



Women's Weight Gain Analysis Using the Neural Network Method in Medan, Indonesia

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Abstract

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BACKGROUND: Obesity has become a global problem, and has even been declared a global epidemic by the World Health Organization. The high percentage of noninfectious diseases in Indonesia is 69.911%. This is experienced by people aged over 18 years. Central obesity is experienced by 26.6% of Indonesia population (44.3 million people). Non-infectious diseases are the biggest cause of death and disability in Indonesia, 80% of non-infectious diseases are caused by an unhealthy lifestyle. The impact caused by this case can affect various aspects in the health, economic, sociocultural, and psychological fields of the sufferer. Therefore, it is very important to prevent and control it. Many health promotion efforts have been carried out to overcome them, from conventional to modern health promotion activities that are considered not optimal to overcome them. The use and utilization of technology is one of the best solutions for solving public service problems. At least its utilization can overcome various geographical, time, and socio-economic problems.

AIM: Assessment is required to determine the primary cause of weight gain.

METHODOLOGY: This type of research is a survey with an explanatory type, to analyze the causal relationship between research variables and body mass index (BMI). It was conducted in the city of Medan in 21 districts. Through sampling with two-stage cluster sampling, as many as 210 women aged 35–50 years were included in the research sample.

RESULTS: The results of the random forest algorithm calculation test and the neural network method with multilayer perceptron showed that the history of being overweight, contraceptive use, and diet were the dominant factors influencing BMI.

CONCLUSION: The history of weight gain with age is the dominant factor influencing changes in BMI.

Introduction

The prevalence of overweight in the population in various countries is now global; the highest number is in the Americas; the lowest in the South-East Asia region; and the highest cases are in women. Obesity is currently a world problem. Even the World Health Organization (WHO) has declared obesity a global epidemic [1]. Southeast Asia is a country that has the highest-burden or prevalence of obesity, especially in Indonesia. There is an increase in the prevalence of obesity in men from 8% to 30%, and in adult women from 8% to 52%. Of the 1.3 million respondents from Jakarta (BPS DKI 2018 data, there are 10.4 million Jakarta residents), 35% of people are obese, and central obesity is 49% [2].

Obesity is the biggest risk factor for the incidence of noncommunicable diseases that cause death and disability in Indonesia. As many as 80% of non-infectious diseases are caused by an unhealthy lifestyle. Various impacts of obesity on health include chronic diseases and reproductive health disorders. As many as 15%–26% of obese people experience

infertility. Infertility is the failure of a pregnancy or not being able to get pregnant after 12 months or more of marriage without using contraception [3]. Menopause women have more opportunities to gain weight. This is influenced by a decrease in the production of the hormone estrogen [4].

The National Health Indicator Survey (SIRKERNAS) also noted that the obesity rate for body mass index (BMI) of 27 rose to 20.7% and obesity with a BMI of 25 became 33.5% [5]. The data obtained from the increase in obesity in the population aged >18 years increased from 15.4% in 2013 to 21.8% in 2016 [6]. An unhealthy lifestyle is a risk factor for the incidence of diseases such as heart disease, stroke, diabetes, and cancer. The high rate of morbidity and mortality due to obesity at productive age is dominated by women. This will affect the global economy as it will be associated with lost productivity. A disproportionate body shape can lead to various perspectives in society, which can lead to embarrassment and feelings of unwellness so that they become less confident.

The importance (urgency) of this research in the health sector is: the high number of deaths from heart and blood vessel disease, diabetes, and cancer;

in the economic sector; the increasing number of obesity cases among young adults (aged 18 years and above), which has an impact on the global economy related to lost productivity; socio-cultural fields; socio-cultural perspective on ideal physical standards (shyness in receiving a direct or indirect reprimand from close relatives or other people, feeling unwell or sick); psychology; controlling a lack of self-confidence that can end in a state of depression due to body image disorders (a person's mental picture of his body shape and size and other people's assessment of his body shape).

Obesity is a preventable case, but various efforts have been made that have not been able to overcome this case, starting from the implementation of obesity early detection activities to the Healthy Living Community Movement (GERMAS), which aims to encourage people to behave in a healthy life/healthy lifestyle starting with themselves, their family, people around us, and in their environment [7].

The increase in cases and the efforts made are felt to be inadequate in controlling obesity. Researchers are interested in finding out what factors influence weight gain in women in the city of Medan. Then, they will design a social media-based health promotion model. This model will integrate a health promotion strategy with an online (web-based) health communication strategy. The application that will be designed is expected to meet the needs of its users and will be equipped with advanced features for controlling and preventing weight gain for its users.

Objective

- a. Identify the general characteristics of the respondent, obstetric and gynecological history, history of diseases that have been experienced, and daily life patterns
- b. Examine the factors that influence BMI
- c. Analyzing the dominant factor of the respondent's characteristics in increasing body weight.

Methods

The type of research is survey research with an explanatory type. Conducted in the city of Medan, in 21 sub-districts and 151 villages, with a two-stage cluster sampling technique, the total sample size is 210 women aged 35–50 years.

The collected data were analyzed using univariate analysis (to present the characteristics of respondents) and bivariate analysis (to determine the factors that influence changes in BMI using the

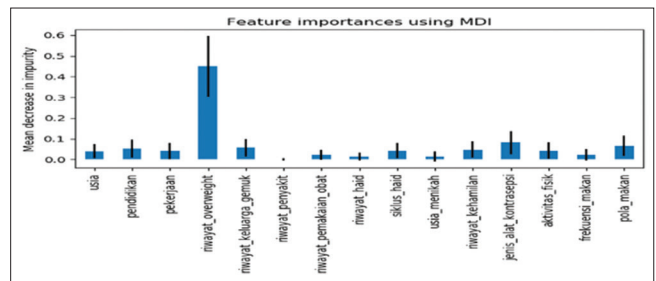


Figure 1: Feature importance using mean decrease impurity

Chi-square test). Multivariate analysis (to see the dominant factors that influence changes in BMI with the random forest algorithm calculation test and the Neural Network method with multilayer perceptron (MLP) [8], [9].

Measurement and data collection

The data collected are primary data from the results of interviews conducted using a questionnaire as a data collection tool. The questionnaire used in this research is:

1. General questionnaire, to see the frequency distribution of respondent characteristics and their history of obstetrics and gynecology
2. Daily lifestyle questionnaire assessing physical activity using the International Physical Activity Questionnaire, rated on a scale of 1 to 2 1 = high (active) and 2 = low (less active). Measuring diet using the Food Recall 24 form hours, analyzed by the nutria survey application, and graded on a scale (1 = good, 2 = not good); Measuring frequency of eating with food frequency measurement and graded on a scale (1 = 3 times, 2 = > 3 times).

Data analysis

The collected data were analyzed using univariate analysis to determine the frequency

Table 1: Factors that affect body mass index

Variable	BMI		Total, n (%)	p	PR	95% CI	
	Normal, n (%)	Abnormal, n (%)				Lower	Upper
Respondent's history of being overweight							
None	35 (71.4)	14 (28.6)	49 (100)	<0.001	19.16	8.571	42.862
Exist	6 (3.7)	155 (96.3)	161 (100)				
Total	41 (19.5)	169 (80.5)	210 (100)				
Fat family history							
None	33 (27.5)	87 (72.5)	120 (100)	0.001	3.09	1.502	6.371
Exist	8 (8.9)	82 (91.6)	90 (100)				
Total	41 (19.5)	169 (80.5)	210 (100)				
Suffered disease history							
None	35 (71.4)	14 (28.6)	49 (100)		19.16	8.571	42.862
Exist	6 (3.7)	155 (96.3)	161 (100)				
Total	41 (19.5)	169 (80.5)	210 (100)				
Contraceptional History							
Nonhormonal	35 (24.8)	106 (75.2)	141 (100)	0.010	2.8	1.261	6.460
Hormonal	6 (8.7)	63 (91.3)	69 (100)				
Total	41 (19.5)	169 (80.5)	210 (100)				
Diet							
Well	28 (27.5)	74 (72.5)	102 (100)	0.008	2.28	1.252	4.154
Not well	13 (12)	95 (88)	108 (100)				
Total	41 (19.5)	169 (80.5)	210 (100)				

BMI: Body mass index, CI: Confidence interval, PR: Prevalance Rate

distribution of the respondents' characteristics, bivariate analysis to determine the magnitude of the independent variable's influence on female BMI at a significance level of $p = 0.05$, and multivariate analysis using random forest algorithm calculation tests and neural methods. Network with MLP to see which factors are more dominant in influencing BMI.

Ethical considerations

This research was approved by the Health Research Ethics Committee of the Health Polytechnic of the Ministry of Health of Medan (Referral Number 01.0147/KEPK/Polltekkes of the Ministry of Health of Medan in 2021). This study was approved by the Health Research Ethics Committee of the Health Polytechnic of the Medan Ministry of Health. Before conducting the study, the researcher explained the research objectives based on 35 items of informed consent from the 2016 CIOMS-WHO (Explanation Before Consent).

Results

Identifying characteristics of respondents

The results of the univariate analysis show that the frequency distribution of respondents' characteristics is broken down as follows: The age of most respondents is in the age category of 35–43 years (68.1%). The level of higher education (SMU to College) is 62.9%. The respondents' occupation is 59%. The respondents are workers. As many as 76.7% of respondents have a history of being overweight with age; 4.2% have fat family members; 2.4% have a history of disease; as many as 7.1% have a history of drug use; 9% had a history of irregular menstruation; 49% had abnormal menstrual cycles; 5.2% married at the age of more than 35 years; 51.4% had a history of pregnancy >2 times; 32.9% had a history of using hormonal contraceptives; As much as 35.7% are physically active; as much as 87% eat frequently; and as much as 80.5% have a poor diet.

Results of bivariate analysis (factors related to BMI)

The results of the study using bivariate analysis using the Chi-square test found that the factors that have an influence on BMI are shown on Table 1.

The test results show that there is a significant effect of the respondent's history of being overweight, family history of obesity, illness, type of contraception, and diet on changes in BMI.

Multivariate analysis results

The multivariate analysis was used to see the prevention model of weight gain, and the dominant factor was then calculated by the random forest algorithm and the neural network method with MLP. Using the precision value formula = $TP/(TP+FP)$ and the recall value formula = $TP/(TP+FN)$, the confusion matrix yielded an accuracy value of 90.566%, precision of 92.8571%, and recall of 95.122% for the Random Forest algorithm, and an accuracy value of 94.34%, precision of 1 (one), and recall of 92.6829% for the MLP algorithm.

In addition, an analysis of the data features was also carried out to find the most informative or important data features using the mean decrease impurity technique associated with the Random Forest algorithm.

The higher the bar, the greater the importance value of a data point, which means the more important and informative the data point is. From the graph above, it can be concluded that the data feature of overweight history (overweight history) is the feature with the highest significance, followed by the importance value of 0.44885, the contraceptive type data feature with an importance value of 0.08217, and the eating pattern data feature with an importance value of 0.06579 (Figure 1).

The resulting dataset is rebuilt using the three features above. The algorithm model is then re-run with the 3-feature dataset above. The results of Random Forest get 88.679% as the accuracy value and MLP with the same accuracy value of 88.679%. Although the level of accuracy decreases, this result shows that with only these three data features, data analysis can be carried out with effectiveness and performance that can compete if the model is run with complete data features.

Discussion

The results of data processing with bivariate analysis showed that the independent variables that affected the increase in the respondent's BMI were the respondent's history of being overweight, family history of obesity, illness, history of pregnancy, type of contraceptive, and diet. These six variables have an influence on body mass index. Variables of age, menstrual status, and physical activity, as well as the frequency of eating, are protective factors against changes in the respondent's BMI.

The results of the multivariate analysis using the random forest algorithm calculation test and the neural network method with MLP showed that the history of being overweight and the history of using

contraceptives and diet were the more dominant factors affecting BMI.

Obesity history based on BMI

Respondents in this study had experienced weight gain over 8 years. Most respondents stated that they had difficulties losing weight even though they had followed a diet program. Respondents experienced an increase in body weight along with increasing age. This needs to be watched out for, considering that if no preventive measures are taken, the weight will increase. Weight gain over 40 years is more vulnerable given the various physiological changes that will be experienced with age. Maintaining a balance in body weight needs to be a matter of concern, especially in terms of socializing information about measuring BMI independently.

Various causes that can play a role in achieving ideal body weight at the age of more than 30 years include: (a) Decreased muscle mass; at the age of 30, muscle mass will decrease 3%–8% per decade (10 years). This causes sarcopenia (a condition where muscle mass decreases with age, causing more muscle cells to be destroyed than needed to build new cells). The body will reduce its caloric needs if muscle mass decreases. If the caloric needs are still the same as the caloric needs when you were young, then you will gain weight because the muscle mass to burn calories is less; (b) Hormonal Changes: In middle age, hormonal changes can occur. Women who are at the age of 45–55 years old, the age of entering the menopause period, cause estrogen production to decrease drastically, which has the potential to accumulate fat in the abdomen. Various effects can be experienced by hormonal changes, including women's moods, which can make it difficult for them to maintain their diet. While changes in the male hormone testosterone can change the circulation of fat and muscle mass, decreased testosterone production can make it difficult for the body to burn calories, thus affecting body weight; (c) Metabolism is getting slower. The metabolic process will slow down with age. This will also affect getting the ideal body weight. Decreased muscle mass will make the metabolic process slow down. In addition to increasing age, body shape, gender, and hypothyroid disease can also affect the slowing down of metabolism. Various preventive measures can be taken to maintain an ideal body weight [10]; (d) Sedentary lifestyle and stress in the age category of 40–59 years, especially office workers, are faced with various challenges that cause stress. Stress related to work can increase the hormone ghrelin, which causes hunger. The busyness experienced causes the break time to prepare lunch to be taken up, so they prefer ready-to-eat food. This situation can also complicate weight loss. (e) Lifestyle changes also contribute to weight gain, decreased physical activity, insufficient sleep, and a preference for junk food. Sleep patterns that are less than sufficient

also affect weight stability. Sleeping <6 h or more than 8 h tends to gain weight [11].

People aged 40–59 years are more prone to obesity than those aged 60 and over. This is caused by genetics and unhealthy lifestyles with age [12].

Tests with random forest algorithm calculations and neural network methods with MLP show that the use of hormonal contraception is a more dominant factor affecting BMI.

Depot medroxyprogesterone acetate (DMPA) is a progesterone injection contraceptive used for 3 months. The mechanism of action of hormonal contraception shows that progesterone suppresses ovulation, prevents implantation, accelerates gamete transport, luteolysis, and thickens cervical mucus so that within 48 h of giving progesterone, it can inhibit sperm motility and penetration. In addition, progesterone also has a metabolic effect that affects carbohydrate metabolism, but no diabetes was found in acceptors. It stimulates appetite control in the hypothalamus, which, if not controlled, will cause body mass to increase, so that bodyweight also increases [13].

The amount of the hormone progesterone causes fat deposits in the body, making it easier to convert carbohydrates and sugars into fat so that the fat under the skin increases [14], [15]. The incidence of obesity due to the use of hormonal contraceptives (injections, pills, implants) is caused by hormones in contraception, namely estrogen and progesterone. Estrogen causes decreased sodium and water expenditure, resulting in fluid accumulation, while progesterone will facilitate the conversion of carbohydrates and sugars into fat, stimulate appetite, and reduce physical activity, resulting in an increase in body weight [16], [17].

Research that has been conducted in the working area of the Lapai Public Health Centre, Padang City, on women who use DMPA injections shows that there is a relationship between the use of DMPA injectable hormonal contraceptives and an increase in body weight of 3.7 kg [18].

The effect of diet on BMI

Testing with the random forest algorithm calculation test and the neural network method with MLP, poor diet is the more dominant factor affecting BMI.

As many as 48.8% of respondents were assessed to consume carbohydrates in the category of more and were overweight or obese. The main carbohydrate source that is often consumed is rice, while noodles and bread are consumed as snacks or as a substitute for rice. The noodles consumed are usually processed by boiling and frying. The bread consumed is usually in the form of dry bread and cakes.

Excess nutrient intake compared to what is needed will be stored in the form of reserves in the

body. Excess carbohydrate intake, which causes blood glucose to increase, will be stored as fat in the body's adipose tissue. On the other hand, if the carbohydrate intake is less than the body's needs, the fat reserves will be processed through a catabolism process into blood glucose and then into the body's energy.

Carbohydrates are one of the energy supplies for the body, so if you consume carbohydrates in large quantities and often, it will cause the energy supply to increase and lead to obesity. Excessive consumption of carbohydrates causes an excess energy supply in the body. The excess energy will also be synthesized into body fat. While the fat available in the body is not used for energy, it will cause obesity.

The results of the study showed that many respondents often consumed other types of food, such as fried foods, namely 53%, with a frequency of 1–3 times a day. Between breakfast and lunch or in the afternoon, respondents consume 2–3 pieces of fried food or more in a day. The lunch menu is often supplemented with fried foods. The habit of consuming other types of drinks, such as sweet tea, is 62.7%, 1–2 times a day.

A diet that consumes fat and sugar should be limited. The balanced nutrition message suggests that sugar consumption should be limited to 4–5 tablespoons per day and fat should be no more than five tablespoons per day. Information about balanced nutrition in this intervention explains to premenopausal women the importance of balanced food intake in the age group of 39–49 years in accordance with balanced nutrition guidelines, Permenkes No. 41/2014, and regular eating frequency to avoid excessive weight gain [19].

The risk of obesity in women increases with age. During menopause, women experience changes in body fat, especially in the abdominal area compared to the lower body, as is often experienced by young women. Excess belly fat is closely linked to obesity and other conditions such as heart disease.

The International Menopause Society (IMS) on the effect of the menopausal transition on weight and body composition IMS concluded that hormonal changes that occur in postmenopausal women contribute to an increase in central abdominal obesity, which in turn interferes with physical and psychological health. There is strong evidence that estrogen hormone therapy will prevent menopausal changes in body fat distribution and its metabolic effects [4].

The body's defense mechanism against hunger will arise when the body does not get the calorie intake it needs every day. This mechanism is triggered by a low-calorie intake of under 1000 calories per day for 2 days. The body automatically reduces calorie burning by saving the few calories it gets. This process creates a slowdown in the body's daily metabolic rate. If you are in this metabolic state, it is impossible to lose weight [20].

Conclusion

The historical factor of weight gain, along with age, is the more dominant factor influencing changes in BMI, followed by a history of using hormonal contraceptives and eating patterns.

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