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Evaluation of the Validity and Usability of the Mobile Application for Early Detection of Metabolic Syndrome: A Cross-Sectional Study

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Abstract:

Metabolic syndrome is a cluster of risk factors for cardiovascular disease and type 2 diabetes mellitus in adults. The development of a health application-based instrument is important. This study aims to evaluate the Content Validity Index (CVI) and System Usability Scale (SUS). This study used a cross-sectional study design. Content validity was analyzed using the Content Validity Index (CVI) method involving five experts. Researchers evaluated the usability of the application using the System Usability Scale (SUS) and tested it on nine users. Researchers analyzed the data descriptively to obtain CVI and SUS scores. The test results showed that the I-CVI value was 1.00 and the S-CVI/Average was 1.00, indicating that all items in the application were highly relevant. The SUS score was 76.11, and the application was categorized as acceptable (good), indicating that the application was easy to use and well received by users. This mobile application has excellent content validity and good usability, making it suitable for use as an early detection instrument for metabolic syndrome. This application has the potential to support health promotion and prevention efforts to reduce non-communicable diseases in the community.

Keywords: content validity index, early detection, health application, metabolic syndrome, system usability scale
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INTRODUCTION

Metabolic syndrome is a cluster of risk factors such as abdominal obesity, hypertension indicated by increased blood pressure, hyperglycemia due to insulin resistance, and dyslipidemia characterized by increased triglycerides and decreased HDL cholesterol levels that significantly increase the risk of cardiovascular disease and type 2 diabetes mellitus (Nazhiifah and Purwanti 2024) (Abdulrazzaq 2022) (Hayden, 2023) (Bovolini et al., 2020). In Indonesia, the prevalence of metabolic syndrome continues to increase in line with the shift to a sedentary lifestyle and a low-fiber, high-calorie diet (Maharani and Purwanti 2025 & Park et al. 2022). This condition shows that the health care system faces a major challenge where metabolic syndrome is often not detected early, but only when complications have

already arisen (Mohseni-Takalloo et al. 2023). Therefore, early detection of metabolic syndrome is important to prevent health impacts in the future (Hernández-Baixauli et al. 2020).

The era of digital transformation has made information technology in the health sector an innovative strategy for improving the early detection of non-communicable diseases (Dewi & Faozi, 2023). One innovation developed as a medium for early detection of metabolic syndrome risk factors is mobile applications. Mobile-based health application content provides the public with access to independent, practical, and rapid risk assessments (Zheng et al. 2023). However, the suitability of a health application depends not only on the quality of valid content but also on its ease of use by the general public. These two factors are key indicators used to evaluate an application (Kurniawan, Nofriadi, and Nata 2022). Content validity ensures that the application's instruments align with its initial purpose, in this case, early detection. At the same time, ease of use plays a role in assessing the application's efficiency and acceptability by the target audience.

The Content Validity Index (CVI) method is used to assess the relevance of instrument items according to experts (Yusoff, 2019). In developing health applications, the use of CVI is beneficial for developers to obtain objective and relevant feedback on the quality of the instrument content. Thus, the instruments used in the application will have a strong and accountable basis for validity (Kurniawan et al. 2022). The CVI method was chosen because it is widely used and considered valid for evaluating the clarity and relevance of application content based on expert assessment, which then ensures its validity.

The System Usability Scale (SUS) is a commonly used international method for evaluating the usability of digital products, including health-based applications. SUS provides a quantitative measure of user perceptions of an application's ease of use, thus providing an overview of the extent to which the application is accepted and used effectively and efficiently by the wider community (Arifin 2024). By combining CVI and SUS assessments, a comprehensive evaluation can be obtained, from content to user experience. SUS was chosen because it is validated, reliable, and frequently used to assess usability, and it allows for rapid and standardized evaluation.

Based on this background, this study aims to evaluate a mobile health application through content validity testing using the Content Validity Index (CVI) and usability assessment using the System Usability Scale (SUS). This evaluation is expected to determine the suitability and relevance of the content and user acceptance of the application as a digital tool for early detection of metabolic syndrome, thereby providing initial evidence to support the initiation of digital-based non-communicable disease prevention in Indonesia.

METHODS

This study used a cross-sectional design. The purpose of this study was to assess the suitability of the content and assess the usability of the health application for early detection of metabolic syndrome. There were two stages of the study: 1) Content Validity Index (CVI) testing involving experts, and 2) usability evaluation using the System Usability Scale (SUS) questionnaire involving health application users. It is hoped that the results of this study will provide comprehensive results regarding the quality of the content and user experience in using the application.

The CVI instrument was designed to assess the relevance and suitability of app content items to screening indicators that reflect the potential risk of metabolic syndrome. The questionnaire consisted of 10 questions, scored on a scale of 1-4, with 1 representing irrelevant and 4 representing highly relevant. The SUS questionnaire consisted of 10 questions, scored on a Likert scale ranging from "strongly disagree" to "strongly agree." The results of the SUS questionnaire reflected user perceptions of the app's ease of use, efficiency, and satisfaction.

The CVI assessment consisted of five experts, including a field nurse, a doctor, and an information technology expert. Respondents were selected based on their competency and experience (Yusoff,

2019). The respondents in the SUS assessment involving 9 users were determined using inclusion criteria considered to represent the metabolic syndrome risk group, including: High blood sugar levels, high cholesterol levels, or obesity. The selection of the number of samples in this study refers to the minimum number of samples required for SUS testing that can represent user experience. (F. Kurniawan, 2024).

Data analysis of the CVI and SUS assessment results using item-CVI (I-CVI) and scale-CVI (S-CVI) calculations aimed to evaluate the relevance of each item to the instrument as a whole. The S-CVI analysis results ≥ 0.80 indicate that the content validity of the application is at a "good" level (Yusoff 2019). Analysis of SUS test results data through the following stages: 1) converting item scores to a scale of 0-4, 2) adding up the total scores, and 3) multiplying the results by 2.5 for the final result in the range of 0-100. The final result of the total SUS assessment ≥ 68 indicates that the application can be used and accepted; if the final score is > 80, it indicates that the application can be used very well. Data analysis used Microsoft Excel and continued with descriptive statistics.

RESULTS

Content Validity Index (CVI) Test Results

The content validity (CVI) test involved five experts with competencies relevant to the development of the health application: one physician, two field nurses, one academic nurse, and one information technology expert. Each expert scored each aspect of the application based on the relevance, clarity, appropriateness, and measurability of the items within the application. The CVI assessment results determined that the application's content validity was at a "good" level before being used for field testing. The CVI test results are shown in Table 1.

Table 1. Data of CVI analysis results

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Experts in Agreement	I-CVI
1	✓	✓	✓	✓	✓	5	1.00
2	✓	✓	✓	✓	✓	5	1.00
3	✓	✓	✓	✓	✓	5	1.00
4	✓	✓	✓	✓	✓	5	1.00
5	✓	✓	✓	✓	✓	5	1.00
6	✓	✓	✓	✓	✓	5	1.00
7	✓	✓	✓	✓	✓	5	1.00
8	✓	✓	✓	✓	✓	5	1.00
9	✓	✓	✓	✓	✓	5	1.00
10	✓	✓	✓	✓	✓	5	1.00
Sum of I-CVI							**10.00**
S-CVI/Ave							**1.00**
Category							**Accepted**

The results presented in Table 1 show that all questionnaire items received an I-CVI score of 1, with a total of 10, and an S-CVI score/average score of 1.00. These assessment results indicate that all experts

gave full marks for the suitability of the items for early detection of metabolic syndrome. The developed instrument falls into the "acceptable" category and meets content validity standards.

System Usability Scale (SUS)

The System Usability Scale (SUS) test involved nine users. Assessments included ease of use, clarity, and consistency of the instrument. The assessment results were then explained to determine the validity of the health application. The results of the SUS analysis are presented in Figure 1.

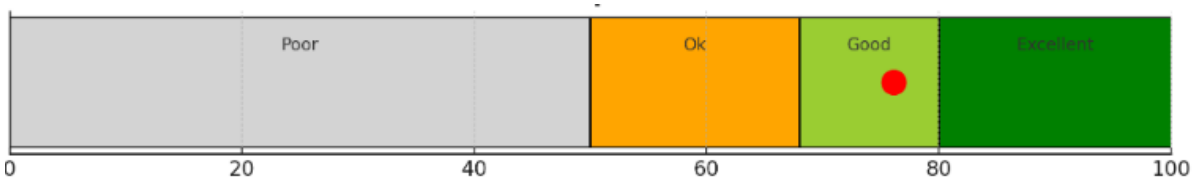

Figure 1. System Usability Scale (SUS) analysis results

The System Usability Scale (SUS) results showed an average score of 76.11, which falls into the "Good" category, meaning it is acceptable, feasible to use, and meets standard usability criteria for user implementation. These results indicate that the health application is usable, easy to understand, and accepted by users, see Figure 2.

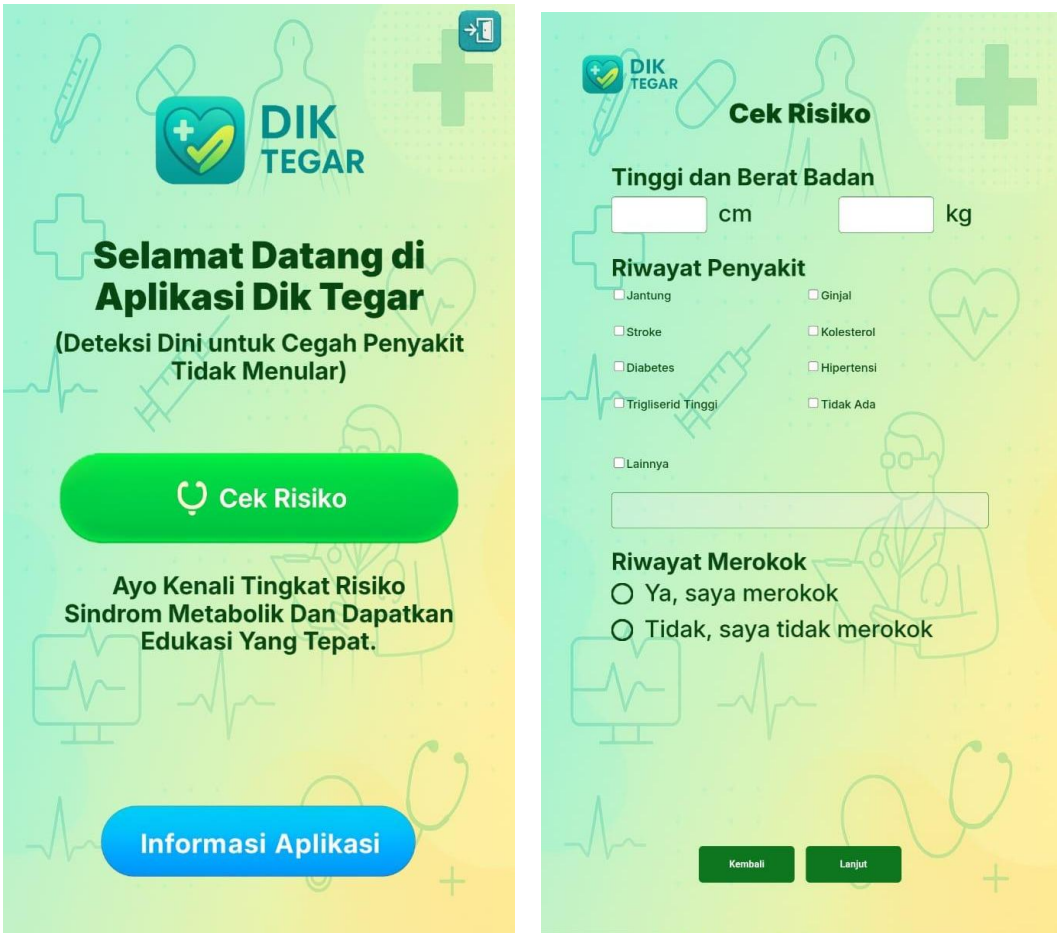

Figure 2 . Initial Display of the mobile Application

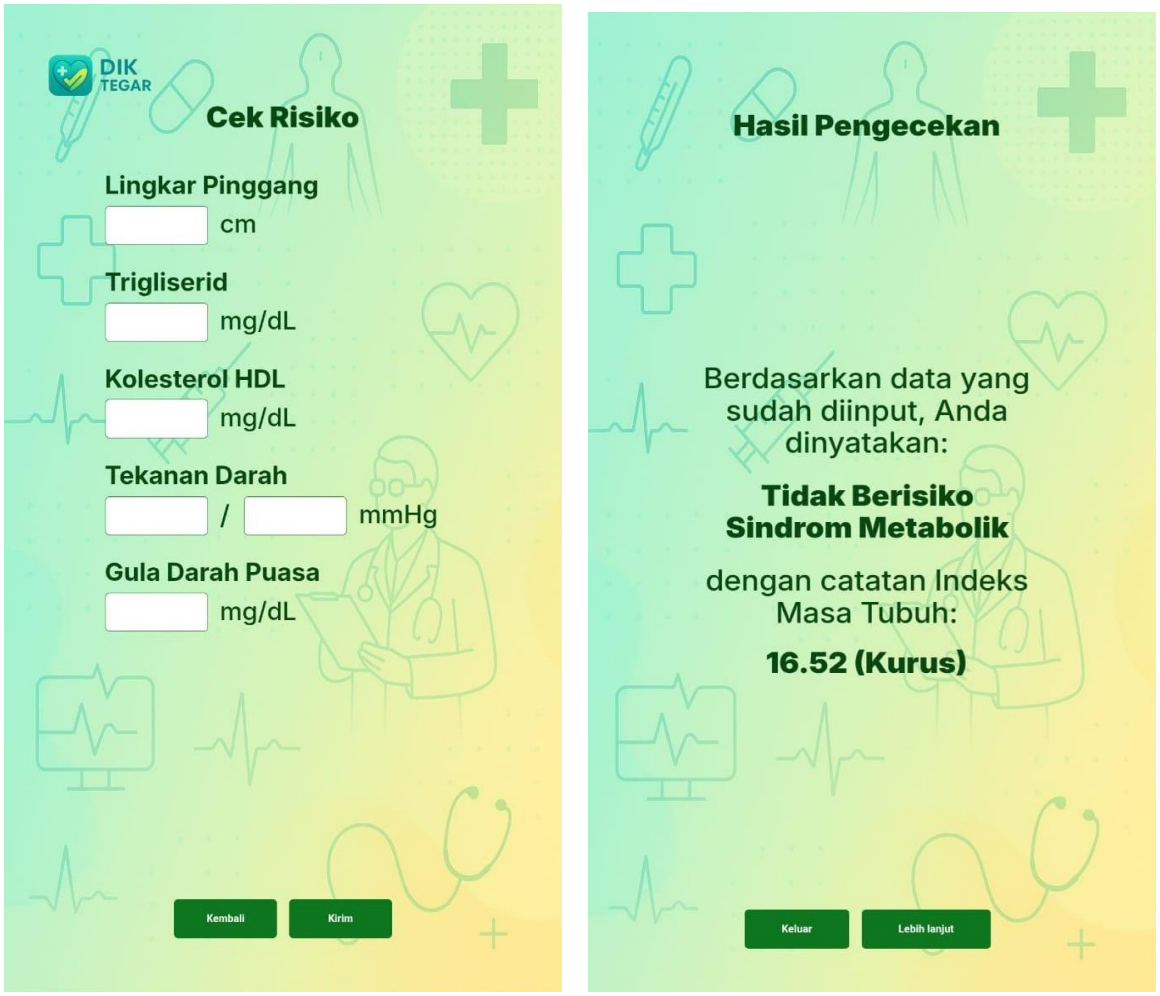

Figure3 . Risk Assessment and Early Detection Results for Metabolic Syndrome

Based on Figures 2 and Figure 3, which show the development of a health application as a tool for early detection of metabolic syndrome, a simple and structured User Interface (UI) design makes it easy for users to input data during the screening process. The initial display of the application (Figure 2) includes the main menu feature and a patient data input menu including age, gender, medical history, anthropometry, and smoking status. The next display (Figure 3) contains a data entry menu that supports early detection of metabolic syndrome risks, including blood pressure, fasting blood glucose levels, triglyceride levels, HDL cholesterol levels, and waist circumference. Based on the data that has been entered, the application automatically processes the data and displays the results of early detection along with educational information on prevention.

DISCUSSION

Healthcare professionals can detect metabolic syndrome early by identifying individual risk factors through a systematic and straightforward approach. This identification includes anthropometric measurements such as waist circumference and body mass index, which can provide a general overview of central obesity, a key predictor of metabolic syndrome (Ramírez-Manent et al., 2023) (Quaye et al., 2019). Regular blood pressure checks are necessary to assess hypertension and fasting blood glucose tests to identify glucose metabolism disorders (Gesteiro et al. 2021). Furthermore, lipid profile testing, specifically triglyceride and HDL levels, is an important indicator for detecting dyslipidemia (Elsayed et al., 2025). Early detection of metabolic syndrome is crucial, especially for

individuals with risk factors, to encourage immediate lifestyle changes or appropriate medical intervention to prevent further complications (Duan et al. 2023).

The utilization of digitalization in healthcare have a strategic role in accelerating the early detection of metabolic syndrome (Keshet et al., 2023). Through the integration of digital technologies such as health applications, electronic data systems, and artificial intelligence algorithms, screening processes can be conducted more efficiently, accurately, and affordably (Huynh et al., 2024)(Liu et al., 2025). Digitalization enables the collection, storage, and analysis of health data in real-time, allowing healthcare professionals to monitor risk factors such as body mass index, blood pressure, glucose levels, and lipid profiles comprehensively (Chen et al., 2023). Moreover, digital tools expand access to healthcare services by providing early detection platforms that can be directly used by the public, especially in areas with limited medical resources (Rhee et al., 2020).

Digitalization plays a significant role in helping individuals at risk for metabolic syndrome determine appropriate follow-up management (Mosquera-Lopez & Jacobs, 2024). Digital-based systems can provide more personalized recommendations tailored to each patient's risk profile, including dietary modifications, physical activity monitoring, and lifestyle interventions (Athar, 2024). Furthermore, clinical decision-making can be faster and more evidence-based through data integration between patients and healthcare providers (Periáñez et al., 2024). Therefore, in addition to increasing the effectiveness of early detection, digitalization also strengthens the sustainability of interventions and patient monitoring to prevent the progression of chronic diseases associated with metabolic syndrome (Liu et al., 2025).

This mobile application was developed as a technology-based screening tool to support early detection. The application's content includes a questionnaire and assessment instruments for metabolic syndrome risk factors, including anthropometric parameters, blood pressure, glucose levels, and lipid profiles. Through a simple and interactive interface, the application provides easy-to-understand risk score results along with appropriate follow-up recommendations based on the results. Additionally, the mobile application is equipped with health education features to raise public awareness, especially for those who receive results indicating no risk for metabolic syndrome, about preventing the syndrome.

The Content Validity Index (CVI) test results for all items in this instrument yielded an I-CVI score of 1.00. This score demonstrates that all experts considered each item in the mobile application relevant to the goal of early detection of metabolic syndrome. Furthermore, the S-CVI/Ave calculation also yielded a score of 1.00, indicating perfect average agreement among experts on all items in the instrument (Yusoff 2019).

An instrument item is considered valid if it obtains an I-CVI value ≥ 0.78 when evaluated by more than three experts. Meanwhile, the instrument is declared to have good content validity if the S-CVI/Ave ≥ 0.80. Thus, the results of this study indicate that the mobile-based metabolic syndrome screening application instrument meets the overall content validity criteria, as all tested items have met the specified standards. These results also explain that the measured components of the instrument are consistent with the previously established framework for early detection of metabolic syndrome (Hernández-Baixauli et al. 2020). Although expert agreement reflects the clarity and relevance of each item, excellent I-CVI and S-CVI/Ave values may also be affected by the homogeneity of assessments and the limited number of items, thus requiring further validation with a more diverse expert panel.

Ensuring that the content has strong validity is essential to maintain the quality of the instrument before it is implemented on a larger scale. A valid instrument will certainly improve the accuracy of screening results, minimize potential bias, and ensure that the information obtained is accurate and reflects the actual conditions of users. Therefore, the results of this mobile app content validity test can effectively support early detection of metabolic syndrome in the community.

This mobile application was evaluated using the System Usability Scale (SUS) with nine respondents, resulting in an average score of 76.11. This result exceeds the minimum score benchmark of 68, indicating that the mobile application falls into the "Acceptable" category and demonstrates a good level of user acceptance (Maramba, Chatterjee, and Newman 2019). The average SUS score of 76.11 indicates that the application is considered to have a clear interface, is easy to use, and can assist users in early detection of metabolic syndrome. According to Bangor, Kortum, & Miller (2009), a SUS score in the range of 70–80 indicates a good level of user satisfaction (good usability) with a high likelihood of reuse (likely to recommend). These results demonstrate that users are comfortable with the application's workflow, although further improvements are still needed to achieve the "Very Good" SUS score category (Kurniawan et al. 2022).

The findings of this study align with the principle that the success of a health app depends not only on the quality of its content but also on the user experience in navigating its features. Even well-validated content may fail to deliver optimal results if it is difficult to use. Therefore, the SUS test findings confirm that in addition to having scientifically valid content, this mobile app has a level of usability suitable for field implementation (Zheng et al. 2023). The app's score of 76.11 also indicates opportunities for improvement. The study identified several aspects that still need improvement, such as simplifying navigation, optimizing the interface design, and adding educational features to make the app more interactive. Implementing these improvements could improve the overall user experience and help the usability score reach the "Very Good" category (Liew et al. 2019). Overall, the SUS results indicate that the "DIK TEGAR" app exhibits an acceptable level of usability and meets established usability standards. With a score exceeding the average and categorized as “Good”, this application shows great potential for wider implementation reach in metabolic syndrome early detection programs, both at the community level and in health care facilities (Weichbroth 2020). A limitation of this study is that the app was evaluated without direct comparison with similar health apps, making it impossible to determine the DIK TEGAR app's position compared to other health apps. This study did not assess long-term outcomes or the impact on clinical outcomes.

CONCLUSION

The development of a health application aims to facilitate patients in the early detection of metabolic syndrome according to their health conditions. The application developer integrates metabolic syndrome risk factors, including age, gender, medical history, anthropometry, smoking status, blood pressure, fasting blood glucose levels, triglyceride levels, HDL cholesterol levels, and waist circumference. The I-CVI result of 1.00 and S-CVI/Ave of 1.00 indicate experts agree the application is relevant and appropriate to the metabolic syndrome risk items. The SUS result of 76.11 indicates that the health application is in the "Good" category and is acceptable.

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ETHICAL STATEMENT

This study was conducted in accordance with ethical principles of health research. Ethics approval was obtained from the Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, with approval number 583/KEPK-FIK/X/2024. All participants were informed about the purpose, procedures, potential risks, and benefits of the study, and written informed consent was obtained before data collection. Participant confidentiality and anonymity were strictly maintained throughout the study.

AUTHOR CONTRIBUTION

OSP, DAP, AS: Conceptualization and study design. AS, SFW, ANL, NZ: Instrument development. OSP, TASIK, UMD, DWP: Data collection. OSP, AS, MHR: Data analysis and interpretation. UMD, ANL, NZ: Manuscript drafting and revision. OSP, AS, TASIK, DAP: Final approval of the manuscript.

STATEMENT CONFLICT OF INTEREST

The author declares that this research has no conflict of interest

DATA AVAILABILITY STATEMENT

All data in this article study are not made public due to confidentiality, but are available from the corresponding author upon reasonable request

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