



Innovation Article

Development of an electronic measuring device for body weight and nutritional status for children under two years old

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ARTICLE INFORMATION

Received: February 09, 2022

Revised: April 28, 2022

Available online: April 30, 2022

KEYWORDS

Electronics; Body Weight; Nutritional Status; Infant

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A B S T R A C T

Background: Measurement of body weight and nutritional status in children under two years are still used manually. Besides that, there is no tool to measure nutritional status, so it is necessary to develop a tool to make it easier.

Purpose: The study aims to develop and test a measuring device for weight and nutritional status in children under two years.

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

Result: The electronic measuring device for weight and nutritional status has been created. The result is that the tool effectively determines the weight and nutritional status. The average value of tool testing is below 5%, which means the calibration value of the tool's sensitivity is valid in determining body weight. In addition, it can also determine nutritional status with a $p=0,65$, which means that there is no difference between measuring nutritional status using the tool and manually.

Conclusion: The electronic measuring device effectively determines the weight and nutritional status.

INTRODUCTION

Malnutrition in children under two is one of the main problems because it dramatically affects their lives in the future. Their growth will be stunted, body defenses will be reduced, and the development of brain function is hampered, but it is also a risk factor for morbidity and mortality. This situation can occur due to both direct and indirect factors. One of the indirect factors is inadequate health service.¹⁻⁴ The nutritional status of children under two years can be measured by body weight index according to age, where bodyweight describes body mass, namely muscle, water, bone, and fat which is very influential on sudden changes in circumstances such as lack of food supply consumed, lack of appetite, disease or infection. So it can be concluded that the weight index by age explains the current nutritional status.^{5,6}

During weighing in health services, efforts to monitor children's weight and nutritional status are carried out. One of

the weighings in health service is during integrated healthcare center activities.⁷ Previously, body weight and nutritional status measurements were carried out manually and separately. Measurement of body weight using a "dacin" tool. At the same time, the measurement of nutritional status uses a manual calculation. The manual calculation's weakness is that it takes a relatively long time considering the time used in integrated healthcare center activities has a time limit and missed nutritional status measurement. The previous study only developed a weighing device in the form of weight using a load cell sensor. While in this study, nutritional status measurements were carried out simultaneously with body weight measurements. So that time problems missed nutritional status measurement, and monitoring of nutritional status problems could be resolved.^{8,9}

In the development of health technology, many studies have been carried out to help paramedics work. One of which is used to measure the body weight of children un-

<https://doi.org/10.30595/medisains.v20i1.13143>

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der two by utilizing a load cell sensor as an innovative bodyweight measurement tool.¹⁰ Measurement of body weight is critical because it monitors growth in children. Toddlerhood is a period of rapid growth and development and a period vulnerable to health problems such as malnutrition. One of the ways to find out if a toddler is malnourished is body weight. So far, the measurement of nutritional status only uses manual calculations. so that a new method is needed to measure nutritional status to facilitate health services and provide valid results.^{11,12} The study aims to develop and test an electronic measuring device for bodyweight and nutritional status in children under two years.

METHOD

The method used in this research is the Research and Development (R&D) method by adopting the simplified Borg and Gall model.¹³ 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 obtained from the phase I research was used to design and develop an electronic measuring device for body weight and nutritional status.

Research Phase III

This stage is the expert validity test and the trial stage. Electronic measuring devices are designed, then evaluated for feasibility and convenience by electronic experts, nutritionists, and midwives. Then conducted a trial phase I to 10 children under the age of two 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 use in the 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 pretest and posttest design. This research was conducted in the working area of Sidangkal Health Centre. The popula-

tion in this study were children under two years old between 1 day to 24 months. The number of samples in this study was 30 respondents taken by simple random sampling technique. This research was conducted in December 2021.

The measured variable is the sensitivity/difference of the instrument in measuring body weight and nutritional status compared to manual measurements. One group is given treatment by measuring instruments using an electronic measuring device for body weight and nutritional status and measuring instruments using manuals and then observing the results. To determine the body weight and nutritional status of children under two years using sensors and manuals, both use the Dependent T-Test and Kruskal Wallis test.

RESULTS

Literature Review and Preliminary Study

Based on the literature study and interviews, the researchers found that measuring weight and nutritional status can make it easier to monitor children's health. The researchers took the initiative to develop a previous tool that only measured body weight. The researchers added a measurement of nutritional status based on body weight to age.

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 load cell sensor as a weight determinant, the HX711 amplifier module as a bridge to capture signals from the sensor to the microcontroller, and the microcontroller as an operation controller on the device (Figure 1). The validation results obtained from all experts based on the validity criteria get a score of 90, which means that the validity criteria in the expert validation assessment are valid—then conducted testing with a small sample of 10 children under two years (Table 1). The tolerance value of the difference between the two measurement results is not more than 5%, which means the sensor sensitivity calibration value used is valid.

Phase II Trial

Table 2 shows a significant difference in body weight using manual measuring tools and electronic measuring devices by looking at the $p=0.014$. This difference is due to the measurement using a manual tool to obtain a measurement result of 1 digit behind the comma while using an electronic measuring device to obtain a result of 2 digits behind the comma.

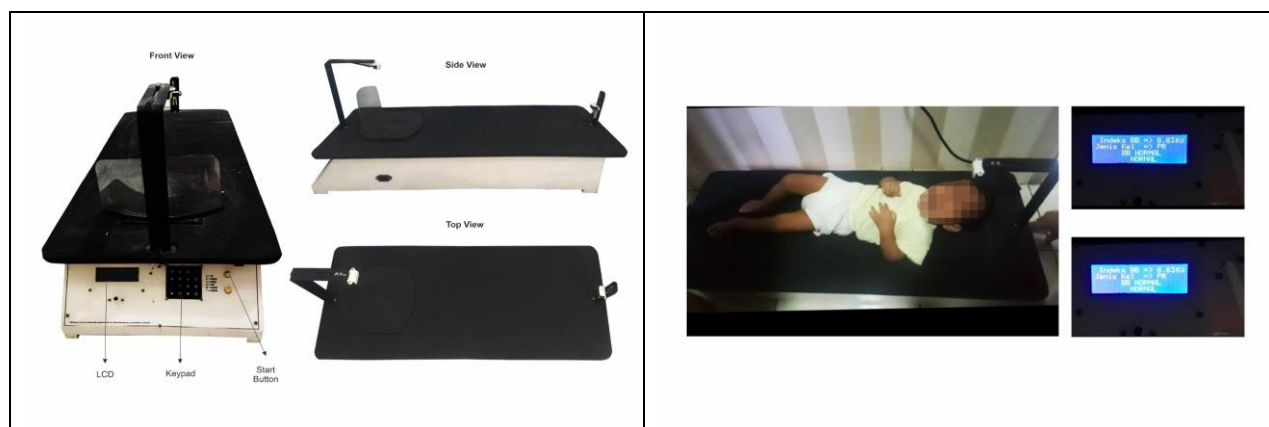


Figure 1. Electronic Measuring Device for Body Weight and Nutritional Status

Table 1. Trial of Weight Measurement Between Manual and Electronic Measuring Devices

Respondent	Manual Tool	Electronic Measuring Device	Difference	Error Percentage
1	4.0	4.10	0.1	2.5
2	3.8	3.90	0.1	2.7
3	4.2	4.20	0	0
4	5.3	5.40	0.1	2
5	5.0	5.00	0	0
6	6.0	6.00	0	0
7	3.6	3.80	0.2	6
8	4.1	4.20	0.1	2.4
9	4.8	4.80	0	0
10	5.7	5.70	0	0
Average Error Percentage				2

Table 3 shows no difference in determining nutritional status using manual calculations compared to an electronic measuring device, as seen from the $p=0.65$. It means that the calculation of nutritional status using manual and electronic measuring devices has the same results, which means that the electronic measuring device is suitable for determining the nutritional status of children under two years.

DISCUSSION

In this study, a load cell sensor is used to determine the body weight of children under two and anthropometric standards in measuring nutritional status modified into an electronic measuring device. The experiments have a tolerance value on the sensor, not more than 5%, which means the sensor sensitivity calibration value used is valid.

The use of this Load Cell sensor can produce a maximum value of 100kg. Cell sensors influence body weight in children under two years and can produce a maximum value of 100kg. This sensor can also be used repeatedly and calibrated as needed with a different value of below 5% to produce a high accuracy value.¹⁴⁻¹⁶ In measuring weight using a sensor with an output value of two digits behind a comma or three digits behind a comma or more, it will have a superior value compared to the output value with one

digit behind the comma even though the output value is not a very significant difference. In addition, the use of the sensor is also capable of weighing up to the smallest value (decimal number). The numbers displayed on the screen are easier to read, and the measurement results do not confuse users.

Research using load cell sensors has also been used in the previous study using load cell sensors as a determinant of body weight used in toddlers during health services. This study used four measurement parameters: body weight using a load cell sensor, body length and head circumference using an ultrasonic sensor, and temperature using an infrared sensor. The measurement results state that the measurement is quite valid, practical, and saves time.¹⁷

This research is in line with previous research, which used load cell sensors to measure body weight in children and ultrasonic sensors SRF-04 to measure children's height, so that body mass index (BMI) was known. In this study, it can also produce a good body mass index output and facilitate performance when taking measurements.¹⁶ Besides that, a previous study also used a load cell sensor as a weight determinant and an ultrasonic sensor as a height determinant.¹⁸

Table 2. Analysis of Body Weight Using Manual and Electronic Measuring Device

Variable	Manual Tool	Electronic Measuring Device	Difference	p-value
Body Weight				
Mean	7.497 ± 2.3740	7.522 ± 2.3501	0.025 ± 0.0504	0.014
Min – Max	3.6 – 11.1	3.80 – 11.10	0.2 – 0	

Table 3. Analysis of Nutritional Status Using Manual and Electronic Measuring Device (n=30)

Variable	Manual Tool	Electronic Measuring Device	n	p-value
Nutritional Status	Underweight	Underweight	3	0.65
	Normal	Normal	27	

A previous study demonstrated the use of a multifunctional instrument table in monitoring the health of toddlers in their research, which used a load cell sensor at the bottom of the instrument table support which was used to measure their body weight. Their research made this multifunctional instrument table to determine temperature, weight, and body length to minimize physical contact with toddlers during the COVID-19 pandemic, where they were required to limit mobilization, interaction, and maintain distance.¹⁹

In the study results, three children were Underweight. This is because at that age has entered the MP-ASI period where this time parents will experience many feeding problems such as shutting up movements because they refuse new foods, children being fussy when given food, children playing more, or children who like to be picky food so that the child's daily nutritional intake will be reduced. Moreover, if this condition continues, it can result in no weight gain or even weight loss.^{20,21}

In this situation, it is essential to monitor the growth and development of children. One of the things that can be done is by providing complete health care facilities at the time of Integrated Healthcare Center services and also prompt service in diagnosing the child's condition so that further actions can be recommended to be given to children when experiencing delayed growth so that the health problems experienced by children at this time can be overcome so that it does not affect their growth in the future.²²

Nutritional status is a reflection of the sufficiency of a nutritional need or the result of a balance of intake and absorption in the use of nutrients that enter the body and is also a reflection of the nutritional state of the wider community.²³ If the intake and absorption of nutrients are good, the child's nutritional status will also be good, and vice versa; underweight will occur if there is interference from the intake or absorption of the nutrition itself.²⁴

The use of load cell sensors can measure body weight in children under two. This can be seen from the sensitivity of the load cell sensor that is used to be valid to determine body weight accurately. In addition to determining body weight, it can also determine nutritional status with weight indicators according to age. The results can be adjusted to

the anthropometric standards of the World Health Organization National Center For Health Statistics (WHONCHS).^{25,26}

CONCLUSIONS AND RECOMMENDATION

Electronic measuring devices for body weight and nutritional status can make it easier and faster to determine the nutritional status of children under two. They can be done simultaneously by measuring body weight and nutritional status. So that it can save time used, speed up the diagnosis needed, and make it easier to carry out further actions. This is highly recommended for health workers to monitor the nutritional status of children under two years.

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