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Development and Feasibility Testing of Digital Uterine Fundal Height Measurement

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ABSTRACT

Background: Fundal height is an indicator for monitoring fetal well-being during pregnancy. It remains done manually, which has limitations such as human error, takes a long time, and is inefficient, requiring changes. This study aims to develop a tool for measuring uterine fundal height by utilizing an artificial intelligence-based rotary encoder sensor to determine gestational age and estimated fetal weight.
Subjects and Method: This was a Research and Development (R&D) conducted at the Adem Ayem Clinic from January to February 2023. Expert validation testing and small-scale product trials. A total of 10 pregnant women were selected in this study, they were divided into two groups: (1) Fundal height of 5 pregnant women was tested using a digital fundal height; and (2) Fundal height of 5 pregnant women were measured using a measuring tape. The dependent variables are uterine fundal height, gestational age, and estimated fetal weight. The independent variable is digital fundal height measurement. Fundal height differences between groups were analyzed using Mann Whitney test.
Results: Development of a digital tool for measuring uterine fundal height that provides feasible and valid results in measuring uterine fundal height and determining gestational age and estimating fetal weight.
Conclusion: Digital fundal height measurement is feasible and valid to measure uterine fundal height, determine gestational age, and estimate fetal weight.

Keywords: uterine fundal height, gestational age, estimated fetal weight, rotary encoder sensor, pregnant women.

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BACKGROUND

Pregnancy is a long-awaited moment for every woman. Pregnancy usually proceeds normally, passing through the birth canal so that the baby is born healthy and full term through the birth canal, but sometimes this does not go as desired. Various efforts to reduce maternal mortality include integrated pregnancy/ antenatal services for pregnant women routinely during pregnancy (Health

Department, 2022; Nuraisya, 2018).

The Maternal Mortality Rate (MMR) fell from 346/100,000 live births (KH) in 2010 down to 305 per 100,000 KH in 2015, but this is far from the National Medium Term Development Plan (RPJMN) target, namely 183/100,000 KH for in 2024, and from the SDGs target, namely 70/100,000 KH for 2030. Based on routine data from reporting coverage of antenatal visits in 2021 of 88.13% of the target of 85% (Ministry of Health of the Republic of Indonesia, 2021).

Antenatal care is a health service provided by health workers to pregnant women. Antenatal care aims to help pregnant women give birth safely and have healthy babies, as well as to detect and predict early pregnancy if there are abnormalities in the fetus (Rizki, 2020; Hety et al., 2021; Nuraisya, 2018).

Uterine Fundus Height is an indicator for monitoring fetal well-being during pregnancy. It can determine gestational age, and can detect high risks, such as detecting inhibited intrauterine growth, increases especially such as twin pregnancies or hydramnios (Sari, 2018; Morse et al., 2009). There are several formulas used to estimate gestational age and estimated fetal weight. The McDonald's formula predicts gestational age based on the height of the uterine fundus. The Johnson formula is a variation of the Mc Donald formula to estimate the estimated fetal weight based on measurements of the distance between the symphysis and fundus (Wijayanti, 2016).

Gestational age is important for the survival and quality of life of the fetus. Estimated gestational age influences care for the mother and baby, knowing the causes and risk factors and evaluating actions for abnormal pregnancies. Determining gestational age uses a simple method, namely by knowing the First Day of Last Menstruation (LMP) and using the formula by Naegle. There are other methods to determine gestational age, such as palpation of the abdomen, the first movement of the fetus, measurement of the height of the uterine fundus, and ultrasonography (USG) (Utami et al., 2019; Nadeem et al., 2022).

Estimation of fetal weight (EFW) during pregnancy is a useful method for preventing morbidity and mortality during the delivery process. Birth weight will determine the certainty and outcome of the birth process (Regitasari et al., 2020). These estimates can create an evidence-based track record/ analysis to help medical practitioners detect potential signs of LBW during pregnancy and provide appropriate interventions (Anggraini et al., 2020)

The measurement of the height of the existing uterine fundus is using a measuring tape. Measuring tapes are available on the market but this measuring tool does not have a sensor. Usually, the measurements of uterine fundal height, calculation of gestational age and estimated fetal weight are done manually (Regitasari et al., 2020). The digital technology of future health services, whether related to big data, artificial intelligence, and machine learning, will change drastically in the digital 4.0 era. This sensor-based tool for measuring uterine fundal height is one of the pillars of health transformation, namely the transformation of health technology (Ministry of Health of the Republic of Indonesia, 2021). The rotary encoder sensor is a sensor for determining distance. In another research, namely the design and manufacture of an Arduino-based digital distance measuring instrument is also used a rotary encoder sensor. The results of this research showed that the average percentage difference between manual measuring instruments reached 0.26% with the measurement method determined in this research. Based on these results, it means that this distance measuring tool is considered good (Wahyudi, 2017).

The development of technology is currently very rapid, including artificial intelligence systems which are currently widely used in the health sector so that they can produce faster and more accurate data or decisions (Amrizal and Aini, 2013).

Based on the identification of the problems above, researchers develop a tool to measure Uterine Fundal Height, namely a tool with complete output or results, which is the measurement of uterine fundus height, gestational age and estimated fetal weight. Researchers use the rotary encoder sensor as a sensor for determining uterine fundal height, an artificial intelligence-based tool for measuring uterine fundal height to determine gestational age and estimated fetal weight.

SUBJECTS AND METHOD

1. Study Design

This was ased Research and Development carried out at Adem Ayem Clinic, Sukoharjo, Central Java, January - February 2023.

2. Population and Sample

The target population was third trimester of pregnant women. A sample of 5 pregnant women was selected purposively.

3. Study Variables

The dependent variables were uterine fundal height, gestational age, estimated fetal weight. The independent variable was a digital uterine fundal height measurement.

4. Definition of Operational Variable

Uterine fundus height measuring instrument is a measuring instrument specially designed using a rotary encoder sensor to measure the height of the uterine fundus and an Arduino nano for data programming to determine gestational age and estimated fetal weight.

Fundal height is a measurement carried out in the second and third trimesters of pregnancy, by measuring the mother's stomach from the symphysis pubis to the fundus.

Gestational age is the age at which the fetus grows in the womb.

Fetal weight estimation was a way to estimate the weight of the fetus while it is still in the womb during pregnancy.

5. Study Instrument

Stage of tool development and data set creation. After that, the research instruments used for small-scale product trials were a digital uterine fundus height measuring instrument design tool, measuring tape, respondent sheet and observation sheet.

6. Data Analysis

Data analysis to determine the percentage of accuracy and error between manual and digital tools using SPSS version 20 software. The average difference between the experimental and control groups was tested using the Mann Whitney test.

7. Research Ethic

Research ethical issues including informed consent, anonymity, and confidentiality, were handled carefully throughout the research process. A letter of approval for research ethics permission was obtained from the Research Ethics Committee of the Health Polytechnic of the Ministry of Health, Semarang, Indonesia, No. No. 096/EA/KEPK/2023.

RESULTS

Figure 1 shows the Zefura uterine fundal height measuring instrument which is designed to measure uterine fundal height using a rotary encoder sensor, and there is an artificial intelligence program to determine gestational age and estimated fetal weight. This tool uses portable WiFi so it must be connected to the device user's WiFi. The following is a display of the tool for measuring uterine fundal height.

Figure 1. Zefura uterine fundal height measuring instrument

Figure 2 shows the menus on the Zefura uterine fundus height measuring instrument. The reset button is used to reset the device before use. The send data button is used to send measurement results data into the data base, making it easier for users to save measurement results data, not recorded manually. The set age button is a button to enter the gestational age according to the HPHT, its function is to compare the gestational age from the TFU measurement results on the measuring instrument with the gestational age according to the HPHT. Next, for the head position button, enter whether the head has entered the pelvis or not, for information on the head position 12, namely not yet in the pelvis, and 11 for the head position has entered the pelvis. And finally, the Lila Results button is the button to enter whether the Lila results are normal or KEK.

Figure 3 shows the power button consisting of an ON button to turn on the tool for use and an OFF button to turn off the tool after the tool is used.

Figure 4 shows a light blue circle which is a circle connected to a rotary encoder sensor which functions to measure the height of the uterine fundus which is used by running a circle from the symphysis to the height of the uterine fundus.

Figure 2. Zefura uterine fundal height measurement tool button/menu

Figure 3. Power On/Off

Figure 4. Rotary Encoder connected circle

Figure 5 shows a USB hole consisting of 2 USB holes which are used to add power to the device, and one to connect the device to a laptop/PC.

Figure 5. USB hole

Figure 6 shows the first LCD display that appears is connecting to WIFI, before using the tool first to connect to the user's WIFI, after connecting to WIFI, there is a display of the Uterine Fundus Height Measuring Tool, after that the following display will appear, namely:

1. Code L is the code for Lila's results, whether normal or chronic energy deficiency (CED).
2. Code N is the code for the head position, number 12 for the head position not yet in the pelvis, number 11 for the head position already in the pelvis

3. Code U is gestational age according to First day of last menstruation (HPHT).
4. Code H is whether the TFU result is normal compared to the gestational age according to HPHT
5. The TFU code is the result of measuring the height of the uterine fundus in cm
6. The estimated infant's weight (TBJ) code is an estimate of fetal weight obtained from the calculation of uterine fundus height, TBJ in grams.
7. The gestational age code is the gestational age obtained from the results of calculating the height of the uterine fundus, gestational age in weeks.
8. Code P is the code for whether or not there is an influence of mid-upper arm circumference (MUAC) on the results of measuring Uterine Fundal Height.

Figure 6 . LCD Display after Measurement

Figure 7 shows the measurement results that can be stored in the data base by pressing the send data button, the data is directly stored in the data base.

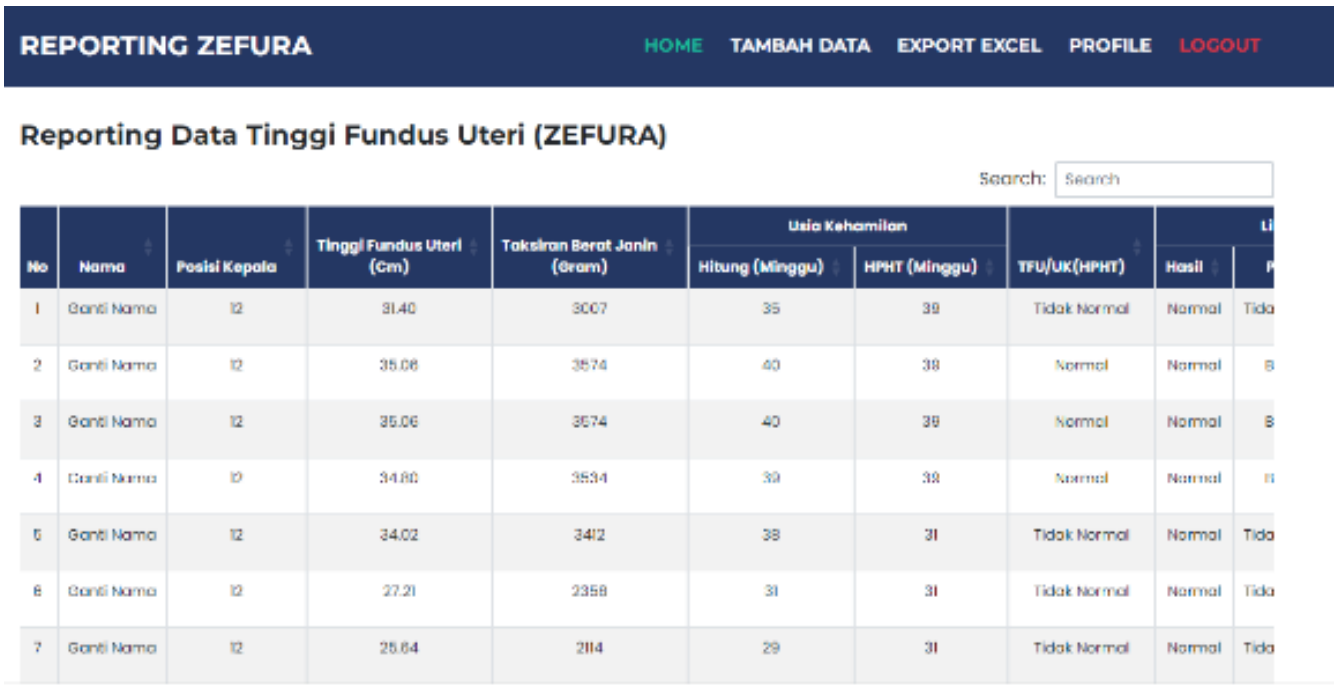

Figure 7. Uterine fundal height data base

The next stage, the researchers carried out an expert validation test to test the suitability of the "Zefura" uterine fundus height measurement tool which was created before being used for examinations of pregnant women. The finished measuring instrument is then validated through expert judgment by 3 experts. Application testing was carried out by obstetricians, namely Obstetrics and Gynecology Specialists, electrical engineering experts and midwifery practitioners. The validation test results for this tool were carried out by 4 validators using validation instruments.

Table 1 shows that expert 1 has a percentage of results of 86.61% with a very feasible conclusion, expert 2 has a percentage of results of 88.33% with a very feasible conclusion, expert 3 has a percentage of results of 91.27% with a very feasible conclusion and expert 4 has a percentage of results of 92.62% with a very feasible conclusion. These results mean that the uterine fundus height measuring instrument is very suitable for use to measure uterine fundal height and determine gestational age and estimated fetal weight.

Table 1. Expert Validation Test Results

Validator	Percentage (%)	Conclusion
Expert 1	86.61	Very feasible
Expert 2	88.33	Very feasible
Expert 3	91.27	Very feasible
Expert 4	92.62	Very feasible

Based on Table 2, it can be seen that the fundal height tool was tested on 5 pregnant women outside the study sample to find out whether the tool could be used according to the study objectives.

Table 2. Results of using a uterine fundus height measuring instrument

Uterine Fundal Height	Gestational Age	Gestational Age	Estimated Fetal Weight
31.40	35	35	3007
27.21	31	31	2358
27.21	31	31	2358
26.95	30	30	2317
31.40	35	35	3007

Table 3 shows that the uterine fundal height measuring instrument has no significant difference in uterine fundus height in the control and intervention groups by looking at the p-value >0.05, namely 0.341, which means that the digital fundal height measuring instrument can be used and produces the same results as the manual measuring instrument (measuring tape). This shows that manual tools and designed measuring tools have almost the same results so they can be used to measure uerine fundal height.

Table 3. Results of the Mann-Whitney test on the development of the uterine fundal height device in pregnant women

Group	Mean	SD	p
Intervention	28.83	2.34	0.341
Control	28.40	2.41	

DISCUSSION

1. Tool Feasibility Test

The validation test results for this tool were carried out by 4 validators using expert validation instruments. The average value of the four validators was 89.71% in the valid and high categories. This shows that this tool is suitable for use to measure uterine fundal height, gestational age and estimated fetal weight. It is appropriate to mean that all aspects of the components of the tool have been considered and adapted to the goals and benefits of the tool being designed.

The quality of feasibility measurements

from obstetricians, specialist obstetricians and gynecologists, electrical engineering experts and two midwife practitioners were assessed from 2 aspects, namely from the design validation instruments and also the materials. The design assessment aspects are the general appearance of the tool, the specific appearance of the tool and the presentation of the media. Meanwhile, the aspects of material assessment are the relevance of the tool to the material, the accuracy of the tool, the completeness of the tool, the basic concept of the material to the tool and the suitability of the tool to needs.

2. Product trials on a small scale

Measurement Results Using a Digital Uterine Fundus Height Measuring Instrument Utilizing a Rotary Encoder Sensor. This study tested the design of a measuring instrument, namely the "Zefura" Uterine Fundus Height Measuring Instrument which is used to measure the height of the uterine fundus using a sensor. The average test result of the tool is no more than 5%, which means that the calibration value of the sensitivity of the sensor used on the tool is valid to use.

This study, which compared with manual measuring instruments, had no significant differences in the control group using a manual tape measure and the intervention using a digital fundus height measuring instrument, so this tool can be used in accordance with the tools that are frequently used so far. The advantage of this tool is that this difference can be seen from the results of the design of the uterine fundus height measuring tool which produces two digits after the comma while the manual tool produces one digit after the comma.

This study is in line with research that designed a digital distance measuring instrument based on Arduino nano using a rotary encoder sensor to measure a certain distance. From the measurement results, it is stated that the average percentage difference with the manual measuring instrument reached 0.25614, this result means that this distance measuring instrument is classified as good (Wahyudi, 2015).

Research on designing a digital distance measuring tool using an Arduino nano-based wheel utilizing a rotary encoder sensor, to make measurements easier, no need for repeated measurements because the tool has good accuracy, an easy-to-use design and can efficiently measure large-scale terrain. From the results measuring all distances tested 10 times at the same distance obtained an average result that corresponds to an error percentage of 0.12% (Kurniati, Rezki, 2019).

Apart from that, there is also research on designing a tool to measure the length of an object to overcome problems experienced by users who have difficulty in reading the measuring points on manual measuring tools. This tool uses an Arduino Nano as the main control which works when given instructions by a programmer via the Arduino IDE editor. The Rotary encoder sensor is a tool for measuring the length of objects that can determine the centimeters of the object to be measured, and LCD as a display screen (Zuhri, 2021).

The results of this study carried out and linked to previous research showed that this uterine fundal height measuring instrument can be used to measure uterine fundal height in pregnant women with an average measurement error percentage of 1.52%, not more than 5% and a percentage accuracy value of (accuracy) 98.48% so this tool is accurate to use. Testing of tools that use sensors with an average test result of the tool that is no more than 5%, which means that the calibration value of the sensitivity of the sensor used on the tool is valid for use.

AUTHOR CONTRIBUTION

Mar'atu Mutiah is the main researcher who selected the research topic, collected data, developed tools, analyzed and reported the data. Diyah Fatmasari reviewed and assisted in the analysis of the results and the manuscript as a whole. Sri Sumarni assisted in literature review, analysis, and interpreted the results.

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CONFLICT OF INTEREST

There was no conflict of interest in this study.

REFERENCE

Amrizal V, Aini Q (2013). Naskah kecerdasan buatan, kecerdasan buatan (Artificial intelligence script, artificial intelligence). Retrieved from: https://repository.uinjkt.ac.id/dspace/bitstream/123456789/44538/2/naskah kecerdasan buatan.pdf.

Anggraini D, Abdollahian M, Marion K (2020). The development of an alternative growth chart for estimated fetal weight in the absence of ultrasound: Application in Indonesia. PLoS One. 15(10 October): 1–24. Retrieved from: https://doi.org/10.1371/journal.pone.0240436.

Hety DS, Anggreni D, Susanti IY (2021). Upaya peningkatan status kesehatan pada ibu hamil melalui ANC terpadu di masa new normal di Puskesmas Mojosari Kecamatan Mojosari Kabupaten Mojokerto (Efforts to improve the health status of pregnant women through integrated ANC in the new normal period at the Mojosari Community Health Center, Mojosari District, Mojokerto Regency). J Pengabdi Masy Al-rsyad. 3(1):112–121. Retrieved from: https://doi.org/https://doi.org/10.36760/jpma.v3i1.263.

Kementerian Kesehatan RI (2021). Profil Kesehatan Indonesia (Indonesian Health Profile). Retrieved from: https://www.globalhep.org/sites/default/files/content/resource/files/2022-11/Profil-Kesehatan-2021.pdf.

Kurniati, Rezki J (2019). Seminar Nasional Industri dan Teknologi (SNIT), Politeknik Negeri Bengkalis (National Seminar on Industry and Technology (SNIT), Bengkalis State Polytechnic). Peranc Apl Antrian Pasien Di Rumah Sakit Menggunakan Metod Fast, (Lcm): 270–276. http://eprosiding.snit-polbeng.org/index.php/snit/article/view/58/56.

Morse K, Williams A, Gardosi J (2009). Fetal growth screening by fundal height measurement', Best Pract and Res: Clin Obstet and Gynaecol. 23(6): 809–818. Retrieved from: https://doi.org/10.1016/j.bpobgyn.2009.09.004.

Nadeem SF, Babar TH, Khan AA, Asim MU, Malik MJ, Ahmad MI (2022). Role of Sonographic Measurement of Fetal Foot Length in Estimating Gestational Age: A Hospital Based Study in South Punjab. Pakistan Armed Forces Med J. 72(3):826–30. Retrieved from: https://doi.org/10.51253/pafmj.v72i3.6887

Regitasari N, Ridha MM, Dian ES (2020). Calculation of fetal weight estimation displayed with TFT LCD. J Electron Electromed Eng Med Informatics

2(1):19–22. Retrieved from: https://-doi.org/10.35882/jeeemi.v2i1.4.

Nuraisya W (2018). Deteksi risiko tinggi kehamilan pada pelayanan ANC terpadu di Puskesmas Bendo Kabupaten Kediri (Detection of high risk pregnancy in integrated ANC services at the Bendo Community Health Center, Kediri Regency). J Kesehat Andalas. 7(2):240. Retrieved from: https://-doi.org/10.25077/jka.v7.i2.p240-245-.2018.

Rizki F (2020). Hasil perhitungan formula sederhana dalam menghitung taksiran berat badan janin (The results of simple formula calculations in calculating the estimated fetal weight). J Kesehat STIKes Muhammadiyah Ciamis. (1):-56–63. Retrieved from: https://doi.-org/10.52221/jurkes.v6i1.60.

Sari DP (2018). Perhitungan usia kehamilan berdasarkan pengukuran tinggi fundus uteri dengan hari pertama haid terakhir di BPS Farida Yuliani Desa Gayaman Kecamatan Mojoanyar Kabupaten Mojokerto (Calculation of gestational age based on measuring the height of the uterine fundus on the first day of the last menstruation at BPS Farida Yuliani, Gayaman Village, Mojoanyar District, Mojokerto Regency). Biomedika. 11(2): 113–117. https:-//doi.org/10.31001/biomedika.v11i2-.402.

Utami FP, Wirakusumah F, Wijayanegara H, Rasyad AS, Soepardan S, Sutisna M (2019). Uji kesesuaian alat digitalisasi TFU, pita ukur dan HPHT Dalam menentukan usia kehamilan pada ibu hamil trimester dua dan trimester tiga tinggi fundus uteri (Suitability test of TFU digitalization tools, measuring tape and HPHT in determining gestational age in second trimester and third trimester pregnant women uterine fundus height). Med Respati J Ilm Kesehat. 14(4):347. https://doi.org/-10.35842/mr.v14i4.247.

Wahyudi AE (2015). Perancangan dan pembuatan alat ukur jarak digital berbasis arduino menggunakan sensor rotary encoder (Design and manufacture of an Arduino-based digital distance measuring instrument using a rotary encoder sensor). Universitas Muhammadiyah Surakarta. Retrieved from: http://eprints.ums.ac.id/36222/1-/naskahpublikasi.pdf.

Wahyudi AE (2017). Perancangan dan pembuatan alat ukur jarak digital berbasis arduino menggunakan sensor rotary encoder (Design and manufacture of an Arduino-based digital distance measuring instrument using a rotary encoder sensor). Forman J of Economic Studies. 13(Icmi): 83–103. Retrieved from: https://www.semanticscholar.org/paper/Perancangan-dan-Pembuatan-Alat-Ukur-Jarak-Digital-Wahyudi/92930d6898887c2d5d2388e82c173bc79b6e82b9.

Wijayanti Y (2016). Perbedaan akurasi antara rumus risanto dan rumus johnson dalam mengestimasi berat bayi berdasarkan tinggi fundus uteri (The difference in accuracy between the Risanto formula and the Johnson formula in estimating baby weight based on uterine fundal height). J Ilmu Kesehatan. 5(10). Retrieved from: https://doi.-org/10.35952/jik.v5i10.36.

Zuhri (2021). Rancang bangun alat ukur digital dalam menentukan panjang benda berbasis rotary encoder (Design of a digital measuring tool to determine the length of objects based on a rotary encoder). Retrieved from: https:-//repository.unipasby.ac.id/id/eprint/335/.