KEMAS 19 (1) (2023) 102-112

Jurnal Kesehatan Masyarakat

http://journal.unnes.ac.id/nju/index.php/kemas

Angraini Model as Effort to Early Detection of Chronic Energy Deficiency in Pregnancy

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Article Info

Article History:
Submitted January 2023
Accepted April 2023
Published July 2023

Keywords:
Angraini model, early detection, CED, pregnant woman

DOI
https://doi.org/10.15294/kemas.v19i1.42212

Abstract

The prevalence of chronic energy deficiency in pregnant women in Indonesia is still high. This condition is one of the unresolved nutritional problems such as stunting. This study aims to develop the Angraini Model, as an effort to early detection of chronic energy deficiency in pregnancy. This research is a quantitative study with a case-control design on 190 CED and non-CED pregnant women in the city of Bandar Lampung. The research took time from October 2018 to July 2021. The data used in this study are 18 indicators and 7 latent variables. Latent variables consist of socioeconomic (education, employment, income, knowledge), culture (age, parity, food taboo), BMI (prepregnancy BMI), laboratory (anemia, iron status, protein status), food intake (energy, protein, fat carbohydrates, iron), weight gain during pregnancy (pregnancy weight gain), and CED (chronic energy deficiency). Data were analyzed using a structural equation model (SEM) with Lisrel software and then built into a web-based expert system. The results of the SEM analysis stated that food intake, laboratory values, and weight gain during pregnancy directly affect the incidence of CED. socioeconomic variables (knowledge, education, employment, and income), culture (age, parity, and food taboo), and prepregnancy BMI indirectly affect the incidence of CED through food intake variables. The model obtained based on SEM analysis is then built in a web-based expert system with the address modelangraini.com. The Angraini model is a web-based expert system that can be used to detect early CED in pregnant women for health workers in primary healthcare facilities.

Introduction

Chronic energy deficiency (CED) is a steady-state at which a person is in energy balance, although at a "cost" either in terms of health risk or as an impairment of functions and health. Chronic energy deficiency can also be defined based on body mass index (BMI) as <18.5 kg/m2 (Dagne, 2021). The prevalence of chronic energy deficiency (CED) in pregnant women in Africa is 23,5% (Desyibelew and Dadi, 2019), in pregnant and lactating women in Rayitu District, Ethiopia is 24% (Gebre et al., 2018), in women of childbearing age (> 18 years) in the city of Midnapore, West Bengal, India by 46,8% (Bose et al., 2007), and in postpartum women (< 1-year giving birth) in the slums of Amritsar city, Punjab, India by 21, 4% (Devgun, Mahajan and Gill, 2014).

The 2018 Indonesia Basic Health Research show that in Indonesia, the prevalence of CED in pregnant women is 17,3%, while in non-pregnant women is 14,5%. The prevalence of CED in pregnant and non-pregnant women in Lampung province is 13,6% and 12,8%. The prevalence of CED in pregnant women in the city of Bandar Lampung is 17,3% greater than the prevalence of CED in Lampung province and several big cities on the island of Sumatra

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pISSN 1858-1196
eISSN 2355-3596

such as Palembang city (15,7%), Pekanbaru city (13,5%), Padang city (14,7%), the city of Medan (9,1%), the city of Jambi (9,03%), and the city of Banda Aceh (12,83%) (Kemenkes RI, 2018).

Pregnant women with CED will be at risk of giving birth to LBW babies, which, if not handled properly, will be at risk of experiencing stunting (Maulina, Alma and Nurrochmah, 2021). Stunting is a condition in which toddlers have less length or height compared to age and is a chronic nutritional problem (WHO, 2019). Stunting will have short and long-term impacts, including disrupting brain development, intelligence, impaired physical growth, and metabolic disorders in the body as well as increasing the risk of developing degenerative diseases, thereby reducing the quality of the nation's next generation (Prendergast and Humphrey, 2014). Specific nutrition intervention efforts for short toddlers are focused on the 1.000 First Days of Life group, namely Pregnant Women, Breastfeeding Mothers, and Children 0-23 months, because the most effective prevention of short toddlers is carried out on 1,000 HPK (Kemenkes RI, 2018).

The factors determining the CED status of a woman of childbearing age, whether pregnant or not, consist of direct, indirect, basic, and main issues. Direct factors include food intake and illness (infectious diseases, anemia, protein deficiency). Indirect factors include food availability, environment (family, environmental hygiene, culture), history of disease/health, health services, obstetrical status/parity, education, and mother's knowledge (UNICEF, 2015). Programs to address CED in Indonesia are currently in the form of managing pregnant women who have experienced CED by administering recovery food supplementation and administering iron tablets to treat anemia. Existing programs are aimed at overcoming CED problems that have already occurred. There are no programs or activities aimed at early detection of CED from upstream so that pregnant women with CED can be prevented. Reducing CED in women of childbearing age, especially pregnant women, is the key to improving the health of pregnant women and children.

Management of pregnant women with CED must start before they become pregnant (future bride), even from the age of teenage girls. These countermeasures require cross-program coordination through reproductive health education activities for adolescent girls through the School Health Program and Adolescent Caring Health Services, future bride counseling, integrated antenatal care (Integrated Antenatal Services) and need cross-sectoral, organizational support, professionals, community leaders, NGOs, and other institutions (Kemenkes RI, 2018).

Efforts for early detection of future bride women or expectant pregnant women require a model for predicting the risk of CED in pregnant women. This prediction model is built from factors that cause CED, both directly and indirectly, such as food intake (energy, protein, carbohydrates, fat, iron), disease (anemia, iron status, protein status), weight gain during pregnancy, prepregnancy BMI, education, knowledge, family income, work, and abs tinence culture, which are then applied to the expert system. The expert system application for early detection of CED in pregnant women is called the ANGRAINI model, which can be used easily and helps doctors, nutritionists, or midwives in predicting CED in pregnant women in primary health care.

Methods

This study is quantitative with a case-control design. This study aims to develop a CED prediction model for pregnant women in Bandar Lampung City and apply it to a web-based expert system. This study was done from October 2018 to July 2021, located in Bandar Lampung City. The sample size was 95 pregnant women with CED and 95 pregnant women non-CED and counted using matched pairs case-control formula. The samples were taken using Multistage Random Sampling.

The inclusion criteria for the case group include mid-upper arm circumference <23.5 cm and being willing to take part in the study, while the inclusion criteria for the control group include mid-upper arm circumference > 23.5 cm and being willing to participate. The exclusion criteria include pregnant women who have a history of malignancy, suffer or have a history of diabetes mellitus, and suffer or have a history of chronic infectious diseases.

This research consists of 18 indicators and 7 latent variables. Latent variables consist of socioeconomic (education, employment, income, knowledge), culture (age, parity, food taboo), BMI (prepregnancy BMI), laboratory (anemia, iron status, protein status), food intake (energy, protein, fat carbohydrates, iron), weight gain during pregnancy (pregnancy weight gain) and CED (chronic energy deficiency). Data on education, employment, income, age, parity, and weight gain in pregnancy by interviews. Data on knowledge and food taboo were obtained by completing a validated questionnaire accompanied by an enumerator. Body Mass Index data is obtained by measuring body weight and height. Anemia data was obtained by examining hemoglobin using the cyanmeth-haemoglobin method and reading it with a spectrophotometer. Data on iron status were obtained by examining serum ferritin using the ELISA method. Data on protein status were obtained by examining serum albumin using the bromine cresol green method. Chronic energy deficiency data is obtained by measuring the circumference of the mid-upper arm.

Development of a CED prediction model for pregnant women through SEM (structural equation modeling) analysis with Lisrel software, which is then applied in a web-based expert system. Development of a prediction model for CED in pregnant women on a web-based expert system according to the specifications with the help of IT experts called the Angraini Model. The Angraini model was developed to be accessible online via the modelangraini.com address. The Angraini model developed was validated by three experts, namely an IT expert (technology and informatics) as a media expert, an educational media expert (professor in the field of education) as an expert in media products, and a professor in the field of nutrition as a material expert. Furthermore, the model was tested on 33 pregnant women who were carried out in 5 health centers in the city of Bandar Lampung (Kedaton, Satelit, Gedong Air, Campang Raya, and Panjang Health Centers).

Results and Discussion

The predictive model development for chronic energy deficiency (CED) in pregnant women is based on structural equation modeling (SEM) analysis. Structural equation modeling analysis was built from 18 indicators and 7 latent variables. Latent variables consist of socioeconomic, culture, BMI, laboratory, food intake, weight gain during pregnancy, and CED (chronic energy deficiency). Socioeconomic latent variables are constructed from 4 indicators, namely SOS1 (Education), SOS2 (work), SOS3 (income), and SOS4 (knowledge). The cultural latent variable is constructed from 3 indicators, namely BUD1 (age), BUD2 (parity), and BUD3 (food taboo). The latent BMI variable was constructed from 1 indicator, namely BMI1 (BMI before pregnancy). The latent variable of food intake is constructed from 5 indicators, namely E1 (energy intake), E2 (carbohydrate intake), E3 (protein intake), E4 (fat intake), and E5 (iron intake). Laboratory latent variables were constructed from 3 indicators, namely LAB1 (anemia), LAB2 (protein status), and LAB3 (iron status). The latent variable for weight gain during pregnancy is constructed from 1 indicator, namely BB1 (weight gain during pregnancy). The latent variable of CED (chronic energy deficiency) is built from 1 indicator, namely KEK1 (incidence of CED). In the SEM analysis, CED is directly constructed from the latent variables of food intake and lab. Socioeconomic and cultural latent variables contribute to CED variables indirectly, namely through the latent variable of food intake. The results of the SEM analysis are presented in Figure 1.

The SEM analysis shows the value of chi-square = 166,46; df=98, p value=0,055, RMSEA=0,0432. The requirements for good SEM data are that they must pass CFA (confirmatory factor analysis) and the goodness of fit model. A good confirmatory factor analysis (CFA) can be seen from a comparison of the chi-square value with df, the p-value, and the RMSEA value. Based on the results obtained in the model above, only the comparison of the chi-square value with the degree of freedom (df), the p-value, and the RMSEA value fulfills the requirements. The results of the SEM analysis also show that several indicators have a loading factor above 0,5, which means they are quite good at measuring the latent factor. Among them, there is an indicator of body weight against body weight latent factor; indicators of energy, carbohydrates, fats, proteins, and iron on food intake latent factors, as well as CED indicators on the latent factor of Chronic Energy Deficiency. Meanwhile, even though the other indicators have a loading factor of less than 0,5, these indicators still correlate with the latent factor.

The value of the goodness of fit model shows that the value of the goodness of fit index (GFI) is 0,963; the root mean square error of approximation (RMSEA) value of 0,0432; comparative fit index (CFI) value of 1,000; the adjusted goodness of fit index (AGFI) value was 0,948 and the normed fit index (NFI) value was 1,000. If one or two of the fit criteria for the model have been met, the model has been declared fit. From the various fit indicator, the proposed measurement model is fit because all indicators of Goodness of Fit are met.

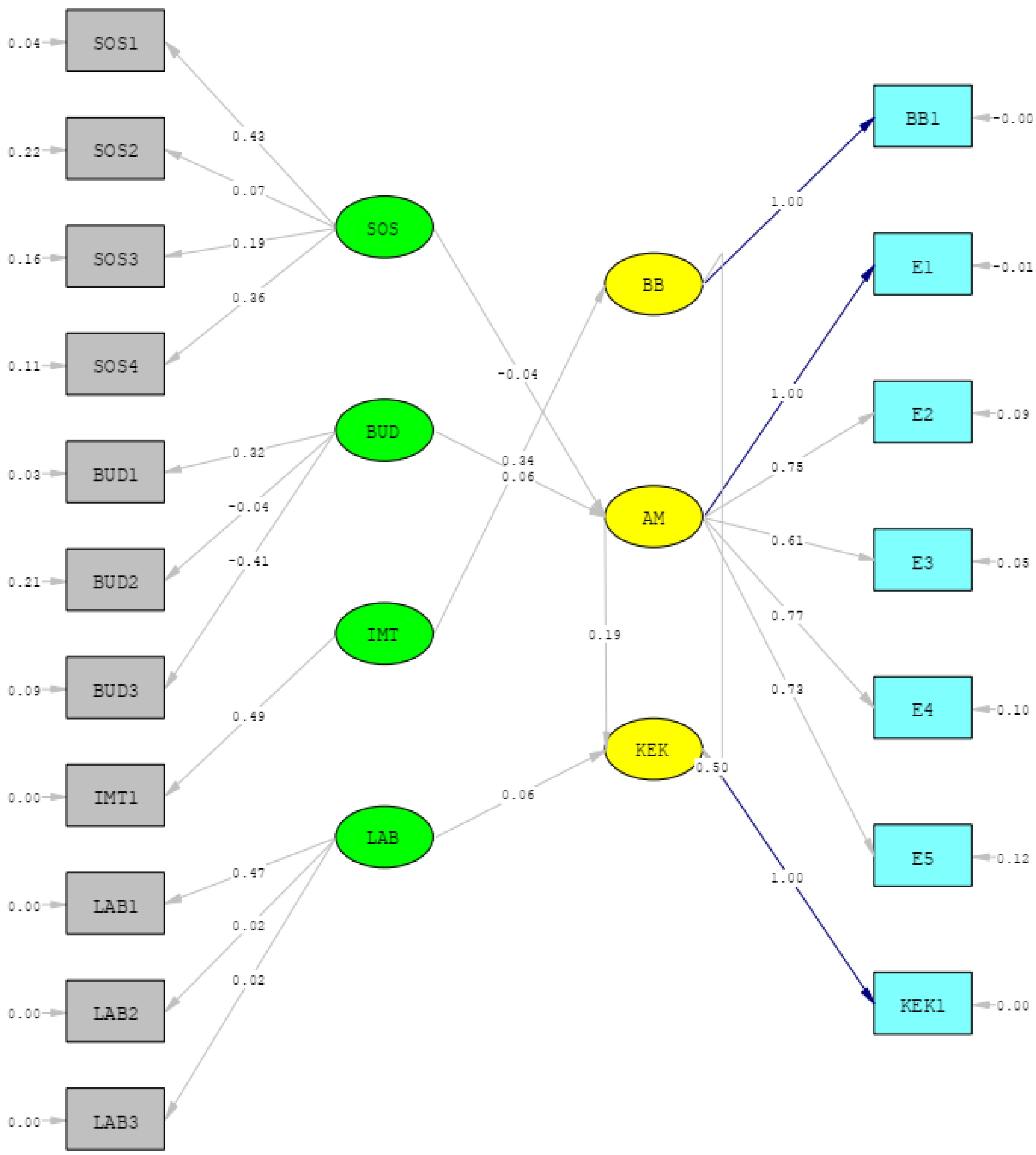

Figure 1. SEM Analysis Model for Predicting Chronic Energy Deficiency in Pregnant Women

The results of the SEM analysis stated that food intake, laboratory values, and weight gain during pregnancy directly affect the incidence of CED. Food intake, laboratory values, and weight gain during pregnancy have a positive relationship with the incidence of CED. Low food intake (energy, protein, carbohydrates, fat, and iron) will cause CED (b=0,19), low laboratory values (anemia, low protein status, and low iron status) will cause CED events (b= 0,06), and less weight gain during pregnancy will lead to CED (b = 0,5).

Food intake is measured based on indicators of food intake (energy, protein, carbohydrates, fat, and iron), socioeconomic (knowledge, education, employment, and income), and culture (age, parity, and food taboo). Thus, the socioeconomic variables (knowledge, education, employment, and income) and culture (age, parity, and food taboo) indirectly affect the incidence of CED through the variable food intake. Laboratory variables were measured based on indicators of hemoglobin values (anemia), serum albumin (protein status), and serum ferritin (iron status). The variable of weight gain during pregnancy is measured based on the variables of weight gain during pregnancy and BMI before pregnancy, so the variable of BMI before pregnancy has an indirect effect on the incidence of CED through the variable of weight gain during pregnancy.

Intake of energy, protein, fat, carbohydrates, iron, and cultural variables had a positive effect on food intake (b=1,00; b=0,75; b=0,6; b=0,77; b=0,73; b = 0,06), while socioeconomic variables have a negative effect (b = -0,04). Low intake of energy, protein, fat, carbohydrates, and iron, as well as cultural factors (age at risk, low parity, and food taboo), cause CED. Low socioeconomic factors (lack of knowledge, basic education, work, and income less than regional minimum wage) do not cause KEK. Education, occupation, income, and knowledge positively affect socioeconomic variables (b=0,43; b=0,07; b=0,19; b=0,36). Age positively affects cultural variables (b=0,32), while parity and food taboo have a negative effect; b=-0,04; b=-0,41). The results of the SEM analysis of the factors that contribute to the prediction of CED in pregnant women are presented in Table 1.

The prediction model for chronic energy deficiency (CED) in pregnant women based on SEM analysis is: CED = 0,19 {1,00 inadequate energy intake + 0,75 inadequate carbohydrate intake + 0,61 inadequate protein intake + 0,77 inadequate fat intake + 0,73 inadequate iron intake) – 0,04 (0,43 basic education + 0,07 work + 0,36 poor of knowledge + 0,19 income less than regional minimum wage)) + 0,06 (0,32 risky age – 0,04 low parity – 0,41 food taboo)} + 0,06 {0,47 anemia + 0,02 low protein status + 0,02 low iron status} + 0,5 {1,00 low of weight gain + 0,34 low of BMI before pregnancy}.

Increased energy in pregnant women is used for the growth and development of the fetus, placenta, and maintenance of health. Pregnant women who consume food with several calories below the recommended adequacy for a long time will result from a risk of CED, which can cause the fetus to grow imperfectly. Energy intake requirements in pregnancy match the demands of resting metabolism, physical activity, and tissue growth. Energy balance in pregnancy is. Therefore, it is defined as energy intake equal to energy expenditure plus energy storage. A detailed understanding of these components and their changes throughout gestation can inform energy intake recommendations for minimizing the risk of poor pregnancy outcomes (Most et al., 2019). Energy should be balanced, otherwise, it will have a detrimental effect on the body. Energy deficiency occurs when energy consumption through food is less than the energy expended (Hill, Wyatt and Peters, 2013). As a result, the body weight is less than the body weight should be (ideal). If it occurs in infants and children, it will interfere with growth. Whereas if it occurs in adults will damage the tissue and experience weight loss (Hill, Wyatt and Peters, 2012).

Inadequate intake of nutrients both before and during pregnancy can cause pregnant women to be malnourished (Mousa, Naqash and Lim, 2019). The needs of pregnant women are greater than those of non-pregnant women. Pregnant women's energy needs should be added according to gestational age (Desyibelew & Dadi, 2019). The energy needs of pregnant women in the first trimester are added by 180 kcal/day. In the second trimester they are added by 300 kcal/day, and in the third trimester, they are added by 300 kcal/day. The energy gain is used for the growth and development of the fetus, placenta, and maintenance of health. Pregnant women who consume food with several calories below the recommended adequacy for years will result in a risk of CED, which can cause the fetus to grow imperfectly (Most et al., 2019).

Protein functions as a building material for the body's structural functions (collagen and elastin), and as a regulator (the formation of hormones and enzymes). Protein also functions as a carrier for specific proteins and as a mediator in the immune response (Bandzerewicz and Gadomska-Gajadhur, 2022). Meeting the protein needs of pregnant women is vital because healthy fetal growth depends on the availability of adequate protein from the mother (Desyibelew & Dadi, 2019). Protein is the basic building material needed for the formation of enzymes, antibodies, muscles, and collagen. Collagen is used as a framework for skin, bones, blood vessels, and other body tissues. During pregnancy, the mother consumes enough protein to meet the increasing needs of herself and the developing fetus. Protein is a source of energy after glycogen, a catalyst for biochemical reactions in the body, and a constituent of cell and tissue structures (Marangoni et al., 2016). Therefore, individuals must get adequate protein intake because protein deficiency will harm an individual, especially pre-conceptional women, pregnant women, and adolescent women (Darnton-Hill and Mkparu, 2015).

Table 1. Results of SEM Analysis of Factors That Play a Role in Predicting Chronic Energy Deficiency in Pregnant Women

Dependent Variables	Independent Variables	b
Structural		
Direct Influence		
Chronic Energy Deficiency	←Food Intake	0,19
	←Laboratory	0,06
	←Weight gain during pregnancy	0,5
Indirect Influence		
Food Intake	←Socioeconomic	-0,04
	←Culture	0,06
Weight gain during pregnancy	←Weight gain	1,00
	←BMI before pregnancy	0,34
Measurements		
Food intake	←Inadequate energy intake	1,00
	←Inadequate protein intake	0,61
	←Inadequate carbohydrate intake	0,75
	←Inadequate fat intake	0,77
	←Inadequate iron intake	0,73
Socioeconomic	←Poor knowledge	0,36
	←Basic Education	0,43
	←Occupation (work)	0,07
	←Income less than regional minimum wage	0,19
Culture	←Risky age	0,32
	←Low parity	-0,04
	←Food taboo	-0,41
Laboratory	←Anemia	0,47
	←Low protein status	0,02
	←Low iron status	0,02

N observations = 190
Chi^2 = 166,4
p=0,00554
RMSEA=0,0432
GFI=0,948
CFI=1,000
Source: Results of SEM analysis using Lisrel, 2021

Consumption of carbohydrates as the biggest energy contributor must be adjusted to the needs of the body. In addition to excessive intake, which will lead to excess weight, if the intake is lacking, there will be a state of protein-energy deficiency (Henselmans et al., 2022). Lack of energy in the body will cause changes in carbohydrates, proteins, or fats to become energy sources so that the main functions of these three nutrients will decrease. If this change lasts for a long time, there will be changes in body weight and tissue damage. Energy in the human body can arise due to the burning of carbohydrates, proteins, and fats, so humans need sufficient food substances to fulfill their energy adequacy (Desyibelew & Dadi, 2019).

The increased need for iron during pregnancy is compounded by the occurrence of pregnancy at too young an age. It is because, in pregnancy, at a very young age, there is still growth that requires more nutrients (Abu-Ouf and Jan, 2015). Meanwhile, with the physiological condition of pregnancy, there will be demands for other needs to meet the baby growth. This condition causes vulnerability to the fulfillment of nutrients which will have an impact on competition between mothers and their babies (Amir, Susetyowati & Fatmawati, 2018).

Maternal weight gain during pregnancy is directly correlated with the incidence of CED because they both describe the adequacy of pregnant women's food intake during pregnancy (Mousa, Naqash and Lim, 2019). Gaining less pregnant weight will cause the risk of stunted fetal growth (intrauterine growth retardation/ IUGR, low birth weight/ LBW) and premature (Blake et al., 2016). The results of Lathifah's research (2019) on 80 pregnant women in Panjang, Bandar Lampung city, found that inappropriate weight gain for pregnant women was associated with low birth weight (LBW) (p=0,002). The nutritional status of pregnant women determines the weight of babies born. The nutritional adequacy of pregnant women can be seen from their weight gain during pregnancy. Low or inappropriate maternal weight gain has a high risk of giving birth to an LBW baby.

A mother's pre-pregnancy BMI is considered to be able to show the nutritional quality of the mother in the pre-pregnancy period as well as indicate the availability of nutrients in the mother's body tissue before pregnancy which will have an impact on the mother's health and fetal growth while in the womb (Bonakdar et al., 2019). The risk of giving birth to an under-weight baby for gestational age decreases along with an increase in BMI before entering pregnancy. Body Mass Index before pregnancy is the most appropriate research to predict the quality of babies born (Ningrum & Cahyaningrum, 2018).

The pregnant women's education level will affect their knowledge about nutrition and health during pregnancy. Knowledge of good nutrition during pregnancy will shape the eating behavior of pregnant women so that they have adequate food intake according to their needs (Mohammadi et al., 2022). The housewives' formal education often has a positive relationship with the development of consumption patterns in the family. Education will affect a mother's knowledge, especially related to health. Mothers with good nutritional knowledge will choose foods that are more nutritious than those that are less nutritious (Muliawati, 2012). Mother's knowledge of high caution signs is not due to age, education, gravida, family support, or sources of information. Women have good knowledge about the cautious signs of pregnancy because they participate in pregnant woman classes in which they gain knowledge (Rina and Meliati, 2020).

A person's occupation can directly describe income, social status, education, and health problems. Occupation can measure socioeconomic status as well as health problems and conditions in which a person works. Women in rural areas mostly work as unpaid family workers. These facts show that women are only used as human resources needed to meet market needs for the consideration of the country's economy and not for the benefit of women. Therefore, women are the "entrance gate" to improving family welfare (Najoan and Manampiring., 2011). Pregnant women who work have less time to prepare food which affects the amount of food consumed. So it affects the nutritional status of pregnant women.

Young age is related to a woman's

readiness to get pregnant, both physically and mentally, thus affecting her food intake. According to Haryani, Darmono & Rakhmawatie (2013), pregnant women less than 20 years old are biologically not optimal, tend to be emotionally unstable, and mentally immature. So they are prone to shocks which results in a lack of attention to meeting the needs of nutrients during pregnancy. Parity is one of the factors causing CED in pregnant women. Parity is the number of children born to a mother. Parity is divided into nulliparas, primiparas, multiparas and grandemultiparas (Mgaya et al., 2013). Nullipara is a woman who has never given birth to a fetus, primipara is a woman who has given birth to a fetus once, multipara is a woman who has given birth to a fetus >1x, and grande-multipara is a woman who has given birth to a fetus >5x (Manuaba et al., 2012; Chakona & Shackleton, 2019).

Food taboos are food ingredients or dishes that individuals in a society are not allowed to eat for cultural reasons. Some abstinence patterns are only adhered to by a section of society or by a larger section of the population. Another diet only applies to groups within some populations and a particular time (Chakona and Shackleton, 2019). If the taboo pattern applies to the entire population and throughout their lives, malnutrition tends not to develop as if the taboo only applies to some groups of people during one stage of the cycle (Susanti, Rusnoto and Asiyah, 2013).

This prediction model is then applied to a web-based expert system that meets specifications. The development of this program is continued with the implementation phase to build the program with programming languages and databases as well as other tools needed. This program was developed using the PHP programming language and MySQL database. In this phase, a database is formed along with the tables needed to store the data used in the simulation. The main functions and program support are also developed according to the software design defined in the design phase.

This prediction model is an online expert system accessed at modelangraini.com, which starts with filling in identity, socioeconomic and cultural data, nutritional knowledge questionnaires, abstinence from eating questionnaires, food intake data for the last 24 hours (nutrition), laboratory values and conclusions and suggestions. The conclusion contains a description of each indicator, and the conclusion is CED risk. The risk/ not at risk of CED was concluded from the final value of the calculation with a cut-off point of 0,28 (the mean score for the calculation of the group of pregnant women who are not CED) that is not at risk of CED (final score <0,28) and risk of CED (final score> 0,28). Chronic energy deficiency risk is divided into 3, namely low risk (final score > 0,28 – 0,66), moderate risk (final score > 0,67 – 1,04), and high risk (final score > 1,04).

The final part of this prediction model is the suggestion section, given according to the results of the prediction model description. The Angraini model was tested on 33 pregnant women in 5 health centers in Bandar Lampung. From the results of the trial implementation of the use of the Angraini model as a prediction model for CED in pregnant women, the results showed that 9 people (27,27%) were not at risk of CED, 4 people (12,12%) were at low risk of CED, 1 person (3,03%) was at risk being CED and 19 people (57,58%) were at high risk of CED. Based on the results of monitoring and evaluation 2 months after the trial, pregnant women who were not at risk of CED were 10 people (30,31%), at low risk were 4 people (12,12%), at moderate risk were 7 people (21,21%) and high risk as many as 12 people (36,36%). The results of trials and evaluations of the implementation of the Angraini Model to predict CED in pregnant women are presented in Table 2.

Table 2. Results of Testing and Evaluation of the Implementation of the Angraini Model as a Prediction Model for Chronic Energy Deficiency (CED) in Pregnant Women

KEK risk	Trials		Evaluation	
	f	%	f	%
No Risk	9	27,27	10	30,31
Low Risk	4	12,12	4	12,12
Moderate Risk	1	3,03	7	21,21
High Risk	19	57,58	12	36,36

Source: Result of Frequency Distribution the Implementation of the Angraini Model, 2021

A predictive model for chronic energy deficiency (Angraini Model) in pregnant women, was developed through a web-based expert system. An expert system is a system that seeks to adopt human knowledge into computers so that computers can solve problems usually done by experts. A considerably good expert system is designed to solve a particular problem by imitating the work of experts. With the development of an expert system, ordinary people can solve quite complex problems that can only be solved with the help of experts. For experts, it will also help their activities as highly experienced assistants. The expertise transfer from experts to computers and then to other people who are not experts is the main goal of expert systems. This process requires 4 activities, namely: additional knowledge, knowledge representation, knowledge inference, and transfer of knowledge to users. Knowledge stored on a computer is referred to as a knowledge base (Kusumadewi, 2013). Maternal nutrition status may influence the level of maternal and infant morbidity, where it may contribute to the high allocation of health financing (Kurniawan, Sistiarani and Hariyadi, 2017).

The predictive model for chronic energy deficiency (Angraini model) in pregnant women, is expected to be able to imitate the work of health experts in the early detection of the risk of chronic energy deficiency in pregnant women. With this expert system, health workers (doctors, midwives, nutrition workers) at primary health care services can carry out initial screening and evaluation of the risk of chronic energy deficiency (CED) in pregnant women, starting from the first time they come to the health service facility until the end of their pregnancy. This expert system is also expected to be able to assist in the eating behavior of pregnant women to avoid the risk of chronic energy deficiency (CED).

Artificial intelligence is one of the fastest-developing areas of science that covers a remarkably wide range of problems to be solved. It has found practical application in many areas of human activity. As well as in medicine. The use of expert systems or artificial intelligence in the field of medicine and health at this time is vital. With the existence of early detection tools in the form of expert systems or artificial intelligence can facilitate screening activities or early detection of risks for individual health problems so that they can be quickly identified and immediately intervened in prevention or treatment programs (Pac, Mikutskaya and Mulawka, 2021).

Expert systems or other artificial intelligence applications in the health sector already exist. Examples are the Permata Bunda simulator which is used to detect or screen for risk under the red line in toddlers, the Regita Model to detect early the risk of complications of pregnancy and childbirth, SOBAR's software (Screening of Behavior and Risk) Model for Cervical Cancer Prevention Classification to detect early risk of cervical cancer for women of childbearing age, the game application Titeer (Tie in smartphone Teen pregnancy prevention Revolution) as an instrument and promotional media used in youth health service programs, and so on. The existence of a web-based expert system as an instrument for predicting chronic energy deficiency in pregnant women (Angraini Model) can add to the digital society platform reference in the field of public health, which is expected to be able to improve public health status.

Conclusion

Angraini's model, as an early detection tool for CED in pregnant women, can help health workers such as doctors, midwives, and nutritionists at primary care health facilities. Angraini models are available online, open, and free access via modelangraini.com. The Angraini model can be used to improve the eating behavior of pregnant women so that it can reduce the risk of CED in pregnancy and stunting in toddlers. With this model, it is hoped that it can overcome and prevent nutritional problems in Indonesia.

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