through the oral function test (*black box testing*) for further development and integration between existing parts of the system.

IV. DISCUSSION

The initial stage of designing a system with a RAD model begins with planning and needs analysis. Planning and analysis of needs is a very important and fundamental initial stage that is used as an approach to identifying the needs of each level of user. Part of this needs analysis will involve the end *user* of the system which is key to this stage of the process. *The end user* knows the expected information results from the system. At this stage, the user conveys their needs and wants[17], [18]. The qualitative approach method is used in digging up information for users conducted through in-depth interviews. In-depth interviews are conducted to identify problems that will be addressed through system development[19]. Based on the results of in-depth interviews, data, and information needs include puskesmas data, posyandu data, patient data, examination data, examination schedule data, drug schedule data, sports activity data, consultation data, reports, and monitoring reports.

The next stage after planning and needs analysis is the design of the system. The design of the system describes the main components and interfaces of each component. The focus of this stage is on how to provide the necessary functionality (must-have items and wish lists) to the system. The result information of the first stage is used to generate some system product designs. *End users* as internal stakeholders review the design results and approve the best design. Once selected, it further creates a blueprint for the design by planning specifications for the required hardware, software, people/users, and data resources and adding additional information for system coding and debugging[18], [20]. The product design of this phase system is depicted through DFD and ERD based on the results of the first stage information. System design aims to carry out a thorough design on all activities of the system architect and improve the understanding of problems based on the results of the first stage. The researcher designed all activities involving the identification as well as a description of the software system as a whole[21], [22]. DFD is a tool for designing a system product that allows developers to describe a system as a network of functional processes connected through data flows[23]. Based on the context diagram and level 1 diagram, there are four users, namely the district/city health office, the head of the puskesmas, cadres, and patients. Context diagrams are the most basic and common data streams that display the lines and relationships of a system with its external entities. While the level 1 diagram is an overview with some details. In the level 1 diagram there are several subprocesses. In this process, the diagram requires an additional data flow and data storage to connect it.

Each user level has restrictions on access rights. The user administrator level has access rights in creating/adding accounts for district/city health offices, puskesmas heads, cadres, and settings in the system. The user level of the district/city health office has access rights to adding the puskesmas head account and adding puskesmas data. The user level of the head of the puskesmas has access rights to view/change puskesmas data, add posyandu data, view patient data, and process reports. The cadre user level has access rights to adding/changing patient data, examinations, examination schedules, drug schedules, sports activities, viewing/consulting, making reports, and monitoring reports. The patient's level user has access rights to viewing non-communicable disease management data (including definitions, hypertension control information, medication reminders, activity reminders, diet reminders, and health check reminders) and submitting consultations.

The third stage is the development and collection of *feedback*. At this stage, system development continues to be carried out based on the results of collecting *feedback*. Feedback collection is carried out by testing the function of the system so that deficiencies that need to be corrected can be identified. Function tests are needed to find out the actual results of information system applications by identifying defects/bugs in information system applications before use, guaranteeing the quality of the developed applications, and identifying possible risks of harm to users when using them[24], [25]. Information systems that have been thoroughly tested can be assessed for reliability and performance capabilities. The testing process requires a stable internet connection to access SIPTM. The developed system has been integrated up to level V. Integration characteristics include system specification integration (level I), user system integration (level II), integration within the scope of technology (level III), organizational integration (level IV), socio-organizational integration (level V), and global integration (level VI)[26]. The system testing carried out is still limited to the menu function test (*Black Box Testing*) contained at each user level so further testing is needed to find out the effectiveness of the system in supporting user performance. *Black box testing* plays a role in helping validate functions in the system as a whole. The test results show that there are still some errors so it needs to be improved and further developed. The advantage of *black box testing* is that testers do not need to have special knowledge about programming languages and implementation[27].

The limitations of the research problem are that this research only develops a non-communicable disease information system based on qualitative analysis. It is necessary to carry out further research related to testing the information system using quantitative analysis.

V. CONCLUSION

The Non-Communicable Disease Information System developed has been integrated and has four user levels which include users of the City Health Office, the Head of Puskesmas, Cadres, and patients. Research with the RAD method is still limited to the stage of development and

collection of feedback so that further research can be carried out until the last stage (implementation). It is necessary to implement a non-communicable disease information system that has been developed at the Puskesmas. After implementation, it is necessary to carry out a quantitative evaluation related to the effectiveness of the use and utilization of information systems.

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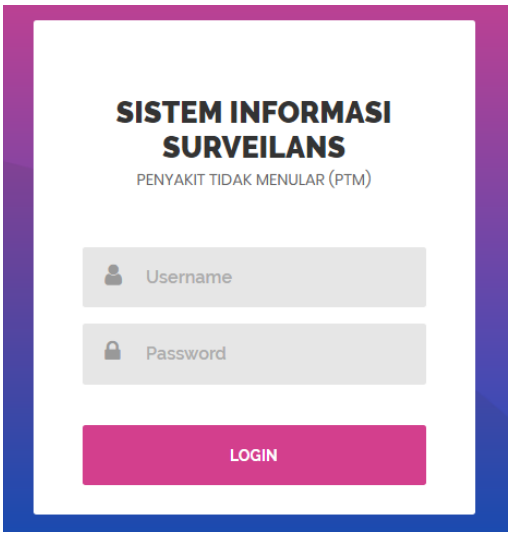
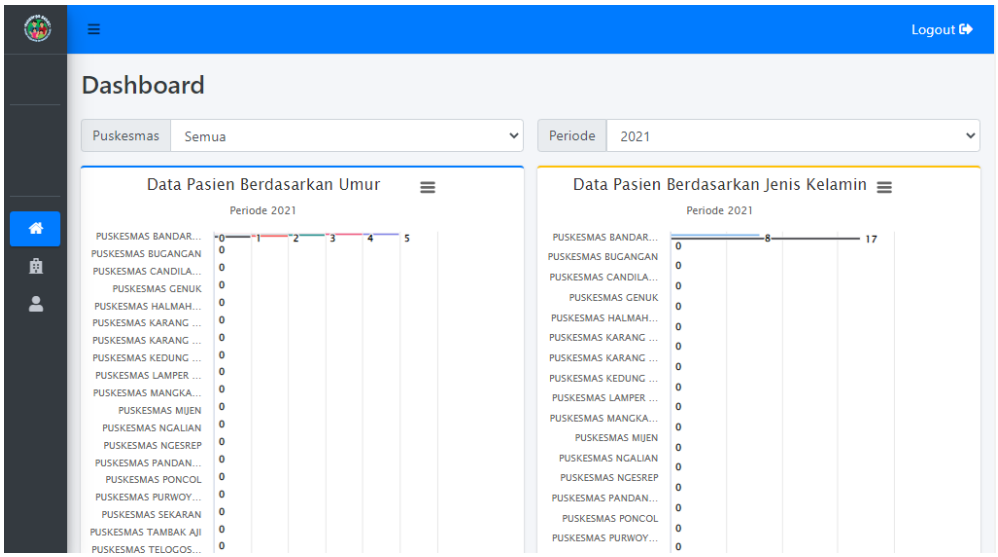
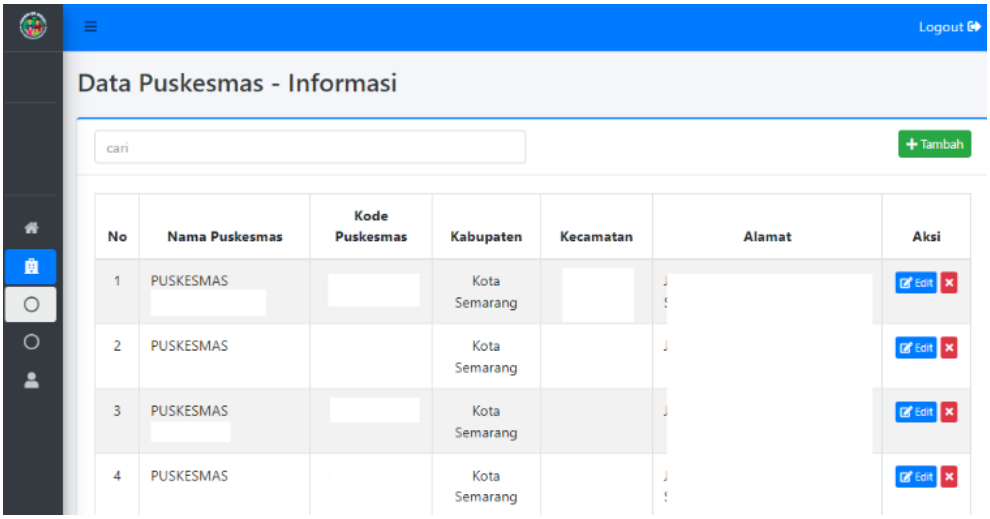
Appendix



APPENDIX 1. **Login menu interface of District Health Office user**

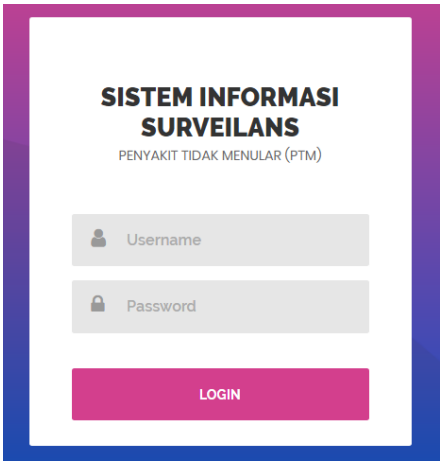


APPENDIX 2. **Dashboard menu interface of District Health Office user**

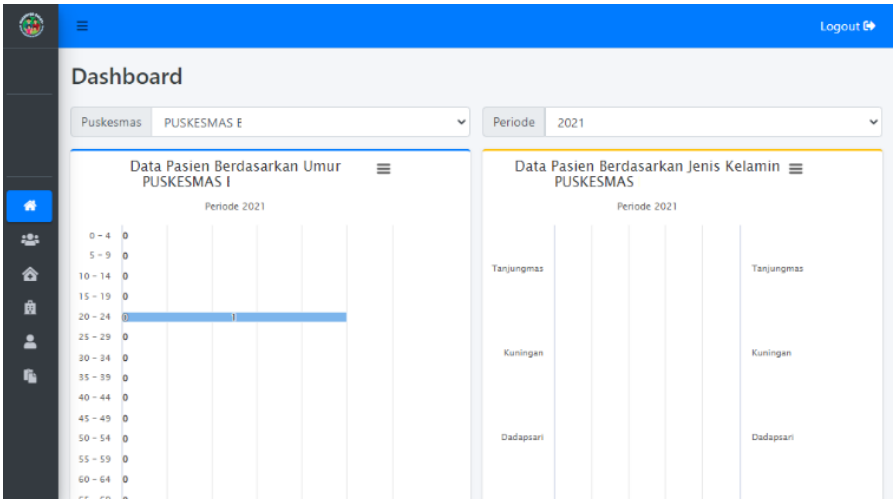


APPENDIX 3. **Health Community Center Data-Information on interface of District Health Office user**

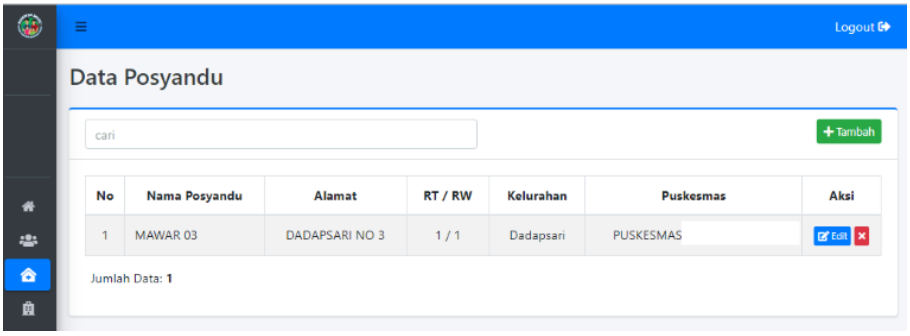
APPENDIX 4. **Health Community Center Data-Working area on interface of District Health Office user**



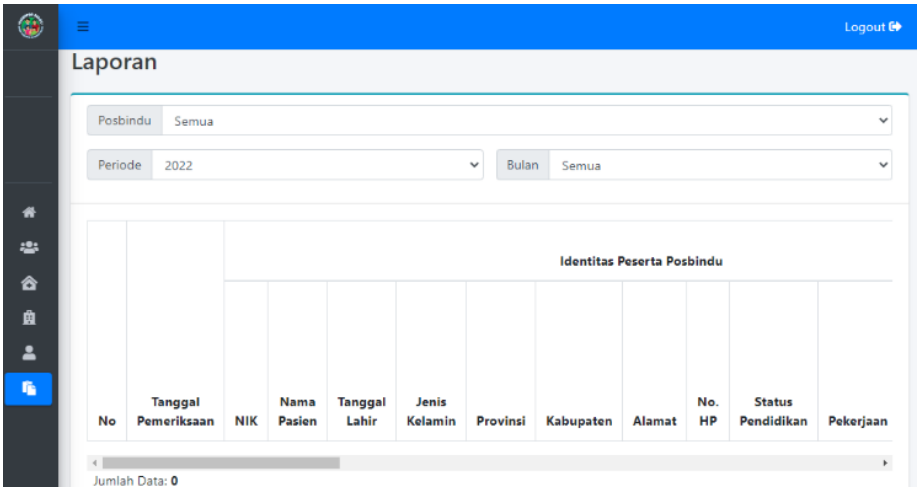
APPENDIX 5. **Login menu interface of Head of Health Community Center (Puskesmas) user**



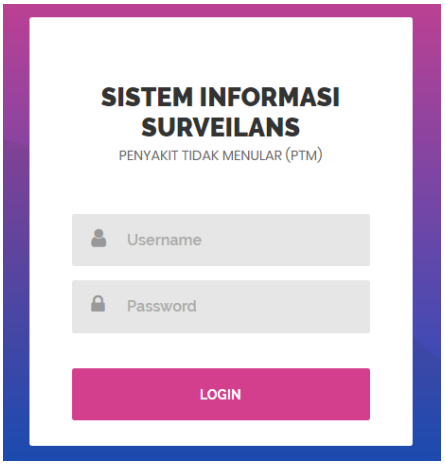
APPENDIX 6. **Dashboard menu interface of Head of Health Community Center (Puskesmas) user**



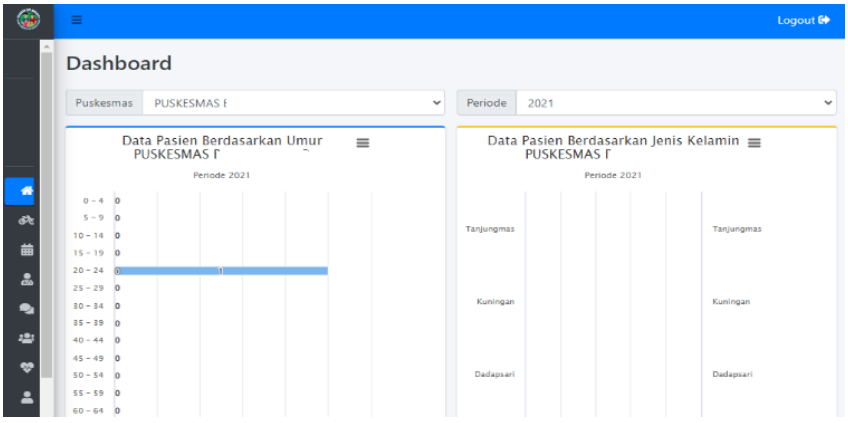
APPENDIX 7. **Posyandu Data menu interface of Head of Health Community Center (Puskesmas) user**



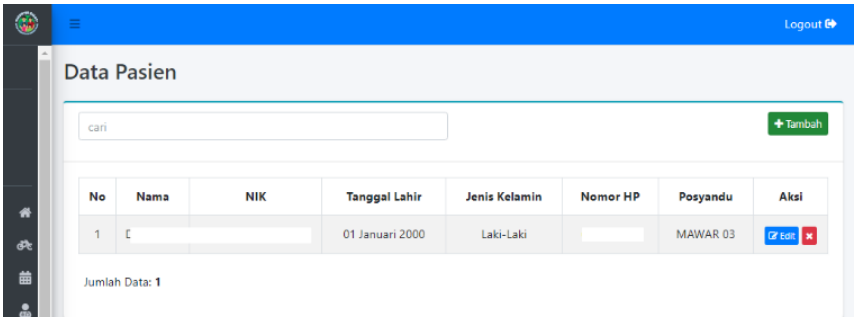
APPENDIX 8. **Report menu interface of Head of Health Community Center (Puskesmas) user**



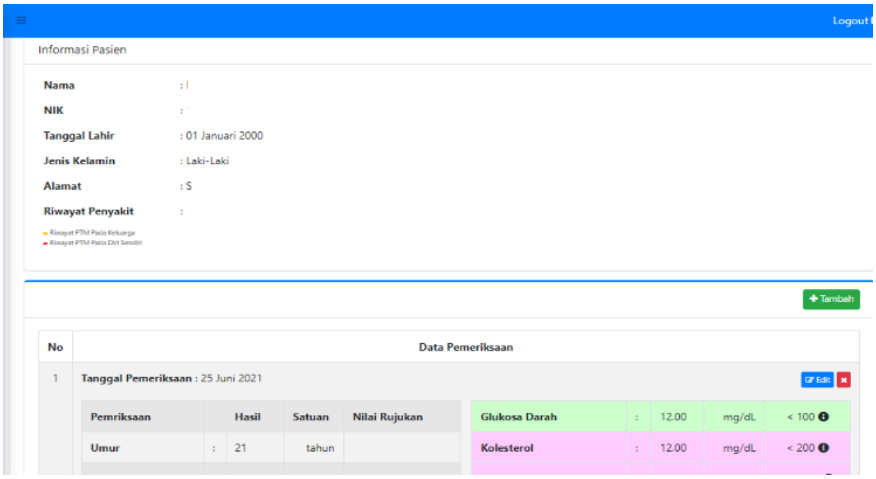
APPENDIX 9. **Login menu interface of Cadre user**



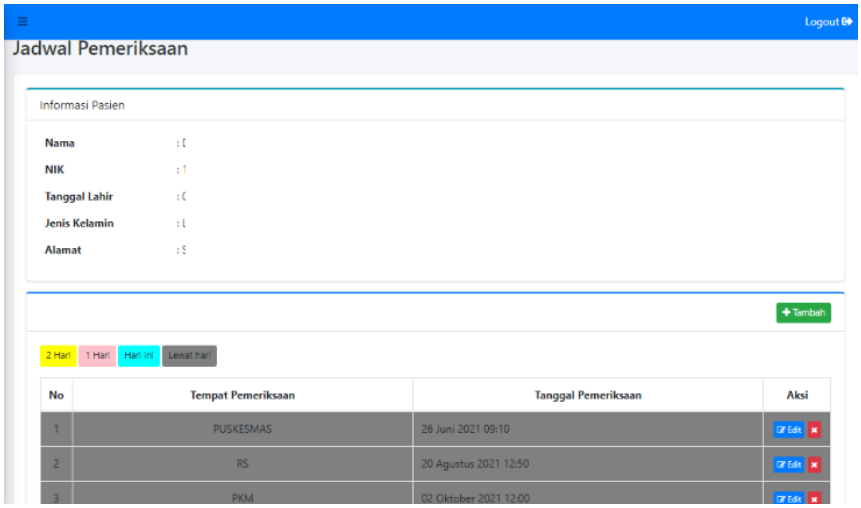
APPENDIX 10. **Dashboard menu interface of Cadre user**



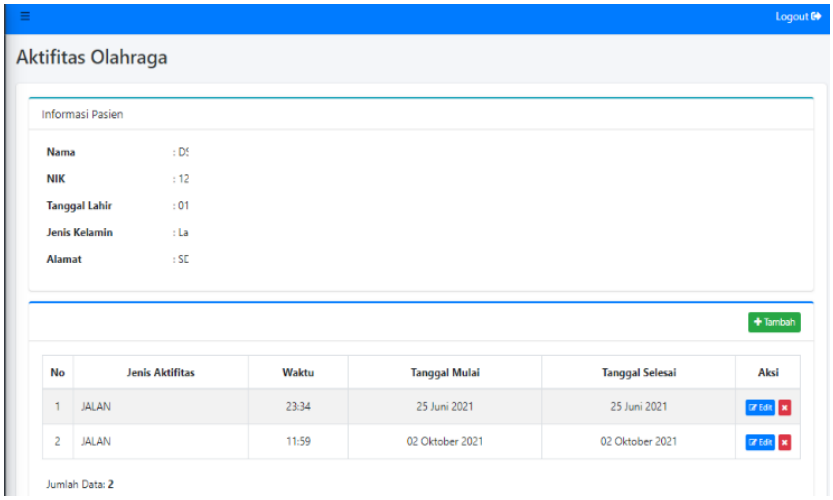
APPENDIX 11. **Patient Data menu interface of Cadre user**



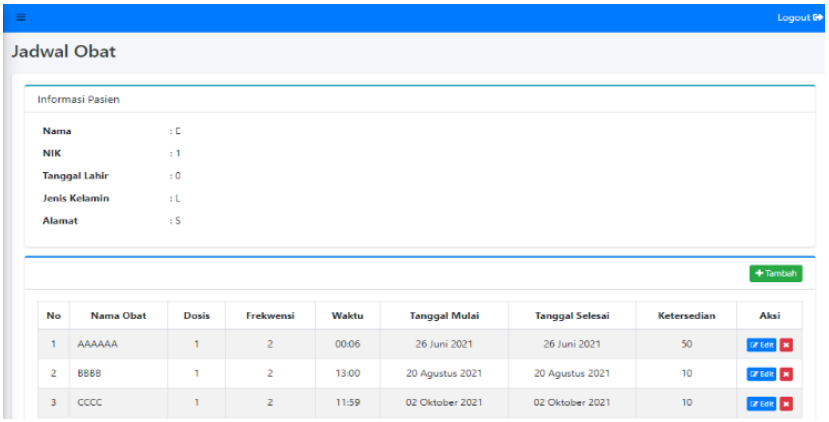
APPENDIX 12. Inspection Data menu interface of Cadre user



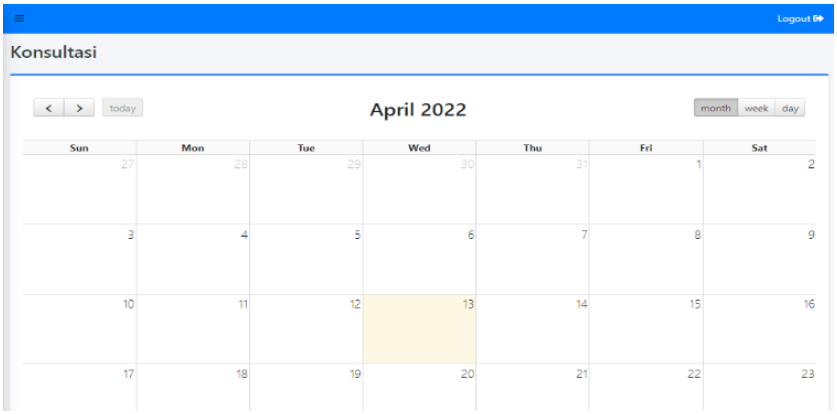
APPENDIX 13. Inspection Schedule Data menu interface of Cadre user



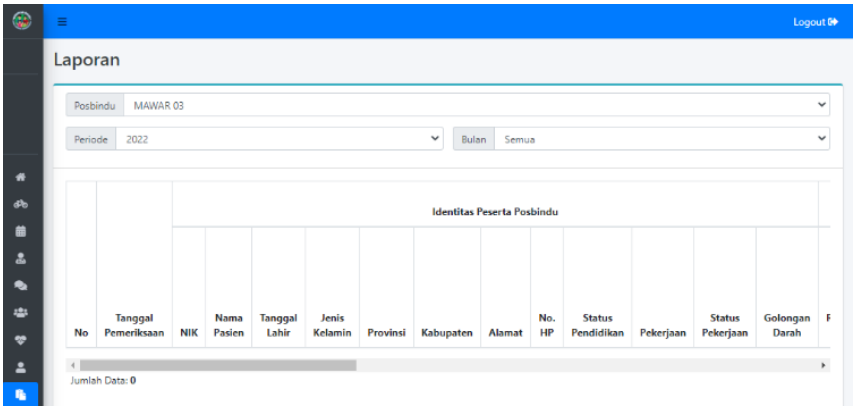
APPENDIX 14. Sports Activity Data menu interface of Cadre user



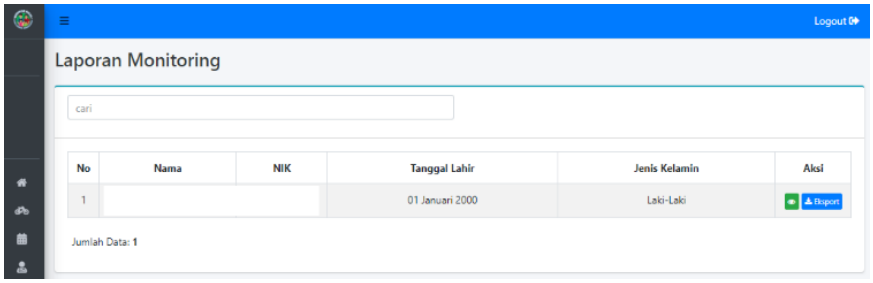
APPENDIX 15. Drug Schedule Data menu interface of Cadre user



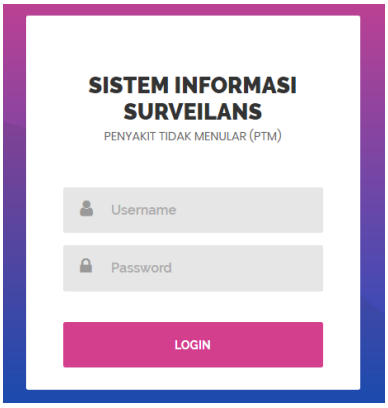
APPENDIX 16. Consulting Data menu interface of Cadre user



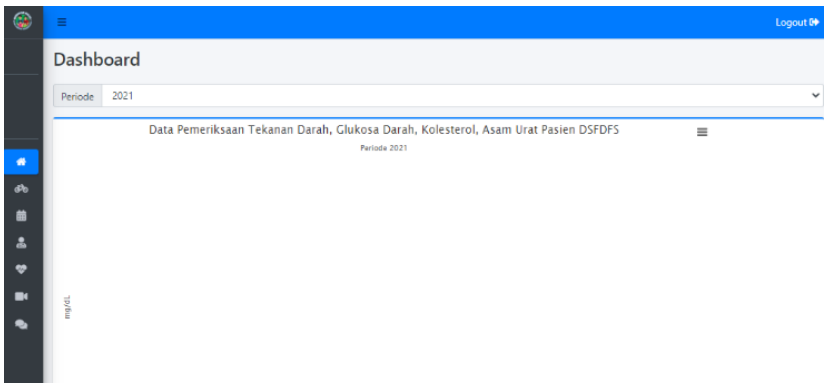
APPENDIX 17. Report menu interface of Cadre user



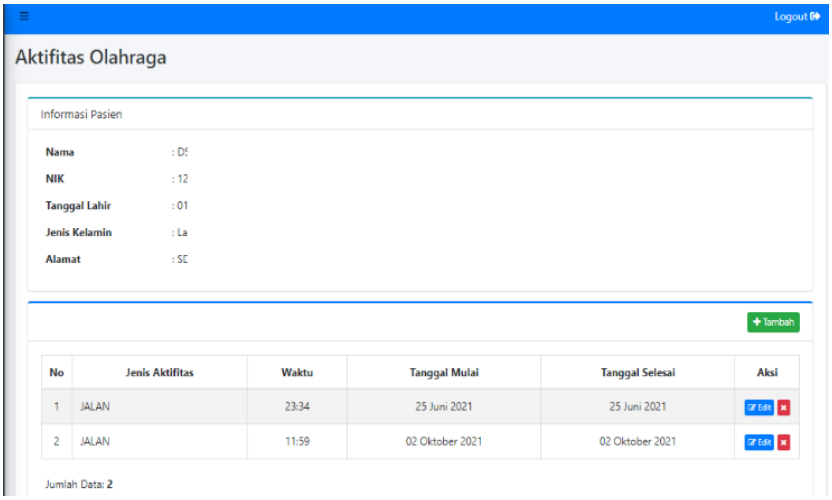
APPENDIX 18. **Monitoring Report menu interface of Cadre user**



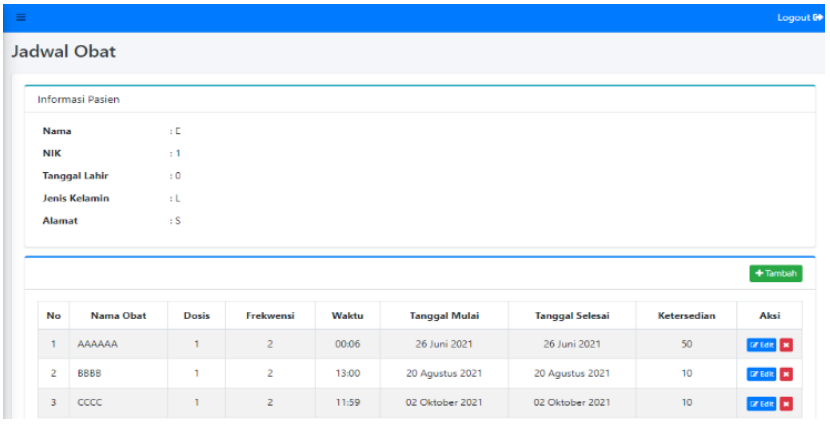
APPENDIX 19. **Login menu interface of Patient user**



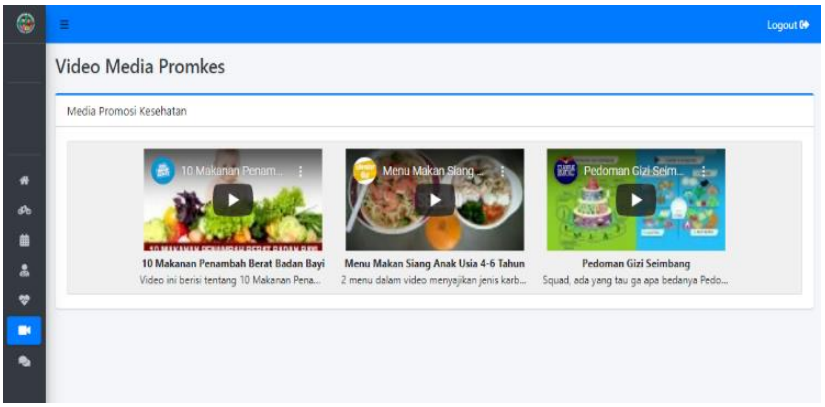
APPENDIX 20. **Dashboard menu interface of Patient user**



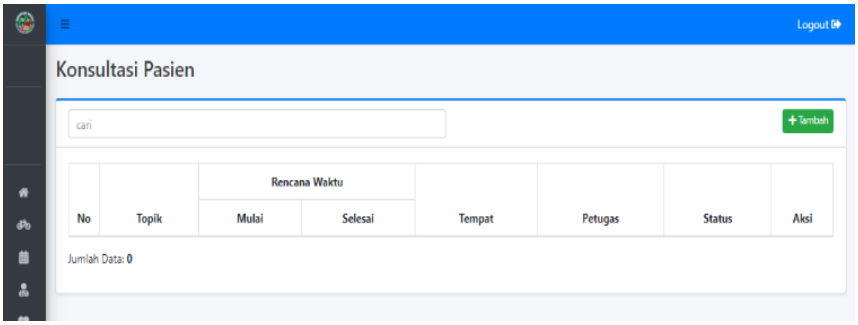
APPENDIX 21. Sports Activities menu interface of Patient user



APPENDIX 22. Drug Schedule menu interface of Patient user



APPENDIX 23. Video of Health Promotion Media menu interface of Patient user



APPENDIX 24. Patient Consultation menu interface of Patient user