Detection of Diseases Caused By Obesity Using Certainty Factor Method

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***Abstract*— Obesity is overweight as a result of excessive body fat accumulation. Everyone needs some body fat to store energy, as a heat insulator, a barrier to organ shocks and other functions. Many diseases can be associated with obesity, such as diabetes, high blood pressure, coronary heart disease, stroke, and even some cancers. Lack of knowledge and concern for nutritional balance in the body and difficulty monitoring weight development are causes of obesity. The purpose of this research is to develop an application to detect diseases due to obesity using the Certainty Factor method based on perceived symptoms. The system will display amount of confidence in symptoms of the possibility of illness due to obesity suffered. The amount of the trust value is result of calculations using Certainty Factor (CF) method. Knowledge representation used in this study is production rule. The inference method used to get conclusion is forward chaining.**

Keywords*— Certainty Factor, forward chaining, obesity, production rule.

I. INTRODUCTION

Obesity is defined as a condition of abnormal or excessive fat accumulation in adipose tissue to a certain degree so that it can damage health. Obesity is a serious illness that can cause emotional and social problems. A person is said to be overweight when he weighs 10% to 20% of normal body weight, while someone is called obese if being overweight reaches more than 20% of normal weight. Obesity is currently a world problem even the World Health Organization (WHO) declared it as a global epidemic [1]. Many diseases can be associated with obesity, such as diabetes, high blood pressure, coronary heart disease, stroke, and even some cancers [2] - [5].

The prevalence of obesity according to Basic Health Research (Riskesdas) 2013 increased when compared with Riskesdas 2010. The obesity rate of men in 2010 was around 15 percent and now it is 20 percent. In women the percentage is from 26 percent to 35 percent [6], [7]. To determine whether someone is obese or not, the most widely used method is to use a Body Mass Index (BMI). BMI is aimed at calculating kilograms per meter squared (kg / m2), correlated with fat contained in the body [8]. Many diseases can be associated with obesity, such as diabetes, high blood pressure, coronary heart disease, stroke, and even some cancers. Lack of knowledge and concern for nutritional balance in the body and difficulty monitoring weight development are the causes of obesity.

Research on development of obesity applications has been done. The first study was research from Mega [9]. This research resulted in an application that can monitor development of nutritional status digitally mobile by using anthropometric methods and can provide advice in accordance with the development of nutritional status and age of infants and toddlers. The design in building this system with the Anthropometry method. Anthropometric index used is body weight according to age (BW / U), height by age (TB / U) and weight by height (BW / TB). The second study is research from Fakhrun Nisa'ul Azizah [10]. The application made is an application to calculate ideal body weight, number of calories your body needs and provide information about the nutritional content of food and increase number of calories burned based on two types of sports activity choices namely walking and running. The method used to calculate calorie requirements is Harris Benedict method, while calorie burner uses exercise calorie formula. This diet program application based on sports activities can help and make it easier for users who want to do a diet program by providing information about weight control, nutritional intake of food and calories needed by the user's body.

The third study was a study from Weni Kurdanti [11], who conducted research on the factors that influence the incidence of obesity in adolescents. Case control studies with a total of 144 subjects, cases were obese adolescents (BMI / U> + 2SD) and controls were non-obese adolescents. The independent variable is the intake of macro nutrients, fiber intake, fast food consumption patterns, consumption patterns of sweet foods or drinks, physical activity, psychological factors (self-esteem), genetic factors, and breakfast intake, while the dependent variable is the incidence of obesity. Data analysis using Chi-Square test and logistic regression. Factors that were significantly associated ($p < 0.05$) and a risk factor for obesity in adolescents were energy intake (OR = 4.69; CI: 2.12-10.35); fat (OR = 2.34; CI: 1.19-4.57); carbohydrates (OR = 2.64; CI: 1.34-5.20); fast food frequency (OR = 2.47; CI: 1.26-4.83); and breakfast intake (OR = 5.24; CI: 2.56-10.71). Adolescents who have excess macro nutrient intake, frequent fast food consumption, inactive physical activity, having mothers and fathers with obesity status, and not eating breakfast, are at greater risk of obesity. Likewise, research on certainly factors to detect obesity has also been carried out [12] - [14].

The aim of study is to develop intelligent applications to detect diseases due to obesity using Certainty Factor method [15] based on perceived symptoms. Developed application consists of five stages. The first stage is detecting body weight including thin, normal or obese using body mass index (BMI) automatically. The second is to determine symptoms of disease due to obesity. The third is to calculate based on Certainty Factor value of each phenomenon. The fourth to detect diseases due to obesity using Certainty Factor method. The fifth one displays a graph of body weight development.

II. METHOD

An expert system is composed by three main modules, namely knowledge reception module, consultation module and explanation module. System is in the module of receiving knowledge, when it receives knowledge from experts. Process of gathering knowledge that will be used for system development is carried out with help of a knowledge engineer. When system is in a position to provide answers to problems raised by user, the expert system is in consultation module. In this module, user interacts with the system by answering questions raised by system.

Certainty Factor Method is a method to prove whether a fact is certain or not certain in form of metrics that are usually used in expert systems. This method is suitable for expert systems that diagnose something that is not certain [16]. Stages in representing qualitative data include: the ability to express degrees of confidence in accordance with the methods previously discussed and the ability to place and combine these degrees of confidence in the expert system. In expressing the degree of confidence used a value called Certainy Factor (CF) to assume the degree of confidence of an expert on a data. Following are the basic formulations of the Certainy Factor:

$$CF[H.E] = MB[H,E] - MD[H,E]$$

Where CF is Certainy Factor in hypothesis H which is influenced by fact E, MB is Measure of Belief (confidence level), it is a measure of increase in confidence of hypothesis H is influenced by fact E, MD is Measure of Disbelief (level of uncertainty), is the increase of mistrust of the hypothesis H influenced by the fact E, E is Evidence (events or facts) and H is Hypothesis (guess). To combine two or more rules, a knowledge-based system with several rules, each of which produces the same conclusion but the uncertainty factor is different, then each rule can be displayed as pieces of evidence that support a shared conclusion. To calculate the CF (belief) from the conclusions needed the following evidence of combination:

$$CF(R1,R2) = CF(R1) + [CF(R2)] \times [1 - CF(R1)]$$

If only add CF R1 and R2, certainty of combination will be more than 1. Modify amount of certainty by adding it to the second certainty factor and multiplying it (1 minus the first certainty factor). So, the greater first CF the smaller certainty of second addition. But additional factors always add some certainty. For the third rule added, the following rules can be used [17].

$$CF(R1,R2,R3) = CF(R1,R2) + [CF(R3)]\,[1 - CF(R1,R2)]$$
$$= CF(R1,R2) + CF(R3) - [CF(R1,R2)].[CF(R3)$$

For solutions with more rules, you can use stratified equations like the equation above. Flow diagram of the detection of diseases caused by obesity using the Certainy Factor method is shown in Figure 1.

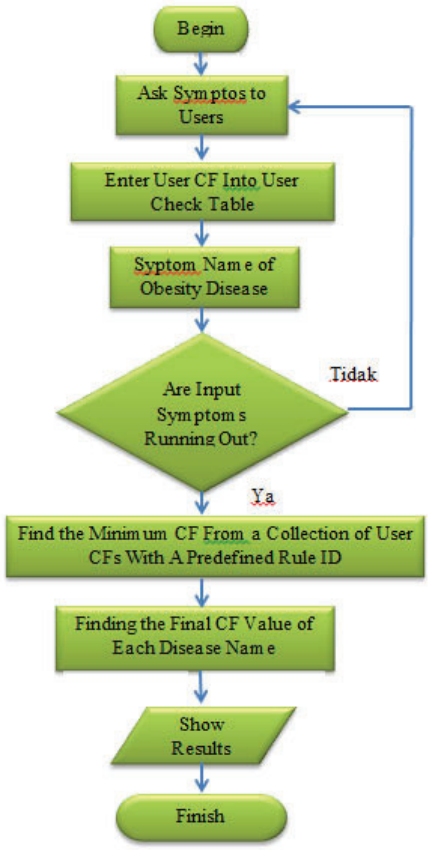

Figure 1. Flowchart Detection of Diseases Caused by Obesity

III. RESULT

Each expert system will have at least one knowledge base, the knowledge base is a collection of facts and their respective rules that will lead to a conclusion. In the system, the user will answer the questions posed according to the symptoms that the user is experiencing. Users only need to answer "YES" or "NO", this answer will be adjusted to the existing knowledge base and rules so that the diagnostic session will produce a conclusion of a disease that may be suffered. In this system there are 5 knowledge bases. The knowledge base includes: a knowledge base of diseases due to obesity, a knowledge base of symptoms and types of obesity based on BMI, a knowledge base of symptoms of obesity disease, a knowledge base of CF values and a knowledge base of solutions to obesity disorders.

There are 3 types of diseases caused by obesity disorders that will be discussed in this expert system. These diseases include: blood sugar, hypertension and heart disease. The Certainty Factor values for the three diseases above are shown in table 1.

Before using application to diagnose disease, users will be grouped into type of Body Mass Index (BMI). BMI is a simple tool for monitoring adult nutritional status specifically related to underweight and overweight [18]. The IMT threshold category is shown in table 2.

Table 1. Certainty Factor Values of Diseases Caused by Obesity

Diseases	Symptoms	Measure of Belief (MB)	Measure of Disbelief (MD)
1. Diabetes	Frequent fatigue	0.45	0.10
	Feel thirsty	0.25	0.05
	Weight loss	0.75	0,10
	Vision problems	0.20	0.07
	Unstable mood	0.05	0.02
	Muscle cramp	0.25	0.15
	Numb	0.45	0.20
	Fungal infections of the genitals	0.85	0.15
2. Heart	Frequent fatigue	0.45	0.10
	Sweating often	0.15	0.10
	Hard to breathe	0.57	0.35
	Frequent nausea and vomiting	0.27	0.15
	Feeling anxious and tense	0.78	0.30
	Chest pain	0.78	0.40
	Headache	0.85	0.22
	Heart rate is suddenly slow or fast	0.85	0.15
	Swelling of the legs and stomach	0.75	0.25
3. Hypertension	Headache	0.85	0.22
	Dizziness (Vertigo)	0.92	0.35
	Reddish face	0.68	0.48
	Frequent fatigue	0.45	0.15
	Fast heartbeat	0.90	0.30

Table 2. BMI Threshold Categories

Status	Category	IMT
Thin	Severe weight loss	< 17,0
	Underweight	17,0 –
Normal		> 18,5 – 25,0
Fat	Being overweight at a mild level	> 25,0 – 27,0
	Being overweight at a heavy level	> 27,0

To calculate or determine a person's IMT using the following formula:

BMI = Body weight / (Height / 100) ^{2}

After knowing the user's IMT category, then next is to find out what nutritional disorders suffered by the user.

For example, someone has a gender: male, height: 174 cm and weight: 80 kg.

BMI = Body weight / (Height / 100) ^{2}

BMI = 80 / (174: 100) ^{2}

BMI = 26.4

From calculation above it is known that person is classified as overweight or obese BMI. Therefore, the diseases he may suffer are diabetes, hypertension and heart disease. Based on questions raised using fat IMT inference tree, the symptoms of disease experienced by the patient are known as follows:

1. Do you often feel tired? (Yes)
2. Do you often have headaches? (Yes)
3. Do you often get dizzy (vertigo)? (Yes)
4. Is your face reddish? (No)
5. Is your heart rate fast? (Yes)

Based on the inference tree, the diagnosis is "hypertension". The CF value of each symptom held is as follows:

1. Frequent fatigue, MB = 0.45; MD = 0.15. CF = 0.45 – 0.15. CF = 0.30
2. Headache, MB = 0.85; MD = 0.22. CF = 0.85 – 0.22. CF = 0.63
3. Dizziness (vertigo),MB = 0.92; MD = 0.35. CF = 0.92 – 0.35. CF = 0.57
4. Reddish face, CF = 0
5. Fast heartbeat, MB = 0.90; MD = 0.30. CF = 0.90 – 0.30. CF = 0.60

The next step is the calculation using the Certainty Factor method.

R1 = 0.30; R2 = 0.63, R3 = 0.57; R4 = 0; R5 = 0.60

The calculation process is as follows:

CF (R1,R2) = CF(R1) + [CF(R2)]x[1-CF(R1)]
= 0.30 + 0.63 x [1 – 0.30]
= 0.30 + 0.63 x 0.70
= 0,74

CF(R1,R2,R3) = CF(R1,R2) +[CF(R3)]x[1- CF(R1,R2)]
= 0.74 + 0.57 x [1 – 0.74]
= 0.74 + 0.57 x 0.26
= 0.89

CF(R1,R2,R3,R4) = CF(R1,R2,R3)+[CF(R4)]x[1-CF(R1,R2,R3)]
= 0.89 + 0 x [1 – 0.89]
= 0.89 + 0 x 0.11
= 0.89

CF(R1,R2,R3,R4,R5)= CF(R1,R2,R3,R4)+[CF(R5)]x[1- CF(R1,R2,R3,R4)
= 0.89 + 0.60 x [1 – 0.89]
= 0.89 + 0.60 x 0.11
= 0.95

Calculation results above, it can be seen that the level of confidence of the results of the diagnosis of hypertension in these patients is 0.95 or 95%. The detection process starts from the user answering questions raised by the system. The display of questions is shown in Figure 2.

Figure 2. Display Questions From the System

After user answers the questions raised by the system, system will then display results of the diagnosis and value of the hypothesis. The results of the detection process are shown in Figure 3.

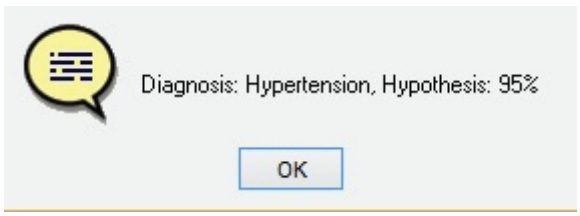

Figure 3. Display of Obesity Disease Detection Results

IV. CONCLUSION

Based on the test results by comparing the results of system diagnoses with diagnoses from nutritionists, an accuracy of 90% was obtained. This shows that the Certanty Factor method can be used to detect diseases caused by obesity.

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