The Effect of Obesity, Carbohydrate, and Fat Intake on the Incidence of Type 2 Diabetes Mellitus at the Age of 30-50 Years in Medan

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Abstract

Diabetes Mellitus (DM) is a disease that is synonymous with elevated blood glucose levels that have an impact on vascular and nervous system disorders. In 2013, the prevalence of DM in Indonesia was 6.8 percent and increased to 8.5 percent in 2018. North Sumatra is in the twelfth position of provinces in Indonesia with a prevalence of 2 percent and Medan is the city with the highest cases with a total of 249.000 cases. In 2022 in Medan, the number of DM cases is known to be 21,515 cases. This study aims to analyze the effect of obesity, carbohydrate, and fat intake on the incidence of type 2 DM at the age of 30–50 years in Medan. The research method used a case-control unmatching design. The study subjects were aged 30-50 years consisting of 65 DM cases and 65 non-DM as controls. Data analysis was carried out univariate, bivariate, and multivariate with SPSS software using multiple logistic regression tests. The results showed that there was an effect between overweight (p=0.014), carbohydrate intake (p= 0.013), and fat intake (p= 0.032) on the incidence of type 2 DM. Multivariate analysis shows that carbohydrate intake is the most influential variable in the incidence of type 2 DM with an Odds Ratio value of 5.696. It is recommended for the community to carry out a healthy lifestyle by maintaining a diet, and an ideal weight, and exercising regularly. It is hoped that the Posbindu and Prolanis programs can be implemented massively at the community health center.

Keywords: Carbohydrate, Fat, Obesity, Type 2 Diabetes Mellitus

INTRODUCTION

One of the indicators of the third goal of the Sustainable Development Goals (SDGs) is efforts to achieve good health and well-being worldwide, to ensure a better and more prosperous life for everyone at all ages. By 2030, it is expected that one-third of premature deaths caused by non-communicable diseases (NCDs) can be reduced through prevention and treatment, and by improving well-being and mental health. The current reality is that the total number of deaths from NCDs has increased due to population growth and increased longevity. Diseases such as cancer, cardiovascular disease, diabetes mellitus (DM), and chronic respiratory disease killed nearly 33.2 million people worldwide in 2019. Non-communicable diseases accounted for 74 percent of all deaths globally. Every year about 17 million people die from NCDs before the age of 70 and two million of them are caused by DM (WHO, 2022).

According to the *American Diabetes Association* (2022) , Diabetes mellitus (DM) is a long-term, diverse metabolic disease with an intricate etiology. Hyperglycemia, or high blood sugar, is a hallmark of it. This condition is brought on by irregularities in either insulin processing or secretion or both. DM has become one of the most prevalent health threats in the

world. In 2016, DM was the fifteenth leading cause of death and is expected to rise to seventh by 2040 (IHME, 2017). In 2021, 537 million people aged 20-79 years suffered from DM worldwide, accounting for 10.5 percent of the population in that age group. It is estimated that by 2030, the prevalence of DM will increase to 11.3 percent of the total world population and grow rapidly to 12.2 percent by 2045 to 783 million people. It is also estimated that around 240 million people are living with undiagnosed DM, meaning that almost one in two adults is unaware that they have DM during their lifetime. Nearly 90 percent of DM cases are type 2 DM. Countries in Africa, Southeast Asia, and the Western Pacific are examples of countries where more than half of the population has undiagnosed DM (IDF, 2021).

The prevalence of DM in the Western Pacific region is 11.9 percent in 2021, with undiagnosed cases at a total of 108.7 million people, and is predicted to increase to 14.4 percent in 2045. In Indonesia, the prevalence of DM is 10.8 percent with 73.7 percent of undiagnosed cases in the age of 20-79 years. The nation in Southeast Asia with the greatest number of cases of diabetes worldwide is Indonesia. This shows the estimated contribution of Indonesia to Southeast Asia's diabetes case prevalence (IHME, 2017).

According to the Basic Health Research based on a doctor's diagnosis in the age group ≥15 years, the prevalence of DM in Indonesia was two percent and increased compared to the 2013 results of 1.5 percent. In 2018, the prevalence of DM according to blood sugar level test results was reported to have increased from 6.9 percent to 8.5 percent. The highest DM cases were in DKI Jakarta Province at 3.4 percent, East Kalimantan and D.I. Yogyakarta at 3.1 percent each, North Sulawesi at three percent, East Java at 2.6 percent while North Sumatra Province was in 12th place with a prevalence of 2.0 percent (Kemenkes RI., 2018). The number of DM sufferers is known to be 249,519 in Sumatera Utara and Medan is the highest city with 95,240 DM cases (Dinas Kesehatan Provinsi Sumatera Utara, 2019). In 2020, the number of DM sufferers was 202,402 cases, of which 124,546 sufferers or 61.53 percent of them received health services and around 38.4 percent of sufferers were known not to have examined health care facilities (Dinas Kesehatan Provinsi Sumatera, 2020).

The determination of the selected locations was done by dividing the public health center based on the level of high and low case numbers, by recapitulating the number of type 2 DM cases at 41 public heatlh center in Medan in 2022 of 21,515 cases, and then taking the average (Dinas Kesehatan Kota Medan, 2022). Public health center with the number of cases above the average are referred as high case category and the number of cases below the average are referred to as low category. The selection of the number of locations was done with consideration of time and limited research staff so that each criterion was only taken two health

centers each representing high and low cases which were considered sufficient to represent the population.

A preliminary survey conducted on 39 visitors at the health center through interviews and health checks obtained the age of 30-50 years as many as 23 people (59%), DM patients were 18 people (46.2%). Based on BMI calculations, respondents who suffered obesity as many as 23 people (59%), the habit of eating sweet foods at least twice a week as many as 22 people (56.4%), fast food and junk food at least twice a week as many as 12 people (30.8%), and 23 people (59%) consume fatty foods for two times a week.

The incidence of DM is more prevalent in individuals with a body mass index (BMI) > 25 kg/m². Eating habits that do not meet calorie requirements and not eating enough fiber and fruits can be the risk factors (Amalia et al., 2022). When we are fat, it is more difficult for the body to use insulin so that insulin resistance can occur (Nasution et al., 2018). In addition, an unhealthy diet can affect the increased risk of developing DM. The food served in the family, the inability to prepare one's own food, and the unavailability of foods that are considered healthy affect one's diet (Wigiyandiaz et al., 2020). A diet that is high in sugar and saturated fat, low in nutrients, and low in fiber will certainly lead to obesity, which can trigger the risk of DM (Febrinasari et al., 2020). A poor diet can be a major risk factor for many chronic diseases, including obesity and diabetes. Lifestyle changes by regulating the amount of calorie intake should be aimed at meeting the ideal body weight with less saturated fat consumption but rich in fiber (Perkeni, 2021). Based on these data, it can be obtained that the incidence of DM is still quite high and it is necessary to conduct research on the effect of obesity, carbohydrate and fat intake on the incidence of type 2 DM at the age of 30-50 years in Medan.

METHODS

This type of research is an observational analytical epidemiological research using case control study design where the research was conducted at four health centers representing Medan, namely Glugur Darat and Helvetia public health centers which represent the highest cases, Teladan and Pulo Brayan's health centers which represent lowest cases. The research was conducted from March to November 2023. Sampling was done by purposive sampling which was adjusted to the inclusion and exclusion criteria.

The sample size obtained was 65 people using the Lemeshow formula where the ratio between cases and controls was 1: 1 so that the total sample size was 130 respondents that divided into 65 cases and 65 control subjects. Selection of cases and controls is done through the unmatching method. The sampling technique was carried out by purposive sampling which

was adjusted to the inclusion and exclusion criteria set by the researcher. Case inclusion criteria in this study were patients aged 30-50 years who were diagnosed by a puskesmas doctor with type 2 DM during the last six months according to medical records, conscious and willing to participate in this study. Case exclusion criteria were patients with type 1 DM, gestational DM and other types of DM. Control inclusion criteria were patients who had never been diagnosed by a health center doctor with type 2 DM and were willing to become respondents in the study. Control exclusion criteria were patients who had psychiatric disorders or hearing impairment. Respondents in the case and control groups have expressed their consent to participate in this study by signing a letter of consent.

Obesity is assessed based on the results of BMI calculations, with not obese being defined as a BMI ≤ 25 kg/m² and obese as a BMI > 25 kg/m² (Kemenkes RI., 2014). The carbohydrate requirement cut-off is 65 percent of total energy intake, where carbohydrate intake above 65 percent of total energy intake is defined as at-risk and carbohydrate intake 65 percent or below of total energy intake is defined as not at-risk (Perkeni, 2021). The cut-off for fat intake was 67 grams per day. Fat intake of more than 67 grams per day was defined as at-risk, whereas fat intake of 67 grams or less per day was defined as not at-risk (Permenkes RI No 30).

The research instruments used in this study were micro toise to measure height digital scales to measure weight to assess body mass index and determine obesity and a Semi-Quantitative Food Frequency (SQ-FFQ) questionnaire to assess carbohydrate and fat intake. Data analysis was conducted using Statistical Package for Social Science (SPSS), version 25.0 which consisted of univariate analysis, bivariate analysis using a simple logistic regression test at 95% confidence level ($\alpha = 5\%$), and multivariate analysis using multiple logistic regression test with 95% confidence level ($\alpha = 5\%$).

In this study, the risk of exposure to disease is seen through the OR value, where if the OR value > 1 states that the independent variable (obesity, carbohydrate, and fat intake) is at risk of causing the dependent variable (DM disease), the OR value = 1 states that the independent variable is not at risk for the dependent variable, while if the OR value < 1 states that the independent variable is a protective or preventive factor for the dependent variable. In this study, bivariate analysis used the OR value to see the magnitude of the risk of each independent variable causing the occurrence of the dependent variable while the OR value in multivariate analysis was used to describe which independent variable most influenced the dependent variable characterized by the largest OR value. This research has gone through

ethical trials from the Health Research Ethics Committee by number 027/KEPK/UNPRI/VI/2023.

RESULTS

Based on the data collection from 65 case subjects and 65 control subjects, the results are described in the following table:

Table 1 Frequency Distribution of Respondents Based on Characteristics

Characteristics	Case		Controls	
	n	%	n	%
Age				
30 – 34 years	1	1.5	7	10.8
35 – 39 years	3	4.6	13	20.0
40 – 44 years	21	32.3	20	30.8
45 – 50 years	40	61.5	25	38.5
Gender				
Male	36	55.4	25	38.5
Female	29	44.6	40	61.5
Education				
Not graduated	1	1.5	0	0
Elementary school	1	1.5	1	1.5
Junior high school	6	9.2	6	9.2
Senior high school	31	47.7	44	67.7
University	26	40.0	14	21.5
Occupation				
Housewife	16	24.6	24	36.9
Government employees	16	24.6	8	12.3
Private employees	7	10.8	8	12.3
Entrepreneur	19	29.2	19	29.2
Laborer/driver	5	7.7	5	7.7
Other	2	3.1	1	1.5
Income				
< Medan City Minimum Wage	25	38.5	31	47.7
≥ Medan City Minimum Wage	40	61.5	34	52.3
Family history				
Yes	31	47.7	25	38.5
No	34	52.3	40	61.5

According to Table 1 above, the majority of case and control respondents were aged 45–50 years, namely in the case group as many as 40 people (61.5%) and in the control group as many as 25 people (38.5%) followed by respondents aged 40–44 years with 21 case respondents (32.3%) and 20 control respondents (30.8%). In this study, the majority of

respondents in the case group were male, namely 36 people (55.4%) while in the control group, the majority were female, namely 40 people (61.5%).

Judging from the level of education in both cases and controls, most respondents completed their education up to high school, namely 31 people (47.7%) in the case group and 44 people (67.7%) in the control group. A total of 26 people (40%) in the case group and 14 people (21.5%) in the control group completed their education up to university. The data also showed that 1 person (1.5%) of the case respondents did not complete their elementary school education.

In the case group, the highest number of respondents worked as entrepreneurs as 19 people (29.2%), then housewives and government employees as many as 16 people (24.6%) each. In the control group, 24 people (36.9%) worked as housewives and 19 people (29.2%) were entrepreneurs.

The majority of respondents in both case and control groups had a family income greater than Medan City minimum wage, namely 40 people (61.5%) in the case group and 34 people (52.3%) in the control group. Judging from the family history of type 2 DM, in the case group the majority did not have a family history, namely 34 people (52.3%), as well as the control group with 40 respondents (61.5%).

Table 2 Minimum, Maximum Value, Mean, and Standard Deviation Based on Variables

	Minimum	Maximum	Mean	Standard Deviation
Obesity				
Case (n=65)	19.9	36.8	26.77	4.06
Control (n=65)	17.6	38.9	25.53	4.48
Carbohydrate Intake				
Case (n=65)	216.0	560.3	391.82	78.85
Control (n=65)	150.9	511.0	343.80	61.56
Fat Intake				
Case (n=65)	35.1	155.1	66.82	19.08
Control (n=65)	24.4	107.0	60.18	17.31

Based on Table 2, the average BMI of respondents in the case group was 26.77 kg/m^2 with the lowest BMI of 19.9 kg/m^2 and the highest of 36.8 kg/m^2. The mean BMI value of respondents in the case group did not differ much from the mean BMI value of respondents in the control group, which was 25.53 kg/m^2 with the lowest BMI of 17.6 kg/m^2 and the highest of 38.9 kg/m^2.

The average total carbohydrate intake of the respondents in the case group was 391.82 g with the lowest total carbohydrate intake of 216.0 g and the highest of 560.3 g. The average value of total carbohydrate intake of respondents in the control group was lower than the case

group, which amounted to 343.80 g with the lowest and highest total carbohydrate intake of 150.9 g and 511.0 g, respectively.

The results also showed that the average total fat intake in the case group was higher than the control group at 66.82 g with the lowest and highest total fat intake values of 35.1 g and 155.1 g, respectively. The average total fat intake of the respondents in the control group was 60.18 g with the lowest total fat intake of 24.4 g and the highest of 107.0 g.

Table 3 Frequency Distribution of Respondents Based on Variables

Variables	Cases		Controls	
	n	%	n	%
Obesity				
Not obese	20	30.8	34	52.3
Obese	45	69.2	31	47.7
Carbohydrate intake				
Not at-risk	33	50.8	47	72.3
At-risk	32	49.2	18	27.7
Fat intake				
Not at-risk	34	52.3	46	70.8
At-risk	31	47.7	19	29.2

Based on Table 3, the results of this study show that the case group was dominated by obese respondents as much as 45 people (69.2%) and not obese as much as 20 people (30.8%) while in the control group, there were 31 obese respondents (47.7%) and not much different from the weight that was not obese, namely 34 people (52.3%).

According to carbohydrate intake, most of the respondents, namely 32 people (49.2%) in the case group had an at-risk carbohydrate intake and the remaining 33 people (50.8%) were not at-risk based on carbohydrate intake, while in the control group, more respondents had not at-risk carbohydrate intake, namely 47 people (72.3%) but 18 people (27.7%) had an at-risk carbohydrate intake.

Furthermore, the category of fat intake in the case group had almost the same percentage of at-risk and not-at-risk fat intake. Respondents who had not at-risk fat intake were 34 people (52.3%) and at-risk fat intake was 31 people (47.7%). Similarly, the control group was dominated by respondents who had no at-risk fat intake category, namely 46 people (70.8%) while 19 people (29.2%) had an at-risk fat intake.

Table 4 The Effect of Obesity on The Incidence of DM Type 2

Obesity	Incidence of DM Type 2				p	OR	95% CI
	Case		Control				
	n	%	n	%			
Obese	45	69.2	31	47.7	0.014	2.468	1.205–5.056
Not obese	20	30.8	34	52.3			
Total	65	100.0	65	100.0			

The results of the analysis showed that the p-value obtained was 0.014 (p<0.05) which means that there is an effect between obesity and the incidence of type 2 DM at the age of 30-50 years in Medan City with an OR value of 2.468 (95% CI = 1.205 - 5.056).

Table 5 The Effect of Carbohydrate Intake on The Incidence of DM Type 2

| Carbohydrate Intake | Incidence of DM Type 2 | | | | p | OR | 95% CI |
| | Case | | Control | | | | |
	n	%	n	%			
At-risk	32	49.2	18	27.7	0.013	2.532	1.221–5.249
Not at-risk	33	50.8	47	72.3			
Total	65	100.0	65	100.0			

The results of bivariate analysis obtained a p-value of 0.013 (p <0.05) which means that there is an effect of carbohydrate intake on the incidence of type 2 DM at the age of 30-50 years in Medan City with an OR value of 2.532 (95% CI = 1.221 - 5.249).

Table 6 The Effect of Fat Intake on The Incidence of DM Type 2

| Fat Intake | Incidence of DM Type 2 | | | | p | OR | 95% CI |
| | Case | | Control | | | | |
	n	%	n	%			
At-risk	31	47.7	19	29.2	0.032	2.207	1.071–4.548
Not at-risk	34	52.3	46	70.8			
Total	65	100.0	65	100.0			

The results of the bivariate test obtained a p-value of 0.032 (p>0.05) which means there is an effect of fat intake on the incidence of type 2 DM at the age of 30-50 years in Medan City with an OR value of 2.207 (95% CI = 1.071 - 4.548).

Table 7 Multivariate Analysis Results Using Multiple Logistic Regression

	Variable	B	*p-value*	OR	95% CI
Step 1[a]	Obesity	1.243	0.003	3.467	1.527 - 7.873
	Carbohydrate Intake	1.740	<0.001	5.696	2.263 - 14.337
	Fat Intake	1.363	0.002	3.906	1.630 - 9.363
	Constant	−1.916	<0.001	0.147	

Based on the results of multivariate analysis, it was found that obesity, carbohydrate, and fat intake are variables that affect the incidence of type 2 DM at the age of 30-50 years with a p-value of less than 0.05, through multivariate analysis can be seen that carbohydrate intake is the most dominant variable with an OR value of 5.696 and p-value of <0.001. This states that the risk of developing type 2 DM in respondents who have an at-risk carbohydrate intake is 5.696 times higher than in respondents who don't have an at-risk carbohydrate intake.

Based on the results of the multiple logistic regression analysis, an equation del can be determined to interpret the dependent variables, namely obesity, carbohydrate, and fat intake on the incidence of type 2 DM at the age of 30-50 years in Medan. The multiple logistic regression equation models that can predict the independent variables is as follows:

$$(Y) = \frac{1}{1+e^{-(\alpha+\beta_1\chi_1+\beta_2\chi_2+\ldots+\beta_i\chi_i)}}$$

$$(Y) = \frac{1}{1+e^{-(-1,916+1,243(1)+1,740(1)+1,363(1))}}$$

$$P(Y) = \frac{1}{1+2,718^{-(2.43)}}$$

$$P(Y) = \frac{1}{1+0,088} \qquad P(Y) = 0,919 = 91,9\%$$

The results of the analysis emphasize that the variables of obesity, carbohydrate and fat intake have the ability to predict the dependent variable by 91.9 percent while the remaining 8.1 percent is influenced by other factors. Based on the results of the logistic regression equation above, it can be concluded that the probability of incidence of type 2 DM in 30-50 year olds in Medan who have obesity, risky carbohydrate and fat intake have a 91.9 percent chance of suffering from type 2 DM while the rest is influenced by other factors.

DISCUSSION

The Effect of Obesity on the Incidence of Type 2 DM in The Age of 30 - 50 Years in Medan City

The results of statistical tests obtained that the obesity variable was more prevalent in the case group, namely 45 people (69.2%) while in the control group there were 31 people (47.7%). From the results of the study obtained a value of p = 0.014 which means that obesity has a significant influence on the occurrence of type 2 DM. The bivariate analysis states that the obesity variable has an OR value of 2.468 on the incidence of DM, which means that respondents who have a fat body are at risk of 2.468 times greater risk of developing type 2 DM compared to respondents who have a thin body or normal body mass index (not at risk).

This study is in line with the results of research conducted by Chairunnisa, W, (2020) which shows that obesity affects the incidence of type 2 DM (p=0.009) with an OR value of 2.347, which means that individuals with obesity are at risk of 2.347 times more likely to experience type 2 DM compared to individuals who are thin or normal. Research conducted by Masi, G., & Oroh, W. (2018) at one of the Manado City health centers also stated that there was a relationship between obesity and the incidence of DM with a p-value <0.05, it was found that most respondents were obese which is one of the risk factors for DM. These results are consistent with research conducted by Kabosu et al., (2019) which shows that there is a significant relationship between obesity and the incidence of type 2 DM with a value of p=0.015 and the results of the OR calculation of 3.826 which means that the incidence of type

2 DM is 3.826 times greater in people who are obesity than those who are not. The results of other studies that are also in line with the results of this study are those conducted in the Central River District of Kalimantan by Aprillia et al., (2022) which also states that obesity has an influence on the incidence of type 2 DM as shown through the results of research with a p value = 0.029 and an OR of 2.227 which means that obese people have a 2.227 times greater risk of developing type 2 DM compared to those who are not obese.

However, this study is not in line with research conducted by Hasibuan (2022) which found that obesity has no influence on the incidence of type 2 DM with a p value of 0.669 (p>0.05). A significant amount of body fat is a component of the complicated health problem known as obesity. One of the risk factors for diabetes mellitus is obesity. Individuals who are obese have excessive calorie input, as a result the beta cells of the pancreas gland will experience fatigue and are unable to produce enough insulin to compensate for excess calorie input so that blood glucose levels will increase and risk causing DM (Decroli, 2019).

Based on the explanation above, the researchers assume that obesity is characterized by an abnormal accumulation of fat which in this study more respondents suffered from obesity than those with normal body weight. Respondents still have the habit of eating more carbohydrates such as rice than other food content. In general, unhealthy snacks such as fried foods on the street are still a habit of respondents as their snacks which will unwittingly have an impact on the onset of diabates. The presence of fat accumulation can affect insulin performance. This can lead to various disease risks, one of which is diabetes.

The Effect of Carbohydrate Intake on the Incidence of Type 2 DM in The Age of 30 - 50 Years in Medan City

Bivariate analysis showed that there was an influence between carbohydrate consumption and the incidence of type 2 DM with a p value <0.05 (p=0.013; 95% CI = 1.221-5.249). The OR value for the carbohydrate intake variable was 2.532, which means that people who consume carbohydrate intake in the risk category have a 2.532 times greater risk of developing type 2 DM compared to people who consume carbohydrate intake in the non-risk category.

Research conducted in rural areas of Banyumas by Wijayanti et al., (2020) also stated that a diet in the form of high carbohydrate intake has a very strong influence on causing type 2 DM with an OR value of 11.8 times greater in those with a risky diet. Other studies have also revealed that dietary patterns based on carbohydrate intake are the most dominant variable in the incidence of type 2 DM with an OR value of 2.250, which means that individuals with a high carbohydrate intake are 2.250 times more likely to develop DM than individuals with

carbohydrate intake within normal limits. Another study that is also in line with this study was conducted by Aufa (2020) which states that there is a correlation between carbohydrate intake and the incidence of type 2 DM.

A study conducted in the West Java area also stated a similar thing where diet affects the incidence of type 2 DM with a p value = 0.003 (OR = 3.8), which means that a person will be at risk of 3.8 times suffering from DM if they have an unbalanced diet compared to those who have a balanced diet. From the results of this study, it was found that an unbalanced diet was more prevalent in the case group who consumed less vegetables and fruit and consumed more staple foods or carbohydrate sources (Anri, 2022).

Carbohydrates are nutrients as the main source of energy supply in the form of glucose that can be converted in cells as energy reserves in the body with the help of the hormone insulin. A person's blood glucose level increases or decreases in the body. Carbohydrate consumption can affect blood glucose levels, in which case carbohydrate consumption has an important role in the process of glucose control in the blood and also other factors that affect it (Yosephin, 2018). Research conducted by Zulkarnaini et al., (2022) also states that there is an effect of diet on the incidence of type 2 DM with an OR value of 2.0, meaning that individuals with an unbalanced diet have twice the risk of developing type 2 DM disease compared to individuals who have a balanced diet.

Another component of a lifestyle that puts one at risk for diabetes mellitus is eating poorly. A poor diet can create overweight, which can then result in obesity and raise a person's chance of developing diabetes since overweight people require more insulin than average to regulate their metabolism. In this study, it was also found that there were still many respondents who thought that eating lots of carbohydrates such as rice was good enough to build body strength, even though other nutrients should be no less important for the body. Many respondents were also found to consume less vegetables and fruits or only just, some respondents often consume excess sugar from the habit of drinking sweet tea or coffee and so on where most of the energy intake comes from carbohydrate intake.

The Effect of Fat Intake on the Incidence of Type 2 DM in The Age of 30 - 50 Years in Medan City

The results of bivariate analysis show that there is an influence between fat intake and the incidence of type 2 DM with a p-value of 0.032 and an OR value of 2.207, which means that someone with a fat intake in the risk category has a 2.207 times greater risk of developing type 2 DM compared to people who have fat intake in the non-risk category. This is in line with research conducted by Suprapti (2018) which found that there is a significant relationship

between fat intake and the incidence of type 2 DM with a p-value of 0.005 and an OR of 2.445 which means that someone with high fat consumption has a risk of 2.245 times experiencing type 2 DM compared to people who have good fat consumption.

Another study conducted in the Sanglah area, Denpasar also stated that there was a relationship between fat intake and the incidence of type 2 DM where excessive fat consumption had the effect of satiety which inhibited other food intake and had an impact on increasing blood cholesterol levels (Wiardani et al., 2018). Fat, which is the largest source of energy, can cause obesity. High fat is one of the factors that interfere with the insulin system so that blood sugar levels increase above normal because body cells cannot use insulin optimally and result in type 2 DM. Research conducted by Irjayanti et al., (2022) furthermore reports a p-value of 0.030 indicating a correlation between diet and the incidence of DM. According to the study, participants generally eat ready-to-eat meals, high-fat foods, and sweets, which naturally include a lot of unhealthy fats that can increase the risk of developing diabetes mellitus. However, this is not in line with research conducted by Ridho (2021) which states that there is no relationship between fat intake and blood glucose levels which can cause type 2 DM with a p-value of 0.653 but high fat intake has a greater effect on blockage of coronary arteries. This is also in line with research conducted by Sambriong (2018) which states that there is no relationship between fat intake and the incidence of DM with a p-value of 0.142. From the results of the study, it was found that fat intake was not directly related to the incidence of DM but visceral obesity which can directly cause DM disease to occur. Neuenschwander, M., et al., (2020) stated that there was no relationship between total fat intake and the incidence of type 2 DM. However, certain types of fat have a significant association with DM incidence. This study emphasizes that a higher dietary intake of plant-based fats can reduce the risk of developing type 2 DM.

Consuming dietary fat can slow down digestion and make it more difficult for insulin to function properly, but it has no immediate effect on blood sugar levels. The pancreas produces the hormone insulin, which aids in transferring glucose from food into the body's cells for use as fuel. In this study, it was found that many respondents consumed fried snacks almost three times a week that sold near their homes as snacks. Fried snacks such as bakwan use a lot of oil. Oil that is heated at high temperatures eventually makes the oil absorbed by fried foods, so that it has a high enough bad fat content that can trigger the arrival of disease.

CONCLUSIONS

Based on the results of this study related to the effect of obesity, carbohydrate, and fat intake on type 2 DM incidence in 30-60 years age group in Medan City, it can be concluded

that there is a significant influence between obesity, carbohydrate and fat intake on the incidence of type 2 DM where the carbohydrate intake variable is the most dominant variable causing type 2 DM where in the final analysis an OR value of 5.696, meaning that a person with an at-risk carbohydrate intake is 5,837 times more likely to develop type 2 DM than a person who does not have an at-risk carbohydrate intake.

The researcher's suggestion for patients and non-patients with type 2 DM should always carry out regular checks and maintain a diet by avoiding the consumption of various types of risk foods, doing regular exercise, and maintaining ideal body weight and to the community health center, it is hoped that it will be able to become a comfortable and educative place for patients who come to visit and improve health programs such as Posbindu and Prolanis more massively so that people who check their health are not only patients who have been treated but people who are still healthy and aware of the importance of health checks.

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