BERKALA KEDOKTERAN
doi: 10.20527/jbk.v19i1.15704
RESEARCH ARTICLE
OPEN ACCES

The 24-Hours Food Recall System for Monitoring Diabetes Melitus Patients

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Abstract:

Diabetes Mellitus is one of the diseases that can cause complications for patients if neglected and is one of the causes of most death cases in Indonesia. This study aims to build a website-based system to help monitor nutrition for DM patients through 24 hours food recall (24HFR). The 24HFR system will integrate the roles of nurses and nutritionists in hospitals to understand patient eating behaviour and formulate nutrition education for patients. This system is built based on the SDLC stages, from the needs analysis stage to testing and implementing the program. The usability test results using SEQ show that health workers can easily use the website-based 24HFR system.

Keywords: Diabetes Mellitus; Food Recalls; SDLC; Single Ease Question; Websites

Introduction

Diabetes Mellitus (DM) is a non-communicable disease that is one of the public health's main problems. Data from the International Diabetes Federation (2019) [1] found that in 2019 it is predicted that there will be 463 million people in the age range of 20-79 years who suffer from DM. This figure is predicted to continue to increase in 2030 by 10.2% and 10.9% in 2040 [1,2]. The prevalence of DM in Indonesia is also concerning.

Indonesia is in the seventh position with the most DM cases globally and 5th in the world for undiagnosed DM cases [1]. DM cases in Indonesia occupy the third position as the cause of the most death cases in 2020[3]. *Diabetes Mellitus* is a long-term disease that, if ignored, can cause various complications. Therefore, several researchers focus on managing DM and understanding the risk factors that can exacerbate the incidence of DM. In addition to providing therapy in the form of pharmacological measures in the treatment of DM, non-pharmacological treatment is also needed, which can be in the form of lifestyle modification for DM patients.

This lifestyle setting can be in the form of increasing activity, regulating diet/nutrition patterns and increasing education about various DM-related problems [4]. One thing that is believed to affect the incidence of a disease is diet. *Diabetes Mellitus* is a disease caused by metabolic disorders, so dietary regulation is necessary [2,5]. In a study conducted in Germany and France, data found that in achieving a higher degree of health, it was felt that the regulation of dietary patterns could have a more significant impact than exercise, activity or heredity[6].

The nutritional assessment process is critical to see the importance of nutritional monitoring in patients suffering from DM. Assessment of nutritional intake by patients with DM will provide important information regarding the frequency and distribution of inadequate nutritional intake. In addition, it can provide guidelines for making nutritional interventions[7]. Handling patient nutrition monitoring is essential because it can provide information about energy and protein intake, which is the basis for determining additional supplements needed by patients, changing the patient's nutritional plan and determining whether the patient needs further consultation with a nutritionist [8].

Creating an assessment model and monitoring nutrition is essential because several studies found that one of the causes of the high readmission rate of patients to the hospital is a factor in handling poor nutrition [9]. Drinic et al. (2017) [10] found that the readmission rate of patients with diabetes was higher when compared to patients without diabetes, around 14-30%. In addition, Holst et al. (2014)[11] research found that malnutrition in hospitalized patients often occurs with a percentage of 20-60% depending on the condition of the hospital and the nutritional assessment tool used. Nutritional assessment regarding nutritional intake is a complex assessment process related to individual habits in consuming daily food [12].

Although it has been realized the importance of monitoring the nutrition of DM patients in hospitals, this still needs to be done. In several studies, it was found that, in many cases, it was difficult to monitor and document the nutritional status of patients due to several reasons. One of them is because nutrition monitoring currently takes a long time [13] and nurses need to gain knowledge in monitoring clinical nutrition and the inability to make decisions regarding patient nutrition [8]. Other factors that affect the quality of nutrition monitoring in hospitals are the ability of nurses to carry out nutritional assessments and the unavailability of tools to conduct more effective and efficient assessments [14].

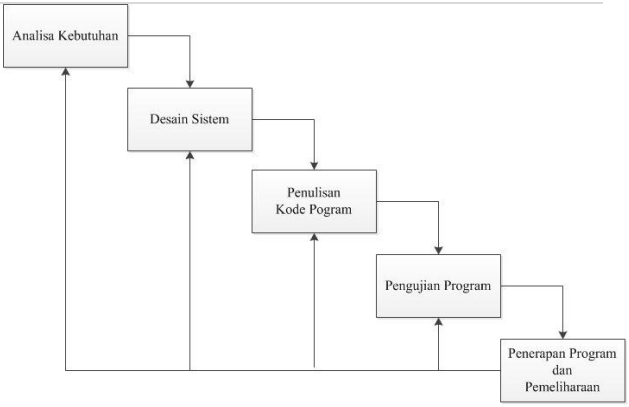
Seeing this phenomenon, the team of health workers sometimes needs help to

identify the basic nutritional needs needed in hospitals correctly. One of the methods used to minimize this is to use self-reported food assessment. Unfortunately, this assessment method has a high degree of bias because the patient himself carries it out without monitoring from health workers [15]. Therefore, it is crucial to innovate to monitor the nutritional status of DM patients in hospitals.

One of the tools used in general to monitor nutrition is 24 hours food recall (24HFR). Currently, the implementation of 24HFR in Indonesia, especially in Makassar City, is still carried out using paper-based and only carried out by A nutritionist. Meanwhile, in terms of monitoring DM patients, nurses also need to understand the patient is eating behaviour to be considered in preparing nursing care and formulating education about nutrition for patients in preparation for a discharge later (discharged planning). Thus, it is vital to make this 24HFR assessment tool to be used in an integrated manner by the entire team of health workers who treat patients who require close nutrition monitoring, such as DM patients. Therefore, this study aims to design a website-based 24HFR to make monitoring the nutritional status of DM patients in hospitals easier.

Research Method

Developing a website-based 24HFR system applies the Research and Development (R&D) methodology, which aims to develop specific products and test product effectiveness by validating user needs. Several steps need to be taken to create changes in the business process of the nutrition monitoring system, which was originally paper-based to become online-based and integrated. The development stages of 24HFR are carried out based on the Software Development Lifecycle (SDLC) [16], which can be seen in Figure 1



Picture. 1 Stages of making a 24HR system for Diabetes Mellitus patients

Each SDLC stage produces output until a 24HFR system is formed which is ready to be implemented. The results of each of these stages will be explained in the next chapter.

Results and Discussion

Need Analysis

In the first phase of 24HFR development, intensive interviews were conducted with two main actors as end-users of the 24HFR assessment tool: nurses and nutritionists. In addition to these two actors, patient actors were added as part of the optional development plan. Table 1 shows the requirements of all 24HFR actors.

Tabel 1. Mapping of User's Needs

No	Specification List		
	Actor	**Need**	**Priority**
1	Nurse	• Manage Patient's Data • *Generate* patient's data • Manage Data *FR* • *Generate* Data *FR* • Read *Advice* from Nutritionist	*High*
2	Nutritionist	• See *FR* Data • Add and validate *Advice* Nutrition	*High*
3	Patient(*)	• See *FR* Data • Read *Advice* Nutrition	*Medium*

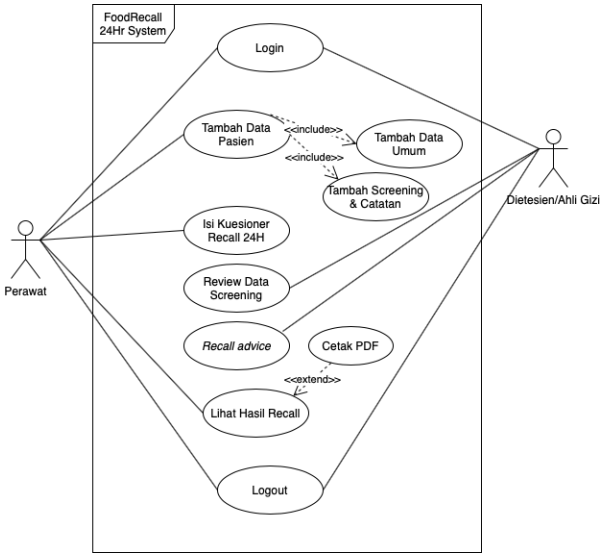
(*)Not the main actor who will be modeled in detail.

System Desain

The results of the needs mapping in the previous stage will be further modelled to form a comprehensive scenario and product details. Some of the models used to build a 24HFR system are:

- Requirements modelling;
- Database modelling; and
- Modeling the interface (user interface).

User requirements (requirements) are modelled using diagrams in the Unified Modeling Language (UML) which also serve as documentation for the design and testing of the program. The use case modelling for the main specifications for the 24HFR system is shown in Figure 2.

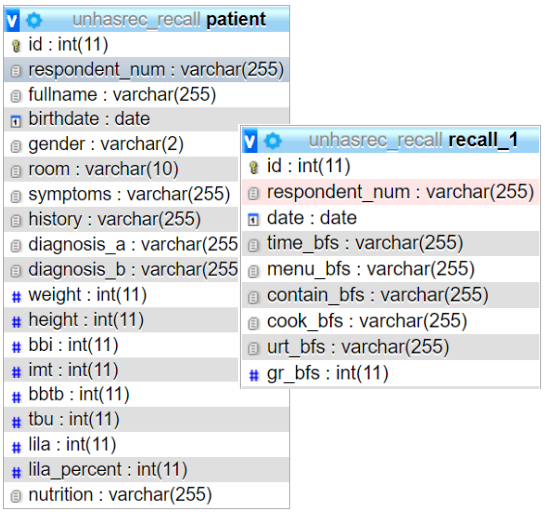


Picture. 2 24HR Use Case Diagram

Requirements modelling with use case diagrams were further developed using a series of other diagrams in UML, namely activity diagrams, class diagrams and sequence diagrams, to prepare for further modelling. The database design is based on user needs which have been analyzed and modelled comprehensively using UML diagrams.

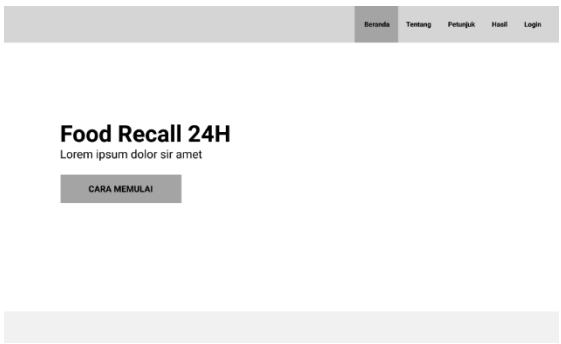
Figure 3 shows two sample tables containing the attributes used in building a 24HFR system. In the patient table, several attributes related to patients are needed that support the nutritional assessment of DM patients. Some of these attributes are: diagnosis a (main diagnosis), diagnosis b (additional diagnosis), weight (weight in kg), height (height in cm), nutrition (nutritional status during examination) and several other attributes.

In addition to the patient table, there is a recall_1 table which serves as the primary assessment to store information about patient food assessments. The table stores the patient's food recall data 5× (five times) a day, namely at breakfast, morning snack, lunch, afternoon snack and dinner. Every time the nurse does a recall, the questionnaire data will record the time, the food menu, the content in the food menu, how to cook it, the URT and the calorie count of the food.

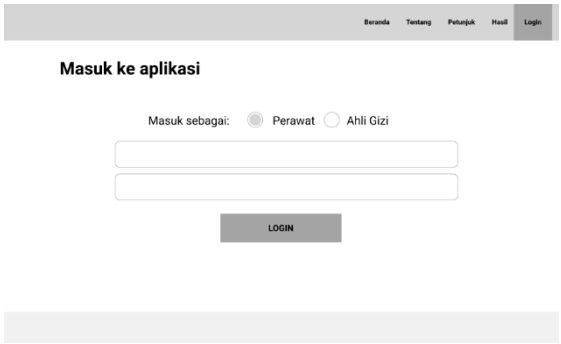


Picture. 3 Patient Table and Recall from the 24HFR database

With the database design using the MySQL platform, the data storage for the 24HFR system is ready to be implemented. Furthermore, in the last part of the system design stage, the user interface modelling process is based on the task flow. This modelling process will produce a wireframe that includes the layout design of the 24HFR website. The wireframe construction was carried out using Figma and resulted in several interface designs with samples which can be seen in Figures 4 and 5



Picture. 4 Home page wireframe design

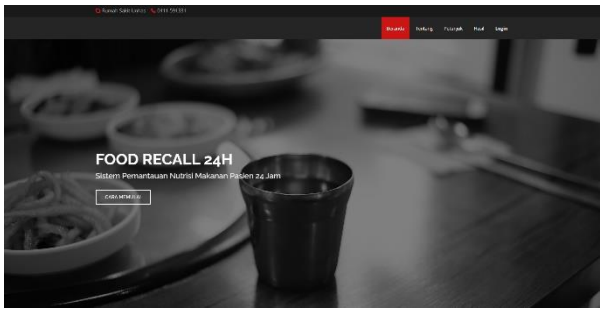


Picture. 5 Login page wireframe design

The entire design to the results of the wireframe is then handed off to the programmer to realize a website-based 24HFR system.

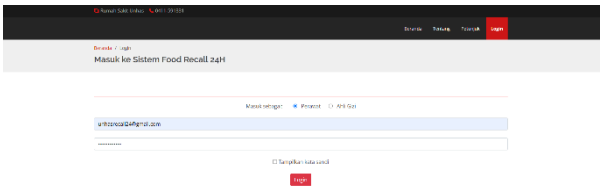
Coding

The development of the 24HFR system applies the HTML, CSS, and Javascript programming languages with the Bootstrap framework and the PHP programming language to connect websites to the MySQL database. In Figure 6, the home page of the hosted 24HFR system is shown and can be accessed on http://unhas-recall24.id.



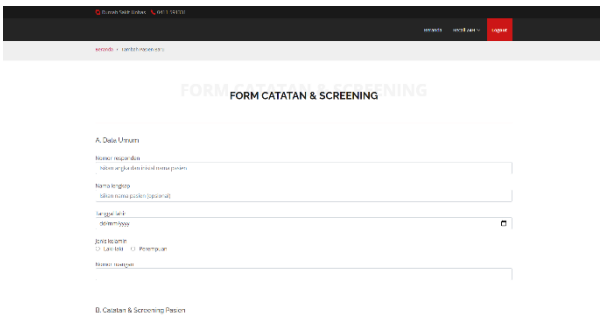
Picture. 6 Homepage 24HR system

To be able to use this system, users from health workers need to log in to prevent access by unauthorized parties. Login has two options, namely login as a nurse or as a nutritionist which can be seen in Figure 7



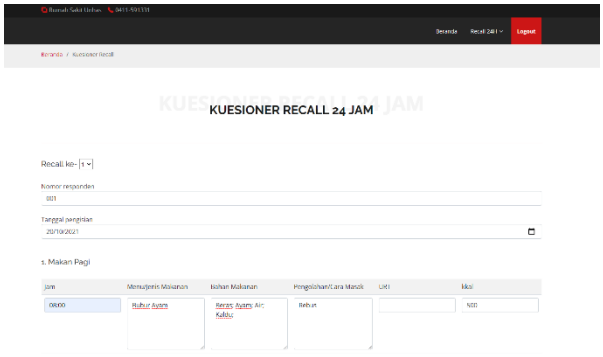
Picture. 7 24HR System Login Page

In the scenario of logging in as a nurse, the user will enter the nurse's home page. Nurses can record inpatient DM patient data first if the patient has not been registered. The record entry and patient screening forms need to be completed first as shown in Figure 8.



Picture. 8 Pages for recording and screening DM patients by nurses.

After recording the initial data on DM inpatients, nurses can then start the food recall process on the patient's food consumption. Figure 9 shows an example of a recall page for breakfast with a total of 500 kcal.

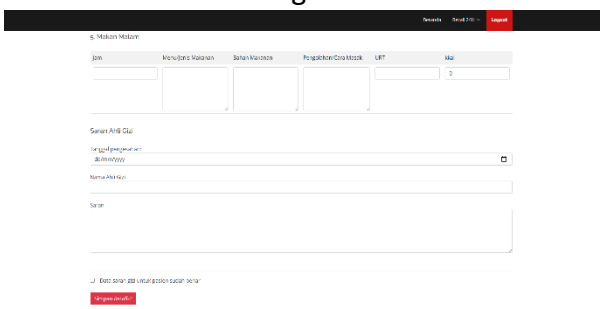


Picture. 9 24-hour food recall questionnaire filling page

The food recall recording process will be carried out for 3 times for 24 hours (there are recalls on the 1st, 2nd and 3rd days). All daily recall data will be added to calories and integrated directly on the nutritionist page.

For the login scenario as a nutritionist, the nutritionist's home page is displayed, which can monitor all recall data that the nurse has input.

For each recall that has been inputted per day, from days 1, 2 and 3, the nutritionist can see the total calories and details of the patient's food consumption. From this data, nutritionists can provide advice and validation on the page shown in Figure 10.



Picture. 10. Page nutritionist advice 24-hour food recall

Suggestions or advice given by nutritionists on food recall data can then be viewed again through the nurse's account. Nurses can download or print recall data for three days with each detailed advice given by a nutritionist to further consider and formulate education about nutrition in preparation for the patient's discharge

Program Testing

Stages of program testing are carried out by applying white box, black box and usability testing. The white box stage is carried out by ensuring that all lines of codes and functions run well. Black box testing applies some test cases related to user requirements (requirements) that have been set in the early stages of design. From the results of black box testing, all the features contained in the 24HFR system can be adequately used by nurses and nutritionists. In addition, additional features that are intended for patients (without logging in) to download recall results can also be appropriately implemented.

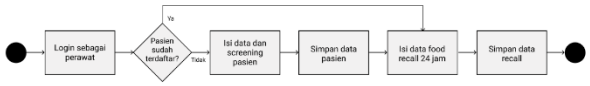
In addition to testing the technical running of the features in the 24HFR system, usability testing is also carried out to measure the level of ease of use and obtain recommendations for the next stage of development and refinement.

Suppose black box testing is based on test cases for features derived from the requirements in the 24HFR system. In that case, usability testing is carried out after the user runs several scenarios of the 24HFR features. This usability test uses the Single Ease Question (SEQ) measurement metrics [17].

In testing using SEQ, one scenario needs to be carried out by each user from among nurses and nutritionists in the city of Makassar. After carrying out the scenario, the user will be asked a general question from SEQ: “In your opinion, how easy is it to use this website-based 24HFR system?”. The result of the answer given by the user is a Likert scale value with a scale between 1 to 7 (see Figure 11), with the lowest value. means "very difficult" and the highest value means "very easy".

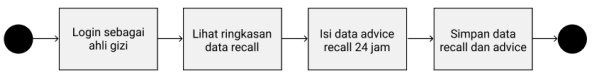
Picture. 11 Rating Scale Single Ease Question

The scenario that needs to be done by nurses before giving an assessment rating can be seen in the task flow in Figure 12. The nurse logs in to the 24HFR system and then fills in the records of the inpatient DM patient screening results. If the data has been saved, the nurse can enter the DM patient recall data according to meal times and save the added data.



Picture. 12 Nurse actor task flow

After the nurse finished running the scenario of filling in the recall data, the follow-up scenario was carried out by the nutritionist. The nutritionist will start by logging in as a nutritionist, viewing the summary of the food recall data filled in by the nurse, providing suggestions for the summary of the recall data and storing it. The scenario carried out by nutritionists can be seen in the task flow in Figure 13



Picture. 13 Task flow actor nutritionists

Based on the usability testing results using SEQ metrics, the application got 7 from nutritionists and 6 from nurses. The score shows that the convenience of the 24HFR system is good; it can be used by nurses and nutritionists, especially at hospitals in the city of Makassar.

Program Implementation and Maintenance

After testing the program, socialization regarding the use of the 24HFR system was carried out among nurses and nutritionists. In implementing the program, several recommendations are given from the end-users directly and from the hospital management. Among others are:

- The role of the nutritionist as an expert is also significant in developing the features of this 24HFR system. In some hospitals, it is possible to directly involve a nutritionist to fill out recalls and monitor patient nutrition. The food recall feature for inpatients should be more than just accessed by nurses and should be recommended for nutritionists.

- Added a nurse's note feature that contains educational supplies for inpatients after returning home to complete recall data that can be downloaded or printed. These additional features provide convenience for nurses regarding nutritional education for DM patients.

Conclusions

A website-based 24HFR (food recall 24 hours) system has been built to assist in monitoring the nutritional status of DM patients in hospitals. Software development is based on the stages of the Software Development Lifecycle (SDLC) used by the two main actors in the hospital, namely nurses and patients.

Based on the results of usability testing using Single Ease Question (SEQ) assessment metrics, a score of 7 was obtained for the ease of use by nutritionists and a score of 6 for scenarios carried out by nurses. The test results also recommended providing additional features that are more comprehensive for each actor or end-user to optimize the implementation of the 24HFR system in hospital

Acknowledgements

The author would express gratitude to Universitas Hasanuddin Teaching Hospital (Rumah Sakit Perguruan Tinggi Negeri Universitas Hasanuddin).

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