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Development of A Detection Tool in Pregnant Women and Its Recommendations in Utilizing Artificial Intelligence

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ABSTRACT

Background: Chronic Energy Deficiency (CED) can be experienced by women of reproductive age (WUS) aged 15–45 years old since adolescence then continues during pregnancy and breastfeeding due to low energy and nutrient reserves. Health technology innovation that utilizes artificial intelligence, i.e. Digital mid-uppr arm circumference (MUAC) which is a digital measurement tool that can make it easier to read anthropometric measurement results, especially in measuring upper arm circumference to detect pregnant women who experience CED.
Subjects and Method: This was a Research and Development with a pre-experimental design with an on shot case study. The number of samples is 100 Subjects, which is done 3 times each month for 3 months. The sample was selected by purposive sample. The analysis used artificial intelligence.
Results: Digital MUAC level of accuracy in detecting CED in pregnant women and its recommendations that utilize artificial intelligence, an accuracy level of 100%.
Conclusion: The CED detection tool Digital MUAC, is a tool capable of detecting CED and providing recommendations based on the results of CED detection in pregnant women who utilize artificial intelligence by having accurate measurement results with an accuracy value of 100%.

Keywords: MUAC digital, artificial intelligence, pregnant women.

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BACKGROUND

Maternal Mortality Rate (MMR) is one of the indicators of health services in Indonesia. Maternal mortality is caused by several factors, such as social factors, cultural factors and economic factors. Poverty in society will lead to poverty of knowledge and information. According to the World Health Organization (WHO), the highest percentage of causes of maternal mortality are bleeding, anemia and chronic energy deficiency (CED). In various developing countries, maternal mortality is around 40% caused by anemia which results in bleeding

in mothers giving birth. Anemia often occurs in pregnant women caused by poor nutritional status. Pregnant women with poor nutritional status can cause chronic energy deficiency (CED) (Suryaningsih, 2017).

One way to categorize pregnant women into CED or not CED is measured by the measurement of the upper arm circumference (MUAC). Measuring the MUAC of pregnant women is one of the parts that must be carried out by health workers. The Indonesian Ministry of Health has written in the Integrated Antenatal Guidelines, in the guidelines it is stated that in antenatal examinations that health workers must provide services according to standards, one of which is measuring MUAC. MUAC measurements are carried out at the first meeting of pregnant women with the Midwife. This measurement aims to detect pregnant women who are at risk of CED early. Pregnant women who are categorized as CED have risk factors for giving birth to babies with low birth weight (Ministry of Health, 2020).

Basic health research data in 2018 showed that the prevalence of CED in pregnant women nationally in Indonesia was 17.3%. While the prevalence of CED in pregnant women in Central Java province was 18% (Basic Health Research, 2018). Furthermore, the prevalence of CED in pregnant women at the Bangetayu Health Center was 13.17%. This figure shows the percentage of CED pregnant women which is expected to decrease by 1.5% each year in order to reach the target of 10% in 2024 (Ministry of Health, 2017).

Chronic Energy Deficiency (CED) can be experienced by women of reproductive age aged 15–45 years old since adolescence then continues during pregnancy and breastfeeding due to low energy and nutrient reserves. One of the long-term impacts of macronutrition problems in WRA and pregnant women with CED is giving birth to babies with low birth weight (LBW). Mothers who experience CED are at risk of giving birth to LBW babies 4.8 times greater than mothers who do not experience CED. Every year, it is estimated that around 350,000 babies are born with LBW ≤2,500 grams which is one of the main causes of malnutrition and infant mortality. To overcome and reduce the birth of LBW babies, earlier steps are needed, including early detection of pregnant women at risk of CED (Reni, 2023).

Health technology innovations that utilize artificial intelligence such as a digital measuring tool that can make it easier to read anthropometric measurement results, especially in measuring the circumference of the upper arm, are in great demand. This is intended so that measurements can be carried out more practically in a short time and reduce bias in reading measurement results. Adhyanti (2022) developed an anthropometric tool, namely by measuring digital body circumference using a tape connected to a digital tool, but this tool must be used for too long and its size is too large, so that the results of the values or numbers read on the tool can be error and patience is needed in pulling the rope on the digital tool.

The study aimed to improve the accuracy of the CED Detection Tool for Pregnant Women and its Recommendations in Utilizing Artificial Intelligence.

SUBJECTS AND METHOD

1. Study Design

This study used a Research and Development (R&D) approach with a pre-experimental design with a one-shot case study. R&D is a series of product development processes and improvements to existing products and testing the effectiveness of these products. This study was conducted in the Bangetayu Health Center Working Area, Semarang City from January to March 2023.

2. Population and Sample

The population in this study were all pregnant women in January - March 2023 who were in the Bangetayu Health Center area of Semarang City. The sampling technique was carried out using the Non Probability Sampling type with the Purposive Sampling technique, the samples used were 100 samples, the samples were taken from the Bangetayu Health Center in Semarang City which consisted of each pregnant woman who entered the first trimester, second trimester and third trimester then MUAC measurements were carried out every month which is from the first month to the third month for pregnant women who entered the first trimester, MUAC measurements every month which is from the fourth month to the sixth month for pregnant women who entered the second trimester and MUAC measurements every month which is from the seventh month to the ninth month for pregnant women who entered the third trimester.

3. Study Variable

The dependent variable in this study was the detection of pregnant women who experience CED. The independent variable in this study was Digital MUAC.

4. Operational Definition of Variable

MUAC Digital is a measuring tool created by MUAC for pregnant women to detect CED.

CED Detection in pregnant women are pregnant women who are found to have risk factors for CED with MUAC <23.5cm.

Nutritional status of pregnant women (Nutritional intake) is the nutrition consumed during pregnancy.

5. Study Instrument

The instruments used in this study include digital MUAC, which has been tested for validity with an expert validation assessment sheet. This study also used other supporting instruments, namely the pregnant woman's nutrition screening sheet and the NHO web application to record subject data.

6. Data Analysis

Data analysis in this study was univariate analysis and analysis of the level of accuracy of MUAC Digital using artificial intelligence (AI) analysis.

7. Research Ethic

Research ethics was conducted with informed consent and confidentiality. The research ethics permit approval letter was obtained from the Research Ethics Committee of the Semarang Ministry of Health Polytechnic. No. 0766/EA/KEPK/2022, on November 21, 2022.

RESULTS

Based on Table 1, characteristic data based on age with an average age of 27 years old, the minimum age of subject is 18 years old and the maximum age is 44 years old. Based on this study, characteristic data was obtained based on gestational age reviewed with 1st Trimester (0-12 weeks), 2nd Trimester (12-24 weeks) and 3rd Trimester (24-40 weeks) with an average gestational age of subject obtained, which was 17 weeks, where the minimum gestational age is 4 weeks and the maximum is 33 weeks. Based on the body mass index with an average body mass index of 22.79 kg/m^2, with a minimum value of 16.00 kg/m2 and a maximum of 39.00 kg/m^2.

Histogram (Figure 1) shows that the data is normally distributed or shows that there is no data that is not normally distributed. Based on Table 2, linear regression can be seen in the nutritional status class with an algorithm value of 1.00, while for the akg class it produces a value of 0. Figure 2 indicated that the greener the color, the more influence the calculation has on the person.

Table 1. Subject Characteristics

Characteristic	Mean	SD	Min.	Max.
Maternal Age (year)	27.11	5.46	18	44
Gestational Age (week)	16.82	11.02	4	33
Body Mass Index (kg/m²)	22.79	4.57	16.00	39.00

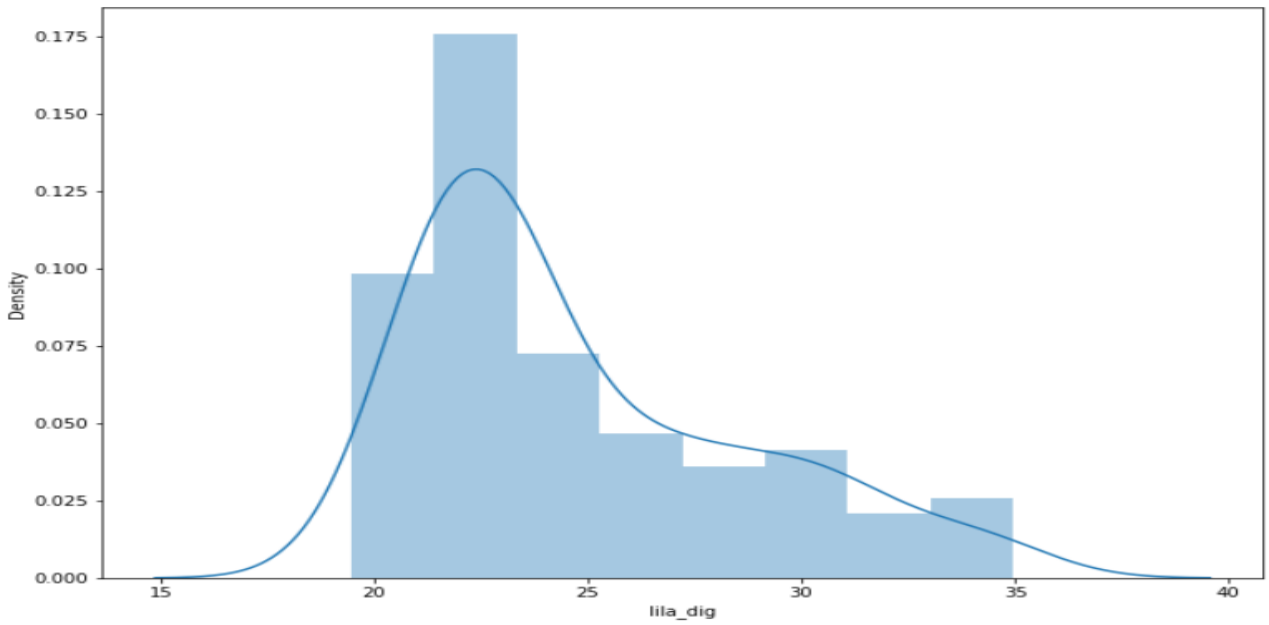

Figure 1. Digital MUAC Histogram Chart

Table 2. Linear regression analysis of Digital MUAC measurement results using artificial intelligence

Feature	LR	Lin Reg	Ridge	Lasso	RF	Mean
class_akg	0.00	0.00	0.00	0.00	0.00	0.00
class_ nutritional status	1.00	1.00	1.00	1.00	1.00	1.00

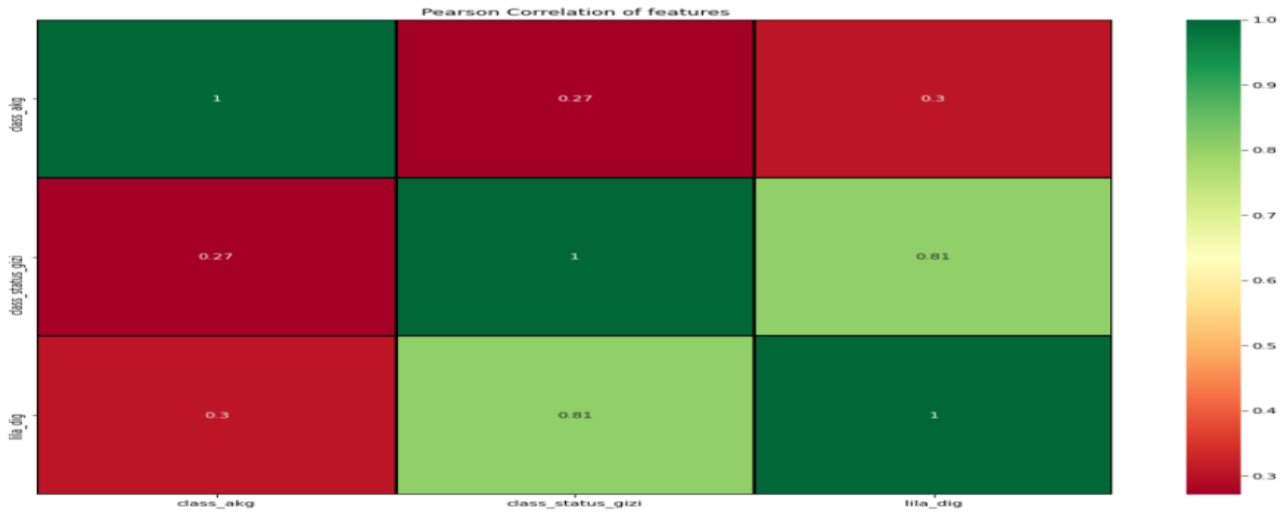

Figure 2. Pearson correlation of features digital MUAC

Table 3. Digital MUAC Classification Evaluation

Classification	Accuracy
Nearest Neighbors	98.00% ± 0.08
RBF SVM	73.00% ± 0.28
Decision Tree	100% ± 0.01
Random Forest	98.00% ± 0.13
Bagging	98.00% ± 0.12
Stacking	98.00% ± 0.08

In table 3, we can see the classification evaluation produced by the Nearest Neighbors algorithm, which is 98.00% with a deviation value of ±0.08, the RBF SVM algorithm is 73.00% with a deviation value of ±0.28, the Decision Tree algorithm is 100% with a deviation value of ±0.01, the Random Forest algorithm is 93.00% with a deviation value of ±0.1281, the Bagging algorithm is 98.00% with a deviation value of ±0.12 and for the Stacking algorithm is 98.00% with a deviation value of ±0.08.

Table 4 shows that the k-fold of the MUAC Digital decision tree has an accuracy level of 100% with a deviation value of ±0.01.

In table 5, the results of the classification evaluation using the confusion matrix on Digital MUAC can be seen, showing that the accuracy figure is 1.00 or 100%.

Table 4. Accuracy of K-Folding Decision Tree Digital MUAC

K-Fold Level	Accuracy
Fold #1	100%
Fold #2	100%
Fold #3	100%
Fold #4	100%
Fold #5	100%
Fold #6	100%
Fold #7	100%
Fold #8	100%
Fold #9	100%
Fold #10	100%
Accuracy from Decision Tree	100% ± 0.0000

Table 5. Table 4 shows that the k-fold of the Digital MUAC decision tree has an accuracy level of 100% with a deviation value of ±0.01.

Diagnosis	Precision	Recall	F1-Score	Support
0 : KEK	1.00	1.00	1.00	7
1 : Normal	1.00	1.00	1.00	3
	Accuracy		1.00	10

Table 6. Digital MUAC Recommendation Data

No	Digital MUAC	Actual recommendations	System recommendation
1	22.61	Mothers consume foods that contain nutritional intake >= 80% AKG per day	Mothers consume foods that contain nutritional intake >= 80% AKG per day
2	26.38	Consume nutritional intake according to the needs of pregnant women	Consume nutritional intake according to the needs of pregnant women

No	Digital MUAC	Actual recommendations	System recommendation
3	29.93	Consume nutritional intake according to the needs of pregnant women	Consume nutritional intake according to the needs of pregnant women
4	23.45	Mothers consume foods that contain nutritional intake >= 80% AKG per day	Mothers consume foods that contain nutritional intake >= 80% AKG per day
5	21.77	Mothers consume foods that contain nutritional intake >= 80% AKG per day	Mothers consume foods that contain nutritional intake >= 80% AKG per day
6	30.56	Consume nutritional intake according to the needs of pregnant women	Consume nutritional intake according to the needs of pregnant women
7	21.35	Mothers consume foods that contain nutritional intake >= 80% AKG per day	Mothers consume foods that contain nutritional intake >= 80% AKG per day
8	30.77	Consume nutritional intake according to the needs of pregnant women	Consume nutritional intake according to the needs of pregnant women
9	27.21	Consume nutritional intake according to the needs of pregnant women	Consume nutritional intake according to the needs of pregnant women
10	21.35	Mothers consume foods that contain nutritional intake >= 80% AKG per day	Mothers consume foods that contain nutritional intake >= 80% AKG per day

In Table 6, it is found that the MUAC Digital recommendation data is the result of the True Negative (TN) test, where in its interpretation it states that the system detects CED and MUAC indicates CED so that the actual recommendation result and the system are that the mother consumes food containing nutritional intake ≥ 80% AKG per day and the result is 5, then True Positive (TP) explains that the system detects normal and MUAC indicates normal so that the actual recommendation result and the system are that the consumption of nutritional intake according to the needs of pregnant women and the result is 5, then if a False Negative (FN) is found, it explains that the system detects CED and MUAC indicates normal so that the actual recommendation result is that the mother consumes food containing nutritional intake ≥80% AKG per day and the system recommendation is that the consumption of nutritional intake according to the needs of pregnant women and the result is 0, while in False Positive (FP) it states that the system detects normal and MUAC indicates CED so that the actual recommendation result is that the consumption of nutritional intake according to the needs of pregnant women and the system recommendation is that the mother consumes food containing nutritional intake ≥ 80% AKG per day and the result is 0.

In Table 7, it can be seen that measurements using Digital MUAC based on the calculation results with the confusion matrix obtained a result of 1.00 or 100% accurate.

Table 7. Matrix Confussion

		Digital MUAC	
		CED	**Normal**
Actual	**CED**	TN = 5	FP = 0
	Normal	FN = 0	TP = 5

Accuracy Calculation
Accuracy = (TP + TN) / (TP+FP+FN+TN) = 1.00 = 100%
Precision = (TP) / (TP+FP) = 1.00 = 100%
Recall = (TP) / (TP+FN) = 1.00 = 100%
F1 Score = 2* (Recall*Precission) / (Recall + Precission) = 1.00 = 100%

DISCUSSION

1. Subject Characteristics

Based on the results of the study of characteristic data based on age, the average age of the respondents is 27 years old which is in accordance with the age of a healthy pregnant woman. BKKBN stated that the ideal age for women to get pregnant is in the age range of 20-35 years old because it is a safe age to give birth and the fertility period is at its peak. Age also affects memory where memory of information can be received both directly and indirectly which will be easier to remember and understand, therefore, mothers will have sufficient knowledge, especially knowledge about the importance of carrying out antenatal care during pregnancy (BKKBN, 2016)

Meanwhile, for the results of the study of gestational age data, with an average gestational age of the subject obtained, namely 17 weeks. A healthy gestational age is a gestational age that is in accordance with the size of the TFU and a gestational age that is not past the month or postdate (Utami, 2019). Carudin (2018) states that pregnant women who come to check their pregnancy at health services are expected to always be healthy and able to identify abnormalities and complications so that pregnant women with complications get the right service (Carudin, 2018).

Subjects who experience malnutrition <18.5 kg/m^2 are 19%, and subjects who experience normal nutrition 18.5-24.9 kg/m^2 are 54%, subjects who experience excess nutrition 25-29.9 kg/m2 are 22% and subjects who experience obesity >30kg/m2 are 5%. It can be concluded that there are some pregnant women who experience malnutrition, overnutrition and obesity. Dewi (2021) reported that the Body Mass Index or BMI in pregnant women is the most influential factor in the weight gain of pregnant women. Mothers with a low pre-pregnancy BMI should experience more weight gain compared to mothers who have a normal or excess pre-pregnancy BMI because of the greater physiological needs to support during pregnancy (Dewi, 2021).

2. Level of Accuracy of CED Detection Tools

In this study, after pre-processing, the data set was divided into two parts, 90% of the data for training and 10% of the data for testing. The data obtained from pregnant women were then processed to obtain quality data by applying data cleaning using the standard Scaler, namely data whose attribute values will be emptied so that the data becomes more accurate.

Based on the MUAC Digital graphic image, the comparison between the height of one stem and another is not much different. Furthermore, the longtail looks short, which means that the data is normally

distributed. In the Linear Regression Analysis results, the Digital MUAC measurement results show that the nutritional class status data can identify CED in pregnant women with good accurate results, namely 100%. Furthermore, in the Pearson Correlation of Features Digital MUAC, here the correlation of Digital MUAC which produces class_akg and nutritional status with the incidence of CED in pregnant women is found to have a strong correlation, namely with a result of 1.00 or 100%.

According to Haryadi (2021), by utilizing several data on stroke patients that have been stored in the database using several attributes, namely age and blood sugar levels. So that by applying the 76 linear regression algorithm, a prediction can be made in identifying stroke disease based on the functional relationship of the attributes in the data.

In the results of the Digital MUAC classification evaluation using the Algorithm, the most normal is the one that is close to 100% (a result that is never wrong) with a deviation value of ±0.0000, here it can be seen that the decision tree algorithm produces an accuracy level of 100% with a deviation value of ±0.0000. With the results of the decision tree algorithm on Digital MUAC, it can be concluded that the level of accuracy of Digital MUAC is with accurate results.

In this study, recommendations from the results of CED detection and in pregnant women use Digital MUAC which utilizes artificial intelligence. To find out the results of the classification evaluation test produced by artificial intelligence, the cross validation method was used with a number of folds of 10 people using the Digital MUAC decision tree produced an accuracy level of 100% with a deviation value of ±0.0000, so it can be concluded that the level of accuracy of Digital MUAC is with accurate results.

According to Wiyanto (2021), who studied an Android-based expert system to predict postpartum hemorrhage events in pregnant women using a decision tree algorithm in managing the dataset, the results of the classification process were obtained, namely the descriptions became three from previously only two descriptions, namely PPH (postpartum hemorrhage) and no PPH to descriptions of PPH, no PPH and potential PPH, with testing obtaining accuracy results of 93.91%.

The results of the classification evaluation using the confusion matrix also show that the accuracy figure for Digital MUAC is 1.00 or 100%, which can be concluded that Digital MUAC in the diagnostic classification test produces accurate figures. Meanwhile, the recommendation results produced from the Digital MUAC measurement using the confusion matrix are obtained if the accuracy, precision, recall and F1 Score values are 100%, it can be interpreted that Digital MUAC is able to provide recommendations from the results of CED detection in pregnant women with very good accuracy. According to Wantoro (2020) in his study which also used the Matrix confusion algorithm to find out how good the drug recommendations are given to children with diarrhea with an accuracy value showing that 70% of the system can provide recommendations for administering drugs correctly.

The Digital MUAC used in this study is equipped with a website application and data storage in this case the cloud, which is very effective both in terms of shortening time both in terms of manual recording, data storage that has so far used physical files or documents and also efficient where with the advancement of technology in health it is expected to facilitate human performance and create 78 good health services. According to Wahyuni (2019) who stated that web-based applications can store

the results of MUAC measurements of a pregnant woman using cloud technology. Cloud technology is used for database reports per period of MUAC measurements of pregnant women, the results of cloud technology testing have been tested in the form of patient data testing, interpreta data and standard data, in addition, trials have been carried out on several browsers, namely Opera, Mozilla and Chrome browsers.

The CED detection tool, namely Digital MUAC, is a tool that is able to detect CED and provide recommendations from the results of CED detection in pregnant women that utilizes artificial intelligence by having accurate measurement results with an accuracy value of 100%. Pregnant women are expected to consume more good nutrition so that nutritional needs during pregnancy can be fulfilled. This research is expected to be used as additional literature and reference reading material in education. For health workers, especially midwives, it is hoped that they can continue to strive to reduce the incidence of CED in pregnant women and can improve faster and more precise health services with the help of health technology. According to Adhyanti (2022), who demonstrated the functionality and acceptance of the digital body circumference measuring device, it was successfully created with accurate results in measuring anthropometry. In addition, the tool made is a very practical, simple tool and can save time.

AUTHOR CONTRIBUTION

Nur Hilda Oktaviani, Melyana Nurul Widyawati, Kurnianingsih collaborated to create a conceptual framework and research methodology. Nur Hilda Oktaviani collected data and analyzed data assisted by a team of artificial intelligence (AI) experts. Melyana Nurul Widyawati and Kurnianingsih guided and provided input in this study.

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CONFLICT OF INTEREST

There was no conflict of interest in this study.

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