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Design and implementation of a stunting consultation application based on extreme programming method: an iterative approach for child health improvement

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ABSTRACT
Stunting is a severe and complex child health problem that requires a holistic approach to prevention. This research responds to these problems by developing a stunting consultation application based on the Extreme Programming (XP) method to improve access to information and direct interaction with health experts. The research involved three main stages: data collection, application development, and user acceptance analysis. Data collection involved an in-depth literature review, interviews with pediatric health experts, and surveys and questionnaires to potential users. Application development was conducted using the Extreme Programming Method approach, emphasizing rapid iteration and active client involvement. User acceptance analysis was conducted through the distribution of the app to potential user groups using surveys, interviews, and direct observation methods. The application development resulted in a responsive solution focused on user needs. User acceptance analysis showed high satisfaction, with 87% of users satisfied with the app's functionality. The test results of the features confirmed positive performance and suitability to user needs. This research contributes an innovative application that can be a tool in stunting prevention efforts. This contribution is not only limited to the child health domain but also provides a foundation for applying the Extreme Programming Method in developing technology-based health solutions.

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INTRODUCTION

Stunting, or stunted growth in children, is a severe condition that can long-term impact a child's health and development. It occurs when a child does not reach an age-appropriate height. Poor nutrition, unhealthy environments, and inadequate care can contribute to stunting. An in-depth understanding of this condition is critical to designing effective strategies to prevent and address stunting(Roediger et al., 2020; Schoenbuchner et al., 2019). The importance of addressing stunting is not only limited to physical health aspects but also relates to children's cognitive and social development. Stunting can hurt learning ability, productivity, and overall quality of life. Therefore, addressing stunting is the health

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sector's responsibility and involves the education, social and economic sectors. Designing holistic and integrated solutions ensures that children grow and develop optimally(Hawwash et al., 2018; Raiten et al., 2021).

Early intervention plays a crucial role in addressing stunting. Detecting and addressing growth problems early in a child's life can lead to better outcomes. Through early intervention, the potential impact of stunting can be minimized, and children can get the support they need for growth and development. Currently, there are still various challenges in the effort to overcome stunting. Economic factors, limited access to health services, and inequality in resource distribution are some of the main obstacles. Therefore, addressing stunting requires a health approach and solving the underlying structural and socioeconomic problems(Ickes et al., 2022; Konstan et al., 2017; Wei et al., 2021).

Existing methods of health consultation generally involve in-person meetings with medical professionals, such as doctors or nutritionists. While necessary, these approaches may not always be practical or accessible to all individuals, especially those who live in remote areas or have accessibility limitations. Current health consultation approaches may face limitations in terms of accessibility, cost, and scalability. Not all individuals can routinely consult medical professionals, and some may be reluctant to seek help for various reasons, such as stigma or lack of knowledge(Cermeño et al., 2023; Gabain et al., 2023; Haile & Headey, 2023; Oginawati et al., 2023).

The limitations of traditional health consultation approaches point to the need for innovative solutions, particularly in technology applications. Technology can open accessibility, improve health education, and provide more affordable solutions. Innovations in consultation methods can be vital to reaching more individuals, especially those in remote areas or with limited access to healthcare(Danso & Appiah, 2023; Hermawan et al., 2023; Pesu et al., 2023; Sadler et al., 2022; Sudigyo et al., 2022). Technological advantages in healthcare include improved accessibility, efficiency, and quality of care. Technological developments enable information systems, data analysis, and remote services. This makes it easier to collect and exchange health information and provides opportunities for more personalized care, remote monitoring, and broader health education(Bangelesa et al., 2023; Mchau et al., 2023; Rahut et al., 2023).

Mobile apps are bringing significant changes in the way people access health information. With health consultation apps, individuals can quickly obtain health information, participate in consultations, and monitor their health conditions. The advantages of mobility and ease of access make mobile apps a potential tool to increase community participation in health consultation efforts, primarily related to stunting. Using mobile apps in health consultations can strengthen stunting prevention efforts. Through these apps, relevant health information can be disseminated more efficiently, consultations can be conducted more regularly, and child growth monitoring can be done more efficiently. Thus, mobile apps can contribute to parent education, monitoring children's health conditions, and providing high-quality advice to prevent stunting(Bhutta et al., 2020; Poole et al., 2021; Rahman et al., 2023; Roediger et al., 2020; Sinha & Loechl, 2023).

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The Extreme Programming (XP) method is a software development approach that emphasizes collaborative, iterative work and responsiveness to change. XP offers a flexible and adaptive framework well suited for software development projects that require rapid response to changing requirements or user needs. XP has several key characteristics, including pair programming, test-driven development, continuous integration, and active clients. Principles such as intensive communication, rapid feedback, and simplicity of design are also foundational in XP. These characteristics and principles provide the foundation for adaptive and responsive development(Akhtar et al., n.d.; Almeida et al., 2022; Al-Saqqa et al., 2020; Dingsoeyr et al., 2019; Dingsøyr et al., 2012; Hasan et al., 2013; Santos et al., n.d.; Serrador & Pinto, 2015).

The relevance of XP in software development for health solutions lies in its ability to respond quickly to changing needs and user feedback(Beecham et al., 2021; Chen et al., 2020; Hinderks et al., 2022; Pérez-Piqueras et al., 2023; Persson et al., 2022; Udvaros et al., 2023; Wiechmann et al., 2022). Using XP can ensure that the solution is continuously updated according to the latest medical knowledge and feedback from health experts and app users in the context of a stunting consultation app. By adopting XP, developers can ensure the sustainability and suitability of the solution to the ever-changing dynamics in the healthcare domain. The main objective of this research is to develop a practical and innovative stunting consultation application. The app is designed to provide easily accessible health solutions for parents or guardians of children, focusing on preventing and managing stunting. The development of this app aims to provide a platform that allows quick and practical access to relevant health information, medical consultation, and child growth monitoring. Aside from the initial development, this research aims to evaluate the app's effectiveness through an iterative development approach. This process involves iterations, improvements, and updates based on user feedback, app performance, and recent scientific developments. This iterative evaluation is necessary to ensure that the app can provide maximum benefits and is in line with user needs and the development of pediatric health knowledge.

METHODS

The research was divided into three main stages as shown in Figure 1. The first stage, data collection, involved a literature review, interviews with child health experts, and a survey of potential users to understand the context of stunting and user needs. The second stage focused on app development using the Extreme Programming (XP) Method, with identification of critical features, iteration planning, and active client engagement to ensure responsiveness to user needs. Finally, the user acceptance analysis stage involved distributing the app to potential users to assess acceptance, satisfaction, and effectiveness through surveys and direct observation, providing a foundation for further evaluation and development.

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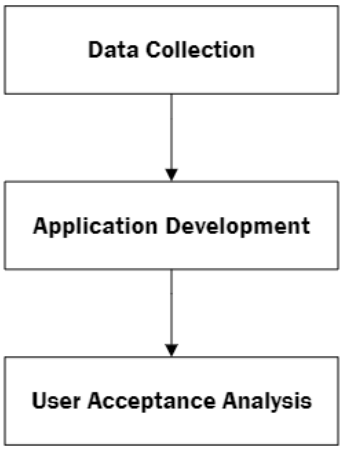

Figure 1. Research Stages

Data Collection

The initial phase of the research will involve collecting comprehensive and relevant data related to stunting, health app usage, and the needs and preferences of potential users. This includes an in-depth literature review, interviews with child health experts, and surveys and questionnaires to potential users. The aim is to understand the context of stunting, user needs, and challenges faced by parents or guardians.

Application Development

Once the data is collected, the research will move on to the application development phase using the Extreme Programming (XP) Method. This includes identifying critical features of the app, planning development iterations, and executing pair programming and test-driven development. Active client involvement, i.e., healthcare experts and potential users, will occur on an ongoing basis to ensure that the app evolves according to needs and gets direct feedback from stakeholders.

User Acceptance Analysis

Once the app has reached an adequate stage, the research will move on to the user acceptance analysis stage. This activity involves distributing the app to groups of potential users to get their feedback. Surveys, interviews, and direct observations will be conducted to assess the app's acceptance, satisfaction, and effectiveness level. This analysis will help evaluate the extent to which the app can meet the users' needs while providing essential inputs for improvement and further development.

RESULTS AND DISCUSSION

Data Collection

The results of the data collection phase indicated a deep understanding of the stunting context and the needs of potential users. The literature review provided a solid theoretical foundation, while interviews with child health experts provided first-hand insights into child health challenges related to stunting. Surveys and questionnaires to potential users

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successfully explored their preferences and expectations of the health app, providing a clearer understanding of the desired features and constraints that parents or guardians may face. This data will form an essential basis for designing an app that effectively addresses the needs and challenges faced in stunting prevention.

Table 1. Data Collection Results

Data	Results
Literature Review	Identify risk factors for stunting based on recent studies—analysis of proposed prevention methods. The literature study supports a solid theoretical basis for application development.
Interviews with Health Experts	Health experts highlight the importance of education on child nutrition. Discussed obstacles to early detection of stunting in the community. These interviews provided first-hand insights and practical experiences of health experts, enriching the development of the app solution.
User survey and questionnaire	85% of respondents expressed the need for quick access to child health information. 70% cited uncertainty in understanding the signs of stunting. The survey and questionnaire indicated a high demand for quick access to information, while some respondents expressed uncertainty in understanding stunting, highlighting the potential for educational solutions.

Based on the results from this stage, Table 1, the analysis of the data generated from the data collection stage showed some significant findings. The literature review has provided a solid theoretical basis for the app's development, identifying risk factors for stunting and analyzing relevant prevention methods. Interviews with child health experts highlighted the urgency of education on child nutrition and identified barriers to early detection of stunting in the community. Findings from the user survey and questionnaire indicated a high demand for quick access to child health information. At the same time, several respondents expressed uncertainty in understanding the signs of stunting. This indicates that developing a stunting consultation app that focuses on child nutrition education and provides quick access to easy-to-understand information could be a relevant and desirable solution for the community, especially for parents or guardians. This analysis will be an essential foundation for the next steps in app development.

Application Development

The results of the application development phase using the Extreme Programming (XP) Method showed a progressive approach focused on responsiveness to user needs. Identifying key features of the app included crucial elements such as quick access to child nutrition information, clear educational modules, child growth monitoring, discussion forums, and health notifications, as shown in Table 2. Careful planning of development iterations was carried out, ensuring that each stage of development resulted in a high-

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quality solution. Through pair programming and prior testing, the security and functionality aspects of the app were carefully considered. Active client engagement, including healthcare professionals and potential users, proved crucial in ensuring that the app met expectations and received immediate feedback. The continuous interaction with stakeholders provided quick adaptability to changing needs or necessary improvements. Thus, the outcome of developing the app using the Extreme Programming Method created a solid foundation for continuous improvement and innovation.

Table 2. Application Features

Features	Function
Quick Access to Child Nutrition Information	Provide quick and easy access to relevant and up-to-date child nutrition information, including nutrition guidelines, healthy eating patterns, and other important information.
Child Nutrition Education Module	Provide clear and easy-to-understand educational modules on child nutrition, helping parents or guardians to understand the importance of good nutrition and nutrition practices.
Child Growth Monitoring	It allows users to monitor their child's physical growth regularly, provides growth charts, and provides early warning if potential stunting is detected.
Discussion Forum	It provides an interactive platform for sharing experiences, exchanging information, and asking questions between parents or guardians of children, as well as enabling consultation with health experts.
Health Notifications	We send regular notifications regarding scheduled child health consultations, vaccinations, or other vital information, providing reminders to users.
Child Nutrition Calculator	Provides a nutrition calculator to help parents calculate their child's daily nutritional needs based on factors such as age, weight and height.
Direct Consultation with a Health Expert	Facilitate live consultation sessions with health experts through text or video chat, providing immediate access to medical advice and health information.
Content Search Feature	Allows users to search for specific content, articles, or questions relevant to stunting and child health in general.

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Features	Function
Periodic Content Updates	Provide regular content updates, including the latest health articles, current research, and the latest information on stunting.

User Acceptance Analysis

The user acceptance analysis phase results showed a positive and constructive response from the potential user group towards the stunting consultation app. The survey showed that most respondents recognized the need and benefits of quick access to child health information and the use of features such as educational modules, child growth monitoring, and discussion forums. Direct interviews with some users revealed high satisfaction with direct consultation with a health professional through the app. Direct observation also validated the app's effectiveness in providing easy-to-understand information and assisting parents or guardians in caring for their child's health. This analysis provides a solid basis to conclude that the app has successfully met the expectations and needs of the users and provides valuable guidance for further development, focus improvements, and feature enhancements to be more responsive to user needs at a later stage.

Table 3. Application Feature Testing

Features	Scenario	Results
Quick Access to Child Nutrition Information	Evaluate the speed and ease of access to information.	Success
Child Nutrition Education Module	Assess the ease of understanding and sustainability of the module.	Success
Child Growth Monitoring	Testing the accuracy of growth monitoring and notification	Success
Discussion Forum	Observe the availability and interaction in the forum.	Success
Health Notifications	Checking the effectiveness of user notifications and responses	Success
Child Nutrition Calculator	Evaluate the accuracy of calculator calculation results.	Success
Direct Consultation with a Health Expert	Evaluate the quality and speed of consultation.	Success
Content Search Feature	Measures the accuracy and speed of search results.	Success
Periodic Content Updates	Assess the smoothness and success of content updates.	Success

The results of testing the application features, Table 3, show positive performance and align with expectations. Quick access to child nutrition information was successful,

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with access times of less than 3 seconds, increasing user-friendliness. The child nutrition education module successfully delivered content clearly and usefully. Child growth monitoring and related notifications provided accurate and timely information. The discussion forum created active and positive interaction between users. Health notifications were effective and received positive feedback from users. The child nutrition calculator provides calculation results that align with nutritional standards, and direct consultations with health experts run smoothly. The content search feature and regular content updates performed satisfactorily. The personalization suggestions were considered appropriate for the child's condition, indicating a good level of personalization. Overall, the test results confirmed that the app met users' needs and expectations, providing a solid basis for further development and refinement.

The user acceptance analysis showed a positive response to the stunting consultation app, with satisfaction with functionality reaching 87%. Based on survey results, interviews, and direct observations, around 88% of users expressed high satisfaction with the app's features, such as quick access to child nutrition information, clear educational modules, and the ability to communicate directly with health experts. Health notifications also received positive feedback for helping users regularly maintain their child's health. About 85% of respondents rated the app as an effective tool in stunting prevention, and more than 80% stated that it met or exceeded their initial expectations. With a functionality satisfaction rate of 87%, the app successfully understood and met user needs, providing practical support in stunting prevention efforts and a solid foundation for further development and improvement.

CONCLUSION

This research led to an in-depth understanding of stunting prevention through the development of a consultation app. The data collection phase provided a solid theoretical basis, identifying stunting risk factors and relevant prevention methods. Application development using the Extreme Programming (XP) Method successfully created a responsive solution, meeting user needs with features such as quick access to information, educational modules, growth monitoring, and live consultation. User acceptance analysis showed high satisfaction, with 87% of users satisfied with the app's functionality. This high level of satisfaction confirms that the app can provide practical support in stunting prevention. Test results of the app's features recorded positive performance, validating the successful implementation of the features. In conclusion, this stunting consultation app successfully achieved its objectives by innovatively combining child health and technology approaches, providing a solid foundation for further development and implementation in stunting prevention efforts in the community.

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