Amerta Nutrition
e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Kurniawan et al. | Amerta Nutrition Vol. 9 Issue 3 (September 2025). 545-556

SYSTEMATIC REVIEW
English Version
OPEN ACCESS

A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years

Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun

Dedik Kurniawan[1]*, Nia Novita Wirawan[2], Herman Tolle[3]

[1]Master of Nutrition Science Program, Faculty of Health Sciences, Universitas Brawijaya, Indonesia
[2]Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Indonesia
[3]Software Engineering Department, Faculty of Computer Science, Universitas Brawijaya, Indonesia

ARTICLE INFO

Received: *13-01-2025*
Accepted: *20-05-2025*
Published online: *12-09-2025*

****Correspondent:***
Dedik Kurniawan
dedik2urniawan1@student.ub.ac.id

DOI:
10.20473/amnt.v9i3.2025.545-556

Available online at:
https://e-journal.unair.ac.id/AMNT

Keywords:
Child, Accuracy, Precision, Digital Application

ABSTRACT

Background: The increasing use of digital applications to analyze nutritional status of children under five years offers significant progress in public health. However, the accuracy and precision of these tools continue to be a concern due to variations in data quality and user proficiency.
Objectives: This study aimed to systematically evaluate the accuracy and precision of digital applications in calculating and assessing nutritional status of children under five years.
Methods: A comprehensive systematic review was conducted by searching PubMed, ScienceDirect, and Google Scholar databases for relevant studies published between 2010 and 2024. The study followed the PRISMA 2020 guidelines for article selection. Risk of bias was assessed using QUADAS-2 for diagnostic studies, then data were analyzed descriptively through a narrative synthesis of results on accuracy, data input methods, and user proficiency.
Discussions: The results showed that out of 925 initially identified articles, 13 met the inclusion criteria and were further analyzed. Advanced algorithms, particularly K-Nearest Neighbor (K-NN) and other machine learning models had high accuracy when supported by quality data and adequate user training. Moreover, real-time IoT-based tools showed high precision in nutritional assessments. Challenges remain in ensuring accurate data entry and algorithm updates to meet the needs of diverse populations.
Conclusions: Digital applications present promising accuracy and precision in evaluating nutritional status of children under five. However, continuous improvement in data quality and user training is essential for the optimal implementation in public health interventions.

INTRODUCTION

Malnutrition in children under five years is a critical global health issue, with millions of the population affected by *stunting*, *wasting*, and underweight, particularly in low- and middle-income countries. Proper nutritional monitoring during the early stages of life is crucial as it influences not only physical growth but also cognitive development and future health outcomes. Nutritional assessments commonly use anthropometric measures, such as weight-for-age, height-for-age, and weight-for-height, which are widely endorsed by global health organizations including the World Health Organization (WHO)[1]. Despite the availability of these measures, the methods used to collect, store, and process nutritional data are often outdated and error-prone, leading to inconsistencies in the monitoring of children health status. The transition towards digital tools, particularly mobile and web-based applications, offers a significant advancement in the field of public health by providing a more accurate, efficient, and user-friendly means of assessing nutritional status[2].

The development of digital applications designed to assess children nutritional status has grown significantly in recent years. These applications use advanced algorithms and models, including the Simple Additive Weighting (SAW) method, machine learning, and decision tree algorithms such as C4.5, to streamline the process of evaluating nutritional health. Studies have shown that applications using these methods can achieve high levels of accuracy in classifying malnutrition, reducing errors related to human calculation and interpretation. For instance, the SAW method has been effective in assessing malnutrition by incorporating multiple anthropometric indicators, including Body Mass Index (BMI), while applications using machine learning techniques such as the K-Nearest Neighbor (KNN)

How to cite: *Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.*

method have shown high accuracy in categorizing children nutritional status[3–6]. These technological advancements provide significant improvements in the management and analysis of nutritional data, particularly in rural or under-resourced areas where malnutrition remains rampant.

The proliferation of digital nutrition applications has offered new opportunities to assess and monitor nutritional status of children globally. However, the accuracy and effectiveness of these applications vary depending on several factors, raising critical study questions[7]. First, there is a need to understand the accuracy of different nutrition applications in assessing children nutritional status and compare with one another. Mobile applications and wearable technologies have provided opportunities for the real-time collection of granular nutrition-related data, which can then be analyzed using machine learning to provide more complex assessments. However, existing methods remain inefficient and complex, often requiring specific sensors[8]. Despite the increasing adoption of digital nutrition applications, there remains a significant study gap in the comparative assessment of accuracy. Various studies have examined the performance of individual applications, but only a few have systematically compared different digital tools using standardized validation methods. Limited studies have also explored the impact of varying data input methods, user capabilities, and algorithmic performance across different populations. Addressing these gaps is crucial for identifying the most effective and reliable digital nutrition assessment tools and for informing best practices in implementation. Second, it is crucial to identify the factors that influence the level of accuracy in nutrition applications, including the algorithms used, data input methods, and user capabilities. Accurate assessment of nutrition status and growth monitoring information is an important part in the prevention and treatment of diseases but remains a challenging task. Mobile augmented reality applications offer a promising alternative for nutritional status assessment, expanding beyond somatopic measurements. By leveraging the ubiquitous smartphone 3D camera capabilities and integrating AI-driven intelligent systems with cloud storage, MAR technology facilitates detailed body dimensions and nutritional status analysis. This approach eliminates the need for physical contact with the subject being measured, offering a potentially more accessible and efficient method[9]. Understanding the strengths and limitations of these various digital tools will be essential for optimizing use in public health interventions aimed at combating children malnutrition globally. This systematic review will address the existing study gap by synthesizing results from multiple studies, comparing different digital nutrition applications, and evaluating methodological rigor to provide a comprehensive assessment of accuracy and usability in diverse settings[8,10].

Based on the discussion above, this review aimed to 1) evaluate the accuracy and precision of digital nutrition applications in assessing children nutritional status and 2) identify the factors influencing the efficacy of these tools by exploring various algorithms, data input methods, and user capabilities. The results will offer valuable insights into optimizing the use of digital nutrition applications in public health interventions aimed at reducing children malnutrition.

METHODS

A comprehensive literature search was conducted to identify relevant studies that evaluated the accuracy and precision of digital applications designed to assess nutritional status in children under five years. The search was performed across multiple academic databases, including PubMed, ScienceDirect, and Google Scholar. The Boolean search strategy incorporated terms related to the Population, Intervention, Comparison, and Outcomes (PICO) framework. Population was defined by terms such as "toddler," "children," "infant," "balita," and "early childhood." Intervention included keywords such as "nutritional status calculator," "digital nutrition assessment," "nutrition app," "mobile health (mHealth)," and "web-based nutrition assessment." Comparison included studies comparing digital applications to manual anthropometric methods or other validated digital tools. Outcome focused on "accuracy," "reliability," "precision," and "anthropometry validation. An example of Boolean Syntax used was: ("toddler" OR "children" OR "infant" OR "balita") AND ("nutrition app" OR "digital nutrition assessment" OR "mobile health" OR "web-based nutrition") AND ("Precision" OR "accuracy" OR "reliability") NOT ("adult" OR "elderly") AND (2010:2024[dp]). Moreover, filters were applied to limit the search to peer-reviewed studies published between 2010 and 2024, in either English or Bahasa Indonesia.

The review adhered to specific inclusion and exclusion criteria to ensure the relevance and quality of the studies selected. Inclusion criteria consisted of studies that assessed digital applications developed to evaluate nutritional status of children aged 0-5 years, with a focus on accuracy and precision. Only studies published between 2010 and 2024 were considered to ensure the inclusion of up-to-date technologies and methodologies. Studies primarily focused on adult or elderly populations, used non-digital methods for nutritional assessment, or presented reviews without empirical data were excluded.

The systematic review included various designs, including Cross-sectional studies evaluating the real-time accuracy of digital tools, Experimental studies assessing the effectiveness of machine learning algorithms for nutritional classification, Validation studies comparing digital assessments with standard anthropometric measurements (e.g., WHO growth standards, and Assessment Anthropometric Standard of Toddler Nutritional Status by Ministry of Health) and Comparative studies analyzing different applications performance in nutritional status assessments. Data were systematically extracted from each included study, focusing on key variables including design, sample size, type of digital tool (e.g., mobile app or web-based platform), and the specific nutritional indicators assessed (e.g., Weight-for-age, Length-for-age, BMI-for-age, weight-for-height). Additionally, the methods of validation, including comparisons with standard measures such as WHO growth standards, were documented. Accuracy and precision results were extracted, along with any identified limitations or biases. The quality of the included studies was assessed using the PRISMA framework for systematic reviews. The risk of bias assessment was conducted using the QUADAS-2 tool for diagnostic studies, ensuring a rigorous evaluation of both the results and the methodological soundness.

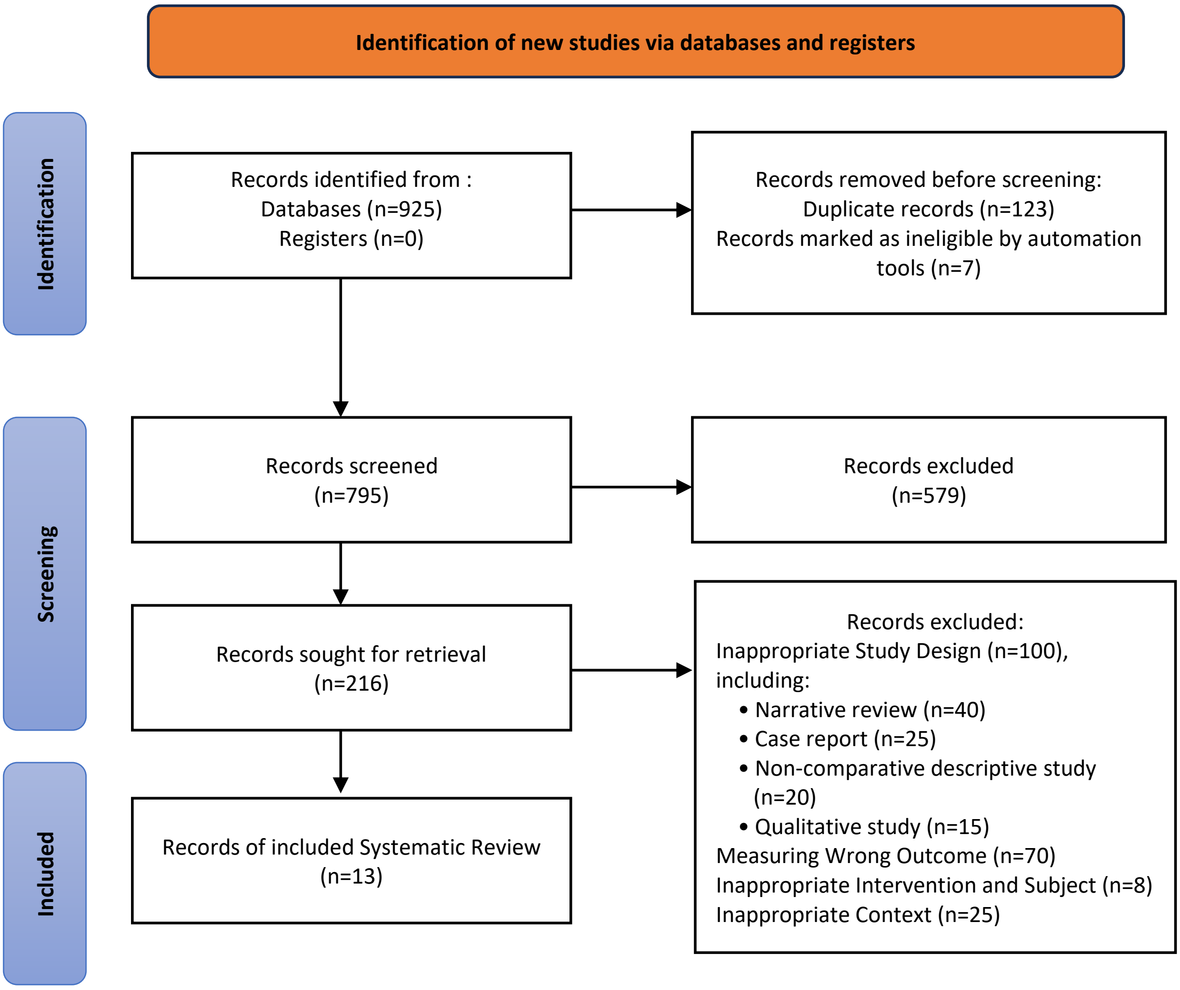

Figure 1. PRISMA Flow chart for article selection for objective[11]

DISCUSSIONS

A systematic approach was used to assess the accuracy of digital applications in evaluating nutritional status of children under five years old. The study adhered to the PRISMA framework for systematic reviews, as shown in Figure 1. Initially, 925 studies were identified from three major databases including PubMed, ScienceDirect, and Google Scholar. After removing duplicates (n=123) and irrelevant records using automation tools (n=7), 795 studies underwent screening. Following a detailed eligibility assessment, 13 studies met the inclusion criteria for final analysis. The QUADAS-2 Risk of Bias Assessment, presented in Table 1, was conducted to evaluate the methodological robustness of the included studies. Most studies showed a low risk of bias in patient selection, index test, reference standards, flow, and timing. However, Teshome et al. in 2017[12] showed a moderate risk of bias in patient selection due to potential issues in the study population. Despite the result, the index test, reference standard, flow, and timing remained at a low risk. The overall risk of bias was considered acceptable, though some caution was required when interpreting the results. In contrast, all other included studies showed low risk across all categories, showing high methodological reliability. This consistency suggested that the selected studies were methodologically sound, supporting the validity of the synthesized results.

Comparative Level of Accuracy and Comparison of Various Application Systems

The assessment of toddler nutritional status through digital applications has evolved with the integration of various algorithms, each contributing distinct advantages in terms of accuracy and reliability. The K-NN method, for example, shows a significant accuracy of 91.94%, making it an effective tool for predicting nutritional outcomes based on large datasets. This method compares new toddler data with pre-existing data to detect early nutritional deficiencies, thereby facilitating timely interventions. The "PSG Balita" application on the Android platform also offers substantial improvements in data management, in line with ISO/IEC 25010 standards, ensuring both the quality and timeliness of data, crucial for strategic nutritional planning.[2]

How to cite: Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.

IoT-based tools, which use real-time data for anthropometric measurements, have shown remarkable precision with a 99.82% accuracy for weight and 97.34% for height, representing a breakthrough in *stunting* prevention efforts[13]. Machine learning approaches, such as the Radial Basis Function (RBF) Neural Network, provide classification accuracies ranging from 90% to 92%, reflecting the potential in accurately evaluate nutritional health through diverse anthropometric indices[14]. Additionally, the C4.5 algorithm offers superior performance over the Naïve Bayes classifier in classifying nutritional data, further validating the efficacy in digital health assessments[15].

Fuzzy logic-based systems also contribute meaningfully to nutritional assessments. For instance, the Fuzzy Sugeno method, which adheres to WHO standards, provides an intuitive and user-friendly platform for monitoring toddler growth. Another application that incorporates fuzzy logic and the TOPSIS method has achieved an accuracy rate of 84%, delivering not only nutritional assessments but also food recommendations tailored to children needs[16]. Although these technologies promise advancements in accuracy and data-driven insights, challenges remain regarding the validity of the input data and the necessity for regular updates to algorithms and datasets. The reliability of these digital tools is highly dependent on the quality and comprehensiveness of the data input, as well as adaptability to different contexts and populations. These tools are highly valuable in complementing nutritional assessment methods but should not be considered replacements for professional evaluations and expert guidance.

Factors Influencing the Efficacy of Digital Nutrition Applications

The efficacy of digital nutrition applications in assessing children nutritional status is influenced by several critical factors, including the algorithm used, data quality, user proficiency, and adaptability to various populations. These factors are essential to ensure accurate and precise anthropometric measurements, which are the foundation for determining malnutrition in children. In addition, the integration of contextual factors such as local health infrastructure, cultural acceptability, and routine data availability also plays a crucial role in maximizing application practical effectiveness and sustainability.

Algorithm Selection

The choice of algorithm plays a crucial role in determining the accuracy of the application. For example, the K-NN algorithm has been shown to deliver high accuracy in classifying malnutrition in children, achieving accuracy rates of up to 91.94% when comparing new anthropometric data with pre-existing datasets. This high level of accuracy is essential for early detection of nutritional deficiencies, allowing timely interventions in malnutrition case[15]. Similarly, machine learning algorithms such as the RBF Neural Network have shown accuracy rates between 90% and 92% in evaluating nutritional status based on Weight-For-Age (WFA) and Height-For-Age (HFA) indices[14].

Data Input and Quality

The quality of data input plays a crucial role in the performance of digital nutrition applications. High-quality and accurate data entry is essential for reliable nutritional assessments. For instance, applications using IoT-based real-time anthropometric tools have shown remarkable precision, achieving accuracy rates of 99.82% for weight measurements and 97.34% for height. However, in regions where access to IoT technology is limited, particularly in rural areas, reliance on manual data entry becomes necessary. This dependency places a heavy emphasis on user training and strict adherence to protocols for data reliability[17]. In these cases, inconsistencies and user errors can lead to significant variations in outcomes, undermining application overall reliability. Therefore, standardized input methods and consistent training are critical to mitigating these errors, as shown by the need for quality-driven design patterns in IoT applications[18], ensuring the accuracy of manual data collection and maintaining consistent data quality.

User Proficiency and Training

The proficiency of users operating digital applications also plays a key role in the efficacy of these tools. User errors such as incorrect data entry or failure to follow measurement protocols can compromise the accuracy of the results. Studies on the "PSG Balita" application, for example, show that improved user training significantly enhances both the accuracy and timeliness of data, ultimately leading to more reliable assessments of nutritional status[19]. Without adequate training, even advanced digital tools may not achieve full potential, particularly in under-resourced settings where users may lack the technical skills needed to operate the systems effectively.

Adaptability to Diverse Populations

To be effective, digital nutrition applications must be adaptable to different population groups. The ability of applications to process varied anthropometric data and adjust to population-specific nutritional needs is crucial. Fuzzy logic-based systems, such as those using the Fuzzy Sugeno method, have shown strong adaptability by providing user-friendly platforms consistent with WHO standards for monitoring child growth. These applications have proven to be particularly effective in rural and under-resourced areas, where accurate, real-time assessments are essential for preventing *stunting* and *wasting*[25].

The accuracy of under-five nutrition assessment applications is influenced by several key factors, such as algorithm selection, data quality, user input, and the ability to process diverse anthropometric data. These factors work together to determine the reliability and effectiveness of digital tools in evaluating and predicting nutritional status of young children. One of the most important aspects is the choice of algorithm, as different methods can produce varying results. For example, K-NN algorithm has shown an accuracy of 91.94% in predicting children nutritional status, and three machine learning algorithms namely Naive Bayes, KNN, and Random Forest were evaluated based on accuracy, precision, and recall. KNN provided the highest accuracy score of 0.967 (almost

How to cite: Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.

100%) in predicting cases of malnutrition, particularly *stunting*, compared to the other two algorithms[28], making it highly effective for comparing new data with existing datasets and allowing early identification of nutritional issues[29]. In contrast, other algorithms, such as the C4.5, have shown a lower accuracy of 72.13%, indicating the impact of algorithm choice on assessment outcomes[30]. Image processing techniques for anthropometric measurements, with accuracies of up to 100%, are instrumental in improving precision of nutritional evaluations[31]. Despite the high accuracy, the computational demands of the K-NN algorithm can hinder implementation in low-resource environments, where access to technology and data may be limited[32]. The complexity of models such as RBF Neural Networks further worsens this issue due to the requirement of significant computational resources and expertise[33]. Although machine learning presents innovative solutions for malnutrition detection, the gap between high performance in controlled settings and practical application in low-resource contexts remains a critical challenge. Overcoming these barriers is essential for ensuring effective implementation and improving health outcomes in underserved populations.

The quality and completeness of input data play a critical role in the effectiveness of these applications. For instance, the Mozita application showed how focusing on information accuracy, timeliness, and ease of use can enhance data quality, ultimately improving the overall reliability of nutritional assessment[34]. However, inaccuracies and data gaps can result in erroneous assessments, similar to image-based applications such as GoFood Lite, where improper use of fiducial markers led to compromised data integrity[35]. Ensuring the accuracy and completeness of data is essential for obtaining trustworthy results. Issues such as user errors and inconsistencies in data entry can also significantly affect the outcomes, emphasizing the need for user training and proper guidance on how to input data correctly[35,36].

The capacity of digital nutrition applications to handle diverse anthropometric data is a critical factor in ensuring accuracy. These applications must be adaptable to the specific nutritional needs of different populations to provide precise assessments. Studies have shown that performance can vary significantly depending on the types of anthropometric data being measured and the range of variations within the population, potentially complicating accurate assessments in more diverse settings. These applications must consider ethnic and cultural differences in anthropometric practices to improve the reliability of nutritional status measurements. Despite offering valuable initial assessments, digital applications must be combined with evaluation methods, such as clinical assessments and anthropometric measurements, to ensure a more comprehensive and accurate analysis of children nutritional status. This review has limitations, including variations in study design, data sources, and methodologies, which may introduce inconsistencies in the reported accuracy of digital nutrition applications. Additionally, heterogeneity in assessment criteria poses challenges in drawing generalized conclusions. Variations in anthropometric measurement techniques across different studies may introduce inconsistencies in accuracy assessments. Furthermore, the predominance of cross-sectional study designs in the included literature limits the ability to establish causal relationships between digital assessment applications and actual nutritional status. Discrepancies in validation methods and reference standards across different applications create challenges in making direct comparisons. Future investigations should prioritize longitudinal studies and the development of standardized validation protocols to enhance the reliability and applicability of digital nutrition assessment applications. Addressing these limitations is crucial to strengthening the credibility and facilitating the integration of these technologies into public health nutrition programs[37–39].

Table 1. Quality Assessment of Studies Evaluating the Accuracy of Digital Diagnostic Tools using the QUADAS-2 Risk of Bias Assessment[20]

Study References	Patient Selection	Index Test	References Standard	Flow and Timing	Overall Risk
Oliviera et al., 2019[1]	Low	Low	Low	Low	Low
Ferliandini et al., 2023[21]	Low	Low	Low	Low	Low
Teshome et al., 2017[12]	Moderate	Low	Low	Low	Low
Kurniastuti, 2017[22]	Low	Low	Low	Low	Low
Heymsfield et al., 2018[23]	Low	Low	Low	Low	Low
Bhattacharya et al., 2019[24]	Low	Low	Low	Low	Low
Rosari et al., 2024[13]	Low	Low	Low	Low	Low
Rahmad et al., 2023[19]	Low	Low	Low	Low	Low
Damar et al., 2022[14]	Low	Low	Low	Low	Low
Ridwan et al., 2021[15]	Low	Low	Low	Low	Low
Suharjito et al., 2017[25]	Low	Low	Low	Low	Low
Permatasari et al., 2017[26]	Low	Low	Low	Low	Low
Conkle et al., 2018[27]	Low	Low	Low	Low	Low

QUADAS-2=Quality Assessment of Diagnostic Accuracy Studies-2

Table 2. Characteristics and Outcomes of Studies Evaluating Accuracy of children Nutrition Digital Health Interventions

Reference	Objectives of the Study	Study Design	References Methods System	Main Result
Oliviera et al., 2019[1]	To develop a free, simple-to-use digital application for assessing overall nutritional status using four anthropometric indicators (height, weight, waist, hip circumference)	A mobile application was developed using the MIT App Inventor and tested by 120 people, including nutritionists, who provided feedback on its usability.	The app calculates nutritional status using the standard deviation classification system (z-scores) based on WHO (2007) standards. It evaluates BMI for adults based on WHO and PAHO guidelines, and Body Adiposity Index (BAI) using Bergman et al.'s formula.	The app achieved good accuracy in classifying nutritional status using simple measurements. Nutritionists reported it could be used by the general population. Initial user testing provided feedback with high user satisfaction but lacked formal accuracy metrics.
Ferliandini et al., 2023[21]	To Provide a reliable tool for monitoring children's nutritional status and Enable early detection of nutritional problems and timely intervention.	The study uses a quantitative study design that focuses on predicting nutritional status of children using the K-NN algorithm. This design comprises collecting data on various parameters such as age, weight, height, and gender of children, which are then used to classify the nutritional status by comparing new data with existing data in the dataset.	K-NN method for predicting nutritional status of children and Algorithm calculates the distance between toddler data for prediction accuracy	The application accuracy level is 91.94% and Enables early detection of nutritional problems.
Teshome et al., 2017[12]	To develop a cost-effective real-time digital system for nutritional assessment using	A system was developed integrating digital clinical scales and anthropometric measurements with	Uses digital scales for weight and ultrasound sensors for height measurement, combining these data	High precision and accuracy achieved through automated measurements. Real-time feedback reduces observer errors. Accuracy metrics

How to cite: Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.

e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Kurniawan et al. | Amerta Nutrition Vol. 9 Issue 3 (September 2025). 545-556

Reference	Objectives of the Study	Study Design	References Methods System	Main Result
	anthropometric data, with immediate feedback.	GPS and other health data. The system provides real-time data transmission and analysis through a mobile platform.	with other indicators like food security. Data are transmitted via cellular network and showed on a web-based dashboard with interactive visualizations.	were not quantified, but precision improved compared to conventional methods.
Kurniastuti, 2017[22]	To develop a Flash-based application to assess infant nutritional status using basic anthropometric inputs (weight, height, head circumference).	The application was created using Macromedia Flash and tested using anthropometric data from infants. The output was compared to standard Ministry of Health nutrition guidelines.	Inputs include age, gender, weight, height, and head circumference. The program classifies nutritional status of the infant as normal, below normal, or above normal based on the comparison with Ministry of Health standards.	Achieved 100% accuracy in comparison to the Ministry of Health standards. The system is highly precise due to its adherence to strict measurement protocols.
Heymsfield et al., 2018[23]	To review the advances in digital anthropometry, including the transition from traditional measuring tools to 3D optical imaging.	This paper is a critical review of new digital anthropometric tools, focusing on the operational details and validation of new technologies.	The main methods include 3D optical scanning for measuring body size and composition. These devices are low-cost and have applications in clinical and study settings.	Validation studies showed high accuracy (ranging from 90-95%) for 3D imaging systems compared to traditional anthropometry. However, precision varied based on the specific body measurement (height/weight being the most accurate).
Bhattacharya et al., 2019[24]	To create a new composite score for nutritional status based on anthropometric measurements and compare its accuracy to BMI and MUAC classifications.	This study collected anthropometric data from 780 participants and used confirmatory factor analysis to develop a composite score.	The new method reduces 12 anthropometric variables into a single composite score, providing a better classification of nutritional status. Comparison was made against traditional BMI and MUAC methods.	The composite score showed higher classification accuracy (98.7%) compared to BMI (95.9%) and MUAC (96.2%). This method provides better precision for population assessments.
Rosari et al., 2024[13]	Develop a tool for measuring children height and weight to assess nutritional status promptly, aiming to preemptively address any nutritional abnormalities and prevent exacerbation.	This study used both qualitative and experimental approaches. It involves measuring the height and weight of young children to evaluate the nutritional status. This study aims to ensure that the tools and programs developed are easy to use and provide accurate results through periodic trials.	The tool developed incorporates IoT technology, using sensors like HC-SR04 for height measurements and HX711 module with loadcell sensor for weight measurements. Data from these sensors are transmitted for real-time analysis, enabling prompt identification of nutritional issues in children.	The developed tool for measuring children height and weight using Anthropometry and IoT technology achieved a minimal error rate of 0.18% for weight measurement with 99.82% accuracy and a 2.66% error rate for height measurement with 97.34% accuracy.
Rahmad et al., 2023[19]	Measure the effect of "PSG Balita" application on data quality.	Quasi-experimental study design conducted in Banda Aceh City in 2021 comprising 30 nutritionists at a health center	A quasi-experimental study design to evaluate the effectiveness of the "PSG Balita" application in enhancing the quality of nutritional status data for children.	After one month of using the "PSG Balita" application, improvements were observed in the aspects of timeliness (p-value<0.001), completeness (p-value<0.001), accuracy (p-value=0.001), and usefulness (p-value=0.002) in monitoring nutritional status of children,

Reference	Objectives of the Study	Study Design	References Methods System	Main Result
				allowing for early identification of malnutrition risk.
Damar et al., 2022[14]	Classify children nutritional status using anthropometric measurements and Implement machine learning for convenient nutritional status assessment.	The study uses a quantitative study design that uses an RBF Neural Network to classify children nutritional status based on three anthropometric measurements: WFA, HFA, and WFH.	The paper used the RBF Neural Network algorithm to classify children nutritional status based on three anthropometric indexes: WFA, HFA, and WFH.	The highest accuracy achieved in classifying children nutritional status based on WFA index was 91.58%, using 36 layers and 2000 or 2200 epochs. For HFA index, the highest accuracy obtained was 92.11% with 144 layers and 2000 epochs.
Ridwan et al., 2021[15]	To evaluate and compare the accuracy of two data mining classification algorithms Naïve Bayes Classifier and C4.5 Algorithm in classifying nutritional status of children based on anthropometric measurements and develop an algorithm that can be implemented into application, facilitating easier decision-making for stakeholders engaged in assessing toddler nutrition status based on anthropometric indices.	This design is focused on evaluating and comparing the performance of two different classification algorithms Naïve Bayes Classifier and C4.5 Algorithm in the context of classifying nutritional status of children based on anthropometric data.	The methods used in the paper include the Naïve Bayes Classifier Algorithm and the C4.5 Algorithm for the classification of Toddler Nutrition Status based on Anthropometry Index.	The C4.5 algorithm showed an accuracy rate of 0.93% better than the Naïve Bayes Classifier Algorithm in classifying Toddler Nutrition Status based on the Anthropometry Index.
Suharjito et al., 2017[25]	Developing an app for toddler nutrition assessment includes creating digital tool that can accurately determine children nutritional status based on key parameters such as age, height, and weight.	The paper uses the Fuzzy Sugeno method for assessing nutritional status of children. This method includes three stages: Fuzzyfication, comparison testing between Sugeno method and anthropometric tables, and evaluation of children nutrition status based on input variables such as age, height, weight, head diameter, and gender.	The programming language used for developing the Android-based decision-making system in this study is Java. The system takes input variables like height, weight, and gender to determine children nutrition status, providing a tool for monitoring and ensuring appropriate growth in children.	The application was tested using 30 samples to determine its accuracy in assessing children' nutritional status. The results showed that 12 out of the 30 children had the same result, categorized as "Good Nutrition", when compared to manual calculations. This shows a high level of agreement between application and traditional methods.
Permatasari et al., 2017[26]	To classify toddler nutritional status using Fuzzy Inference System (FIS) and Comparing results with Ministry of Health standards.	The study uses a quantitative study design that applies the Fuzzy Inference System (FIS) Mamdani method to classify nutritional status of children based on the weight and height measurements. It comprises	The paper uses the Fuzzy Inference System (FIS) with the Mamdani method to classify nutritional status of children based on the weight and height. This method comprises establishing rules based on the	The accuracy level of the fuzzy model developed in this study for classifying toddler nutritional status was approximately 84%, compared to the Assessment Anthropometric Standard of Toddler Nutritional Status by the Ministry of Health.

How to cite: *Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.*

Reference	Objectives of the Study	Study Design	References Methods System	Main Result
		the collection of data from 114 children and the establishment of nine rules to determine nutritional status categories, including *stunting*, *wasting*, normal, and overweight.	Assessment Anthropometric Standard of Toddler Nutritional Status by the Ministry of Health and using the IF-THEN operator to connect input and output variables.	
Conkle et al., 2018[27]	To evaluate 3D imaging for measuring child anthropometry accurately and Assess the reliability of 3D scans versus manual measurements.	The study uses a quantitative design to evaluate the accuracy and reliability of a low-cost, handheld 3D imaging system for measuring children anthropometry, specifically stature, head, and arm circumference. Conducted in 2016-2017, the study comprised recruiting 474 apparently healthy children aged 0-5 years from various facilities in metro Atlanta, Georgia.	The 3D scanning device used was a tablet with an attached Structure Sensor 3D scanner, which was off-the-shelf commercial hardware and cost USD 379. The anthropometrists carried this device to collect 3D scans and demographic information, and the custom software AutoAnthro from BST was used for scanning and data entry.	The study found that the 3D imaging system used for child anthropometry was reliable, with measurement reliability of repeated 3D scans being within 1 mm of manual measurement reliability for stature, head circumference, and arm circumference.

PAHO Guideline=Pan American Health Organization Guideline, MUAC=Mid-Upper Arm Circumference, HC-SR04=Ultrasonic Distance Sensor Module (Model HC-SR04), PSG Balita=Penilaian Status Gizi untuk Balita, BST=Body Surface Translations

How to cite: *Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.*

Strengths and Limitations

This systematic review presents several strengths, first, it synthesizes evidence from a diverse range of studies that evaluated digital tools for nutritional assessment in children, offering valuable insights into the accuracy, feasibility, and contextual adaptability of nutrition applications. Second, the inclusion of multiple anthropometric indicators and methodological perspectives enhances the comprehensiveness of the results. Some limitations include the predominance of cross-sectional studies which restricts the ability to infer causality between digital assessment tools and nutritional outcomes. Moreover, variability in study design, data quality, and validation procedures among included studies may affect the consistency and comparability of results. Despite these limitations, this review provides a critical foundation for future studies and the development of standardized digital nutrition tools.

CONCLUSIONS

In conclusion, digital applications for assessing under-five nutritional status present significant potential in enhancing the accuracy and efficiency of nutritional evaluations, particularly through advanced algorithms such as K-NN and image processing techniques. However, the effectiveness of these applications is highly dependent on the quality of data input, user accuracy, and the ability to handle diverse anthropometric data. Despite providing valuable preliminary assessments, these applications need to be combined with other evaluation methods and supported by continuous user training and data validation to ensure comprehensive and reliable assessments of children nutrition.

ACKNOWLEDGEMENT

The authors are grateful to the Faculty of Health Sciences and the Faculty of Computer Science at Universitas Brawijaya for the support throughout this study.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors declare that there is no conflict of interest related to the publication of this article. This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

AUTHOR CONTRIBUTIONS

DK: led the conceptualization of the study including defining the study objectives and study design, managed the data collection process and coordinated the methodological framework selection, contributed significantly to the manuscript writing, particularly in the results and discussion section, scontributed to manuscript reviewing and editing, ensuring intellectual rigor and clarity, provided final approval of the submitted version and agreed to be accountable for all aspects of the work; NNW: conducted data analysis, performed statistical validation, and interpreted the results, led the synthesis of key results and ensured the accuracy and consistency of the reported data, provided critical insights into the discussion and implications of the study within the field of nutrition, contributed to manuscript reviewing and editing, ensuring intellectual rigor and clarity, provided final approval of the submitted version and agreed to be accountable for all aspects of the work; HT: oversaw the systematic literature review, identified and screened relevant studies, and assessed risk of bias, provided technical expertise in digital applications and algorithmic methodologies related to nutritional status assessments, assisted in drafting and refining the manuscript, particularly in the methodological and technical sections, contributed to manuscript reviewing and editing, ensuring intellectual rigor and clarity, provided final approval of the submitted version and agreed to be accountable for all aspects of the work.

REFERENCES

1. De Oliveira, M. H., Gottsfritz, I. B., Lopes, L., Conde, W. L. & Joao, L. S. NUTRICARE Application to Access Nutritional Status on Adults and Older People Combining Four Indicators (P16-052-19). *Current Developments in Nutrition* **3**, nzz050.P16-052-19 (2019).
2. Rahmad, A. H. A. *et al.* Effectiveness of Using Android-Based Applications for Nutrition Monitoring of Children in Banda Aceh. *Open Access Macedonian Journal of Medical Sciences* **10**, 444–451 (2022).
3. Rinawan, F. R. *et al.* Understanding mobile application development and implementation for monitoring Posyandu data in Indonesia: a 3-year hybrid action study to build "a bridge" from the community to the national scale. *BMC Public Health* **21**, 1024 (2021).
4. Hairani, H., Nurhayati, L. & Innuddin, M. Web-Based Application for Toddler Nutrition Classification Using C4.5 Algorithm. *IJECSA* **1**, 77–82 (2022).
5. Sendari, S., Widyaningtyas, T. & Maulidia, N. A. Classification of Toddler Nutrition Status with Anthropometry using the K-Nearest Neighbor Method. in *2019 International Conference on Electrical, Electronics and Information Engineering (ICEEIE)* vol. 6 1–5 (2019).
6. Faza, A. *et al.* Posyandu Application in Indonesia: From Health Informatics Data Quality Bridging Bottom-Up and Top-Down Policy Implementation. *Informatics* **9**, 74 (2022).
7. Fernandes, T. Malnutrition and school feeding programmes. *JNHFE* **8**, (2018).
8. Romero-Tapiador, S. *et al.* AI4Food-NutritionFW: A Novel Framework for the Automatic Synthesis and Analysis of Eating Behaviours. Preprint at https://doi.org/10.48550/ARXIV.2309.06308 (2023).
9. Markus, P. Beta version of Child Growth Monitor released asap due to Covid-19. *Welthungerhilfe.de - Für eine Welt ohne Hunger und Armut* https://www.welthungerhilfe.org/news/latest-articles/2020/early-release-of-child-growth-monitor.
10. Stutz, T., Dinic, R., Domhardt, M. & Ginzinger, S. Can mobile augmented reality systems assist in

portion estimation? A user study. in *2014 IEEE International Symposium on Mixed and Augmented Reality - Media, Art, Social Science, Humanities and Design (IMSAR-MASH'D)* 51–57 (IEEE, Germany, 2014). doi:Preprint at https://doi.org/10.1109/ISMAR-AMH.2014.6935438.
11. Haddaway, N. R., Page, M. J., Pritchard, C. C. & McGuinness, L. A. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Systematic Reviews* **18**, e1230 (2022).
12. Teshome, E. M., Kiprotich, P. & Andango, P. E. Paradigm shift: efficient and cost effective real-time nutritional assessment technique. *African Journal of Food, Agriculture, Nutrition and Development* **17**, 12807–12816 (2017).
13. Rosari, A. *et al.* Developing a Nutritional Assessment Tool for Children Using Anthropometry and IoT Technology. *International Journal of Advanced Health Science and Technology* **4**, 67–71 (2024).
14. Damar, D. P. M., Sa'adah, S. & Wulandari, G. S. Classification of Toddler Nutritional Status Using Radial Basis Function Neural Network. in *2022 6th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE)* 314–319 (IEEE, Yogyakarta, Indonesia, 2022). doi:Preprint at https://doi.org/10.1109/ICITISEE57756.2022.10057785.
15. Ridwan, A. & Sari, T. N. The comparison of accuracy between naïve bayes clasifier and c4.5 algorithm in classifying toddler nutrition status based on anthropometry index. *J. Phys.: Conf. Ser.* **1764**, 012047 (2021).
16. Aziz, M. Aplikasi penentu status dan asupan gizi pada balita menggunakan metode fuzzy dan topsis berbasis android. (University of Technology Yogyakarta, 2019).
17. Romero, M. L. & Suyama, R. Data Quality in IoT Applications: A Scoping Review. in *2023 15th IEEE International Conference on Industry Applications (INDUSCON)* 1368–1373 (2023). doi:Preprint at https://doi.org/10.1109/INDUSCON58041.2023.10374893.
18. Rath, C. K., Mandal, A. K. & Sarkar, A. Data Quality Driven Design Patterns for Internet of Things. in *Applied Computing for Software and Smart Systems* (eds. Chaki, R., Cortesi, A., Saeed, K. & Chaki, N.) 285–303 (Springer Nature, Singapore, 2023). doi:Preprint at https://doi.org/10.1007/978-981-19-6791-7_18.
19. Al Rahmad, A. H., Ichsan, I. & Wilis, R. Implementation of Android Platform Application 'PSG Balita' ISO/IEC 25010 Standardized to Improve Nutritional Status Data for Toddler. *JIK* **17**, 14–21 (2023).
20. Whiting, P. F. *et al.* QUADAS-2: A Revised Tool for the Quality Assessment of Diagnostic Accuracy Studies. *Ann Intern Med* **155**, 529–536 (2011).
21. Ferliandini, D. A. & Risnanto, S. Aplikasi prediksi status gizi balita berbasis web menggunakan metode k-nearest neighbor. *Prosiding Seminar Sosial Politik, Bisnis, Akuntansi dan Teknik* **5**, 622–631 (2023).
22. Kurniastuti, I. Application of baby's nutrition status using Macromedia Flash. in *2017 4th International Conference on Computer Applications and Information Processing Technology (CAIPT)* 1–6 (2017). doi:Preprint at https://doi.org/10.1109/CAIPT.2017.8320699.
23. Heymsfield, S. B. *et al.* Digital Anthropometry: A Critical Review. *Eur J Clin Nutr* **72**, 680–687 (2018).
24. Bhattacharya, A., Pal, B., Mukherjee, S. & Roy, S. K. Assessment of nutritional status using anthropometric variables by multivariate analysis. *BMC Public Health* **19**, 1045 (2019).
25. Suharjito, S., Jimmy, J. & Girsang, A. S. Mobile Decision Support System to Determine Children Nutrition Using Fuzzy Sugeno. *IJECE* **7**, 3683 (2017).
26. Permatasari, D., Azizah, I. N., Hadiat, H. L. & Abadi, A. M. Classification of toddler nutritional status using fuzzy inference system (FIS). in 040007 (Yogyakarta, Indonesia, 2017). doi:Preprint at https://doi.org/10.1063/1.4995122.
27. Conkle, J. *et al.* Accuracy and reliability of a low-cost, handheld 3D imaging system for child anthropometry. *PLoS ONE* **13**, e0205320 (2018).
28. Putri, I. P., Terttiaavini, T. & Arminarahmah, N. Analisis Perbandingan Algoritma Machine Learning untuk Prediksi *Stunting* pada Anak: Comparative Analysis of Machine Learning Algorithms for Predicting Child *Stunting*. *MALCOM: Indonesian Journal of Machine Learning and Computer Science* **4**, 257–265 (2024).
29. Ferliandini, D. A. & Risnanto, S. Aplikasi Prediksi Status Gizi Balita Berbasis Web Menggunakan Metode K-Nearest Neighbor. *sobat* **5**, 622 (2023).
30. Molina, J. I. & Malese, L. P. Sistem pendukung keputusan penentuan status gizi balita pada dinas kesehatan kabupaten alor menggunakan algoritma c4.5. *JTIK* **17**, 1–13 (2024).
31. Nutrients | Free Full-Text | Evaluation of an Application for Mobile Telephones (e-12HR) to Increase Adherence to the Mediterranean Diet in University Students: A Controlled, Randomized and Multicentric Study. https://www.mdpi.com/2072-6643/14/19/4196.
32. Janssen, S. M., Bouzembrak, Y. & Tekinerdogan, B. Artificial Intelligence in Malnutrition: A Systematic Literature Review. *Advances in Nutrition* **15**, 100264 (2024).
33. Kishore, K. K., Suman, J. V., Mnikyamba, I. L., Polamuri, S. R. & Venkatesh, B. Prediction of malnutrition in newbornInfants using machine learning techniques. Preprint at https://doi.org/10.21203/rs.3.rs-2958834/v1 (2023).

34. Widodo, A. P., Adi, K., Nugraheni, S. A. & Indri, W. Measurement of information quality on mozita application uses the weighted average model. *J. Phys.: Conf. Ser.* **1524**, 012009 (2020).
35. Vasiloglou, M. F. *et al.* The Human Factor in Automated Image-Based Nutrition Apps: Analysis of Common Mistakes Using the goFOOD Lite App. *JMIR Mhealth Uhealth* **9**, e24467 (2021).
36. Lemma, S., Janson, A., Persson, L.-Å., Wickremasinghe, D. & Källestål, C. Improving quality and use of routine health information system data in low- and middle-income countries: A scoping review. *PLOS ONE* **15**, e0239683 (2020).
37. Yang, Y.-L., Yang, H.-L., Kusuma, J. D. & Shiao, S.-Y. P. K. Validating Accuracy of an Internet-Based Application against USDA Computerized Nutrition Data System for Research on Essential Nutrients among Social-Ethnic Diets for the E-Health Era. *Nutrients* **14**, 3168 (2022).
38. Kusuma, J. D., Yang, H.-L., Yang, Y.-L., Chen, Z.-F. & Shiao, S.-Y. P. K. Validating Accuracy of a Mobile Application against Food Frequency Questionnaire on Key Nutrients with Modern Diets for mHealth Era. *Nutrients* **14**, 537 (2022).
39. Green Corkins, K. & Teague, E. E. Pediatric Nutrition Assessment: Anthropometrics to Zinc. *Nut in Clin Prac* **32**, 40–51 (2017).

How to cite: *Kurniawan, D., Wirawan, N. N., & Tolle, H. (2025) A Systematic Review of Digital Applications Accuracy for Calculating and Assessing Nutritional Status of Children Under Five Years: Tinjauan Pustaka Sistematis Analisis Akurasi Aplikasi Digital dalam Perhitungan dan Penilaian Status Gizi Anak di Bawah Lima Tahun. Amerta Nutrition, 9(3), 545–556.*