



Innovation Article

Development of an electronic measuring device for height and nutritional status equipped with artificial intelligence for screening stunting toddlers

Nursita Istiqomah ^{1✉}, Melyana Nurul Widyawati ¹, Kurnianingsih ², Donny Kristanto Mulyantoro ³

¹ Postgraduate Program, Master of Applied Midwifery, Health Polytechnic of Health Semarang, Central Java, Indonesia

² Faculty of Computer Engineering Technology, Polytechnic State of Semarang, Central Java, Indonesia

³ National Research and Innovation Agency, Magelang, Central Java, Indonesia

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CORRESPONDENCE

Phone: +62 857-2595-7977
E-mail: nursita977@gmail.com

ABSTRACT

Background: Technological advancements have changed various aspects of human life, including in the world of health. One technological breakthrough that dominates attention is artificial intelligence (AI). Artificial intelligence has proven its potential to revolutionize many fields, including the health sector. One of the urgent health problems that requires innovative solutions is detecting the problem of stunting in children under five.

Purpose: The study aims to develop and test a measuring device that effectively determines the body height and nutritional status in toddlers 0-5 years.

Method: This study is in Research and Development (R&D); it consisted of 5 stages: stage I (literature study), stage II (product development), stage III (expert validity and phase trials), stage IV (product revision and final product), and stage V (phase II trials).

Results: The electronic measuring device for height and nutritional status has been created. The result is that the tool effectively determines the height and nutritional status. The value of the ultrasonic sensor works quite well, with a maximum test error value of 0.11 and an average of 0.033, which means the calibration value of the tool's sensitivity is valid in determining body height.

Conclusion: The electronic measuring device effectively determines the body's height and nutritional status.

INTRODUCTION

Nutrition is a big problem in Indonesia and is fundamental for human life.¹ Inadequate nutrition in toddlers is closely related to the risk of growth retardation.² Currently, Indonesia still has a double nutritional problem or what is called a double burden of malnutrition, including the problem of malnutrition and excess nutrition.³ Malnutrition is a concern in nutritional problems, namely stunting and wasting.⁴

Around 17% of toddlers in Indonesia are underweight or very underweight in 2021. 1.2% of them are significantly underweight, while 6.1% are underweight. There is a difference in percentage between very underweight (1.2%) and underweight (6.1%). This difference is thought to be due to the manual measurement process.⁵

Reading anthropometric measuring instruments is still done manually with the naked eye. The measurement results are also still written manually after completion, requiring a long time and more effort.⁶ Where time is limited in integrated healthcare center activities, tools are needed to shorten the anthropometric measurement process for toddlers.

So, it is necessary to develop innovative anthropometric measuring tools that make it possible to obtain valid, fast, precise, and accurate measuring results. System information technology has a role in health, where several technologies have been proven to detect, diagnose, treat, and educate easily, quickly, and effectively and can be used at any time.⁷ The development of technology is currently very rapid, including artificial intelligence systems, which are

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currently widely used in the health sector so that they can produce faster and more accurate data or decisions.^{8,9}

Previous research only examined babies 0-1 years old up to 2 years old.¹⁰⁻¹⁴ Only displays and prints weight data, while other data is not displayed.¹⁵ The research used the learning vector quantization method (LVQ1 and LVQ3) with the variables weight, height, accompanying infections, appetite, and patriarchal occupation. Accuracy results were only 88% using the LVQ1 algorithm and 95.2% using the LVQ313 algorithm, and studies only measured body weight at ages 0-2 years.¹⁶

There needs to be an innovative tool that can be used up to the age of 5 years, which is equipped with an ultrasonic sensor to measure the length or height of toddlers directly, quickly, precisely, and integrated using artificial intelligence so that it will make it easier for health workers and parents to find out the nutritional status of toddlers. This research aims to create and test trials of an electronic measuring device for height and nutritional status equipped with artificial intelligence for screening stunting toddlers.

METHOD

The method used in this research is the Research and Development (R&D). It consisted of 5 stages: stage I (literature study), stage II (product development), stage III (expert validity and phase trials), stage IV (product revision and final product), and stage V (phase II trials).

Research Phase I

At this stage are the literature review and preliminary study. In this study, researchers gathered information from the literature and health workers and mother who has a toddler – the results from this stage were used as a reference for making product.

Research Phase II

This stage is product development. The data from the phase I research was used to design and develop an electronic measuring device for body height and nutritional status.

Research Phase III

This stage is the expert validity test and the trial stage. Electronic measuring devices are designed and evaluated for feasibility and convenience by electronic experts, nutritionists, and midwives. Then, a trial phase I to 10 children aged 0-5 years.

Research Phase IV

This stage is product revision and the final product. An electronic measuring device that experts have validated is

then revised according to the suggestions and input of expert validation after the revised electronic measuring device is ready at the final product stage and can be used in phase II trials.

Research Phase V

At this stage is phase II trials; the product test phase uses a type of Pra-Experimental research with a one-group pre-test and post-test design. This research was conducted in the working area of Sidangkal Health Centre. The population in this study were toddlers aged between 0 and 5 years. The number of samples in this study was 360 respondents taken by stratified random sampling technique. This research was conducted in February-March 2023. The measured variable is the sensitivity/ difference of the instrument in measuring height and nutritional status compared to manual measurements—data analyzed by the Independent T-Test and Wilcoxon test.

RESULTS

Literature Review and Preliminary Study

Based on the literature study and interviews, the researchers found that measuring height and nutritional status can make it easier to monitor children's health. Researchers took the initiative to develop a tool that previously only measured nutritional status in babies up to 2 years old. Researchers added measurements of nutritional status based on height for ages up to 5 years of age, which is called SITA tech.

Product Development, Expert Validity, Phase I Trial, and Product Revision

In this phase, the assembly of the tool is assisted by a team of electrical experts. The components used in this tool include the ultrasonic sensor as a height determinant (Figure 1). The validation results obtained from all experts based on the validity criteria get a score of 87,81, which means that the validity criteria in the expert validation assessment are valid, then conducted testing with a small sample of 10 toddlers 0-5 years (Table 1). The value of the ultrasonic sensor works quite well, with a maximum test error value of 0.11 and an average of 0.033, which means the sensor sensitivity calibration value used is valid.

Phase II Trial

Table 2 shows that there is a similarity between body height using manual measuring instruments and electronic measuring instruments ($p=0.001$). The similarity of the measurement results shows that the SITA Tech tool is valid and effective for measuring the height and nutritional status of toddlers. Table 3 shows that there are similarities in determining nutritional status using manual calculations compared to electronic measuring instruments, seen from the accuracy value of 0.92. Calculating nutritional status

using manual and electronic measuring instruments has the same results.

Table 1. Height Measurement Between Manual and Electronic

Sample	Manual	Electronic	Diff	Margin Error
1	109	109.01	0.01	0.01
2	97	97.02	0.02	0.02
3	97	97.11	0.11	0.11
4	100	100.01	0.01	0.01
5	105.9	105.9	0	0.00
6	49	49.01	0.01	0.02
7	63	63	0	0.00
8	85.6	85.61	0.01	0.01
9	100	100.01	0.01	0.01
10	55	55.02	0.02	0.04

Table 2. Analysis of Body Height Using Manual and Electronic (n=360)

Body Length	Manual	Electronic	p-value
Mean±SD	86.51±13.96	86.53±13.96	0.001
Min-Max	43.00-116.00	43.01-116.03	

Table 3. The Toddler Nutritional Status (Body Length / Age)

Category	Precision	Recall	F1-score	n
Very short	0.96	76	0.85	37
Short	0.69	80	0.74	50
Standard	0.96	96	0.96	264
Tall	0.82	100	0.90	9
<i>Accuracy</i>			0.92	360

DISCUSSION

In this study, an ultrasonic sensor was used to determine the height of toddlers, and anthropometric standards to measure nutritional status were modified into electronic measuring instruments. The experimental value of the ultrasonic sensor worked quite well, with a maximum test error value of 0.11 and an average of 0.033, which means that the sensor sensitivity calibration value used was valid. This sensor can also be used repeatedly and calibrated as needed with a difference value of less than 0.05, resulting in a high accuracy value.

The results of this study consistently show that AI has great potential in identifying the risk of stunting in toddlers with higher accuracy compared to traditional methods. The results of this study support the results of previous research that used AI to detect nutritional status in children.^{17,18} High sensitivity in detecting truly stunted toddlers is essential for identifying cases that require further attention and intervention.¹⁹ In addition, reasonable specificity in avoiding prediction errors is essential in minimizing the number of false cases that may be subjected to unnecessary interventions. Using AI in stunting screening opens up opportunities to improve the effectiveness of child growth monitoring programs and nutrition interventions at the community level. These results suggest that AI can be a valuable tool in supporting efforts to prevent stunting in children under five.²⁰

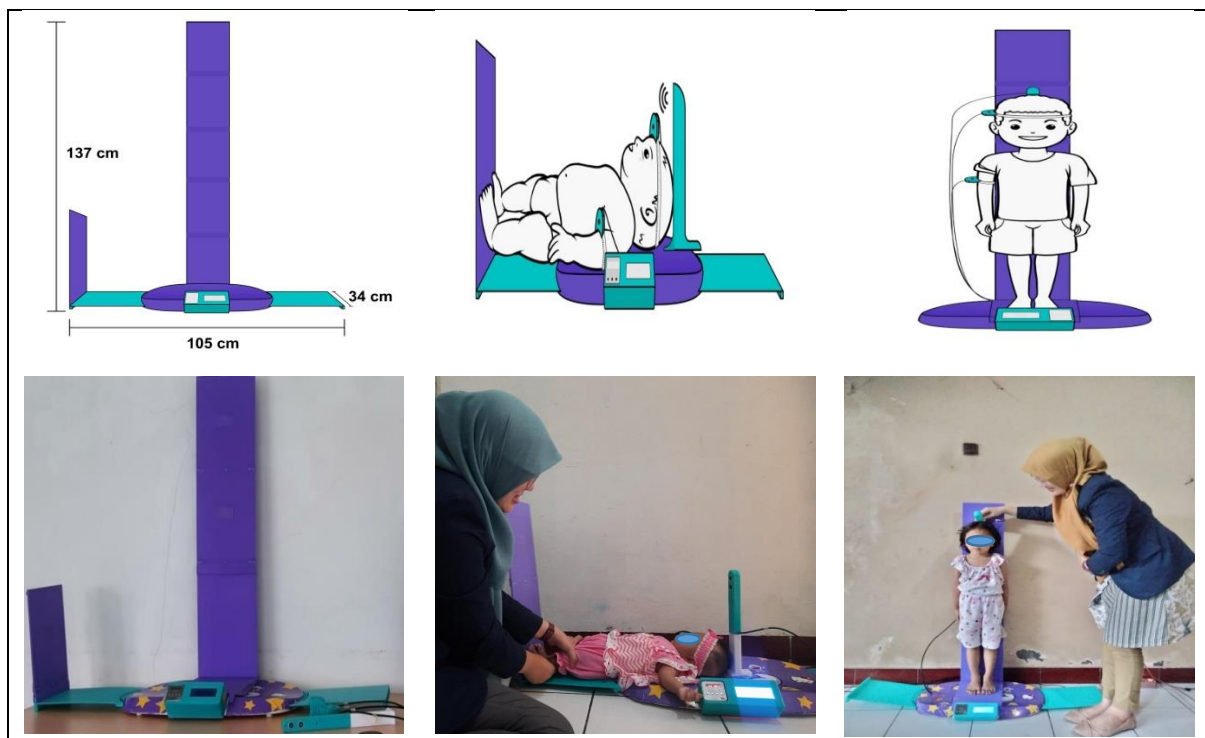


Figure 1. Electronic Measuring Device for Height and Nutritional Status

It is important to note that the validation results of the AI-based model in this study resulted in high sensitivity and specificity across different categories of under-fives. This indicates that the AI model could identify under-fives with different nutritional statuses, including very short, short, standard, and tall under-fives, according to the study.^{21,22} This high accuracy supports the model's reliability and provides confidence in its use in healthcare practice. However, it is essential to remember that every system is flawed, and there are still some cases where the model's predictions do not match reality. Therefore, it is vital to continuously monitor and update the AI model to improve its performance over time.

The comparison results between measurements using AI-based anthropometric gauges and manual gauges show that both provide similar results. This shows that the AI-based measuring device has met the anthropometric standards set for children. This finding supports research that says the validity of using AI-based tools in measuring the body length of toddlers with accuracy equivalent to manual measuring devices.²³⁻²⁵

This finding has important implications for pediatric health practice. The use of AI-based anthropometric measuring devices can improve the efficiency of measuring the height of children under five years old, which is an essential step in monitoring their nutritional status. With this technology, the measurement process can be faster and more accurate, which in turn can support early identification of stunting and more timely intervention planning. In addition, using AI can reduce the workload of health workers and allow them to focus on the necessary intervention measures. It can also support more informed decision-making in planning nutrition programs and individualized care for under-fives at risk of stunting.

CONCLUSIONS AND RECOMMENDATION

Electronic measuring devices for body height and nutritional status can make it easier and faster to determine the nutritional status of a toddler. They can be 0-5 years. They can be done simultaneously by measuring body height and nutritional status. So that it can save time, speed up the diagnosis needed, and make it easier to carry out further actions. It is highly recommended that health workers monitor the nutritional status of toddlers 0-5 years.

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