

Analysis of the Relationship Between Dietary Patterns, Physical Activity, and Body Mass Index on Type 2 Diabetes Mellitus Prevention in Moyongkota Village

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Abstract

Diabetes mellitus (DM) is a chronic disease affecting millions of people worldwide, caused by either insufficient insulin production by the pancreas or the body's inability to effectively use the insulin produced. Type 2 DM is the most common form, accounting for approximately 90% of all diabetes cases globally. The prevalence of DM has been increasing worldwide, both in high-income countries and in low- and middle-income countries. This study aims to analyze the relationship between dietary patterns, physical activity, and body mass index (BMI) with preventive behaviors for Type 2 Diabetes Mellitus (T2DM) in Moyongkota Village, Modayag Barat Health Center, Bolaang Mongondow Timur Regency. This research employed a quantitative method with a cross-sectional approach, involving 77 randomly selected samples. Data were collected using a questionnaire that had been tested for validity and reliability. Data analysis was conducted using the Chi-Square test with a significance level of $\alpha = 0.05$. The Chi-Square test results showed a significant relationship between dietary patterns and preventive behaviors for T2DM ($p = 0.000 < 0.05$). There was also a significant relationship between physical activity and preventive behaviors for T2DM ($p = 0.000 < 0.05$). Furthermore, a significant relationship was found between BMI and preventive behaviors for T2DM ($p = 0.000 < 0.05$).

Keywords: *Diabetes Mellitus Prevention, Physical Activity, Dietary Patterns, Body Mass Index*

Abstrak (Indonesian)

Diabetes mellitus (DM) merupakan salah satu penyakit kronik yang terjadi pada jutaan orang di dunia, diakibatkan karena kekurangan produksi insulin oleh pankreas atau insulin yang diproduksi tidak dapat digunakan secara efektif oleh tubuh. DM Tipe 2 adalah jenis diabetes yang paling umum, menyumbang sekitar 90% dari semua Diabetes di seluruh dunia. Prevalensi Diabetes Melitus mengalami peningkatan secara global, baik di negara berpenghasilan tinggi maupun negara berpenghasilan rendah dan menengah. Penelitian ini bertujuan untuk Menganalisis Faktor Pola Makan, Aktivitas Fisik Dan IMT Dengan Perilaku Pencegahan Diabetes Melitus Diabetes Melitud Tipe 2 Di Desa Moyong Kota Puskesmas Modayag Barat Kabupaten Bolaang Mongondow Timur. Jenis Penelitian ini 46ebagi penelitian kuantitatif dengan pendekatan cross sectional yang dilakukan terhadap 77 sampel yang ditentukan secara random sampling. Pengumpulan data diperoleh dari alat ukur menggunakan kuesioner yang sudah dilakukan uji validitas dan reabilitas. Analisa data Menggunakan uji Chi-Square sampel dengan kemaknaan $\alpha = 0,05$. Hasil Uji Chi-Square di dapatkan adanya hubungan yang bermakna antara Pola Makan dengan perilaku pencegahan Diabetes Melitus DMT2 ($p=0.000<0.05$). Hasil Uji Chi-Square di dapatkan adanya hubungan yang bermakna antara aktifitas fisik dengan perilaku pencegahan Diabetes Melitus DMT2 ($p=0.000<0.05$). Hasil Uji Chi-Square di dapatkan adanya hubungan yang bermakna antara IMT dengan perilaku pencegahan Diabetes Melitus DMT2 ($p=0.000<0.05$).

Kata kunci: Pencegahan Diabetes Melitus, Aktivitas Fisik, Pola Makan, Indeks Massa Tubuh

INTRODUCTION

Diabetes mellitus (DM) is a chronic disease that affects millions of people around the world, caused by a lack of insulin production by the pancreas or the body's inability to use insulin effectively. Type 2 diabetes mellitus is the most common type, accounting for about 90% of all diabetes cases in the world¹. The hormone insulin has an important role in regulating blood sugar levels². Insulin deficiency can lead to hyperglycemia or increased blood glucose levels³. The prevalence of Diabetes Mellitus is increasing globally, both in high-income countries and in middle- and low-income countries. The WHO reports that since 1980 the number of people with Diabetes Mellitus has quadrupled, reaching 422 million people in 2014³. The IDF (2020) reported that in 2019 there were 463 million adults (aged 20–79 years) living with diabetes, equivalent to 9.3% of the world's population. In the same year, about 4.2 million people died from diabetes and its complications, or the equivalent of one death every eight seconds, which accounted for 11.3% of global deaths in that age group. Indonesia is ranked seventh in the world with the number of people with Diabetes Mellitus of 10.7 million people, and around 73.7% of them have not been diagnosed (IDF, 2019). Riskesdas data shows that the prevalence of diabetes based on blood sugar checks increased from 6.9% (2013) to 8.5% (2018). At the provincial level, North Sulawesi ranks second in the number of non-communicable diseases after heart and blood vessel diseases, with a proportion of Diabetes Mellitus of 15.79%⁴. The prevalence of Diabetes Mellitus in this province increased slightly from 1.6% (2018) to 1.7% (2023)^{5,6}. Data from the West Modayag Health Center shows that in 2024 there will be 376 cases of Type 2 Diabetes Mellitus (34.7%) and this number continues to increase every month due to unhealthy lifestyles, improper diets, and low physical activity. Especially in Moyongkota Village, the increase in Type 2 Diabetes Mellitus cases is closely related to socio-cultural factors. The consumption pattern of traditional foods high in sugar and fat is still considered part of the customs and a form of respect in family events. The view that a fat body is a sign of prosperity makes the risk of obesity often overlooked. The culture of less active living, especially among the elderly and housewives, also exacerbates this condition. In addition, low awareness to carry out routine health check-ups and lack of education from health workers and community leaders are obstacles in the prevention of Diabetes Mellitus. Previous research has shown that factors related to Type 2 Diabetes Mellitus prevention behavior include Dietary Activity, Diet, Lifestyle, and Body Mass Index (BMI)⁷. Physical activity has an important role in controlling blood glucose levels by increasing glucose uptake by muscles and insulin sensitivity⁸. A balanced diet, weight control, and regular health check-ups are the main strategies to prevent Type 2 Diabetes Mellitus. This study aims to analyze the relationship between factors such as Diet, Physical Activity, and Body Mass Index (BMI) with the incidence of Type 2 Diabetes Mellitus in Moyongkota Village, West Modayag Health Center, East Bolaang Mongondow Regency.

METHODS

Design, place and time

This type of research is a quantitative research with a *cross sectional design*, which is a research design that aims to determine the relationship between independent variables and dependent variables that are measured simultaneously at one time. This design was chosen because it is able to provide an overview of the relationship between the factors of diet, physical activity, and body mass index (BMI) and the prevention behavior of Type 2 Diabetes Mellitus without the need for long-term observation. This research was carried out in the working area of the West Modayag Health Center, precisely in Moyongkota Village, West Modayag District, East Bolaang Mongondow Regency. This location was chosen because it has a fairly high number of Type 2 Diabetes Mellitus sufferers and there are variations in diet and physical activity levels of people that have the potential to affect the prevention behavior of the disease. The research implementation period starts from June 4, 2025 to June 11, 2025, which includes the preparation stage, data collection using questionnaires that have been tested for validity and reliability, as well as initial data processing to ensure the completeness of the information obtained from respondents.

Number and method of taking subjects

The population in this study is all people who live in Moyongkota Village, West Modayag District, East Bolaang Mongondow Regency, which is in the working area of the West Modayag Health Center. The subjects of the study are people who meet the inclusion criteria, namely ≥ 20 years old, domiciled in Moyongkota Village, can communicate well, and are willing to become respondents by signing an *informed consent sheet*. Exclusion criteria included respondents who were seriously ill, had communication disorders, or were absent from the site during data collection. The number of subjects of this study is 77 people, which was obtained through random sampling techniques. This technique was chosen so that each member of the population has an equal chance of becoming a research subject, so that it can reduce selection bias and improve data representativeness. Data were collected using structured questionnaires that had been tested for validity and reliability before being used in field data collection.

Types and Methods of Data Collection

The data types in this study consist of primary data and secondary data. Primary data was obtained directly from respondents through filling out a structured questionnaire that had been tested for validity and reliability. The questionnaire included questions regarding respondents' characteristics, diet, physical activity, body mass index (BMI), and preventive

behaviors for Type 2 Diabetes Mellitus. Secondary data was obtained from the reports and records of the West Modayag Health Center, including data on the number of cases of Type 2 Diabetes Mellitus and the profile of the health center's work area. Data collection was carried out by visiting respondents directly at their homes. The researcher provides an explanation of the objectives and procedures of the research, then asks the respondents to sign an agreement sheet (*informed consent*). Next, respondents were asked to fill out a questionnaire guided by the researcher to ensure that all questions were answered clearly.

Data processing and analysis

The data collected from the questionnaire is first checked for completeness through *the editing* process to ensure that no answers are missed or inconsistent. Next, the coding process is carried out, which is the provision of numerical codes for each category of answers to facilitate data processing. The next stage is *data entry*, which is entering all the data that has been coded into a computer program using SPSS software. After the data is entered, cleaning is carried out to check for input errors or duplicate data that can affect the results of the analysis. Data analysis was carried out in two stages, namely univariate analysis and bivariate analysis. Univariate analysis is used to describe each research variable in the form of frequency and percentage distributions. Bivariate analysis was conducted to test the relationship between independent variables (diet, physical activity, and body mass index) and dependent variables (prevention behavior of Type 2 Diabetes Mellitus) using the Chi-Square test with a significance level of $\alpha = 0.05$. The results of the analysis are presented in the form of tables and narratives to facilitate data interpretation.

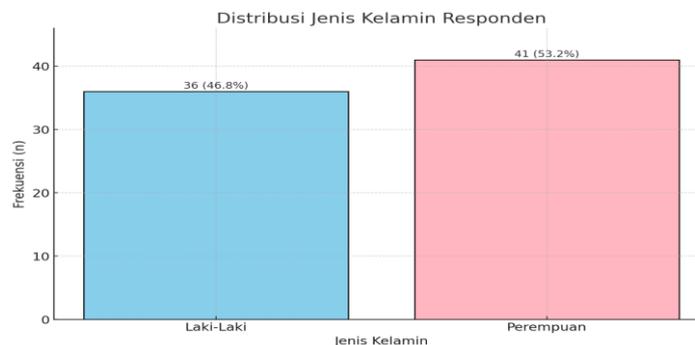
RESULTS AND DISCUSSION

A. RESULTS

This study involved 77 respondents from Moyongkota Village, West Modayag District, East Bolaang Mongondow Regency. Based on age distribution, most respondents were in the late adult age group. The majority of respondents are female and have the last level of education at the secondary school level. In terms of employment, most respondents worked as housewives, followed by farmers and traders. The distribution of Body Mass Index showed that some respondents had normal nutritional status, but there were also respondents who were included in the overweight and obese categories.

1. Univariate Analysis

a. Distribution of Frequency of respondents by Gender



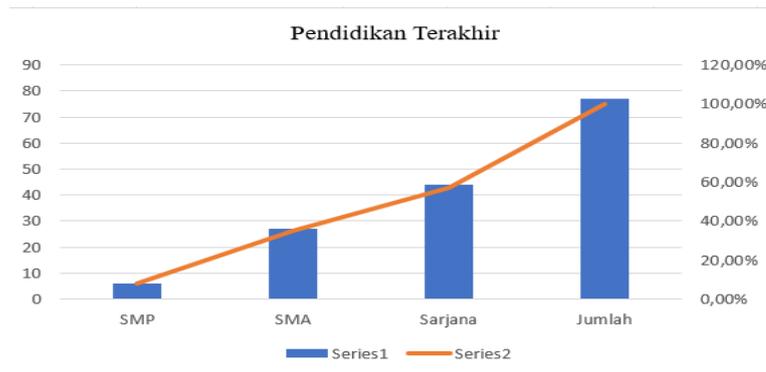
Based on the Histogram, it shows that most of the respondents are female with a percentage of 53.2% (n=41)

b. Distribution of respondent frequencies by age



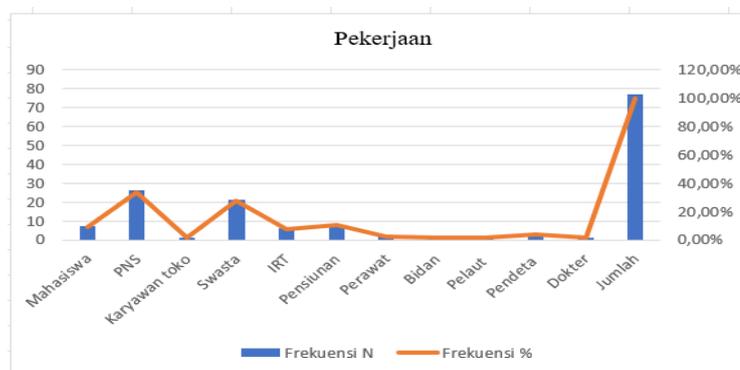
Based on the Histogram shows that the most age groups are 31-40 years old and 51-60 with a percentage of 33.8% (n=26)

c. Frequency distribution of respondents by last education



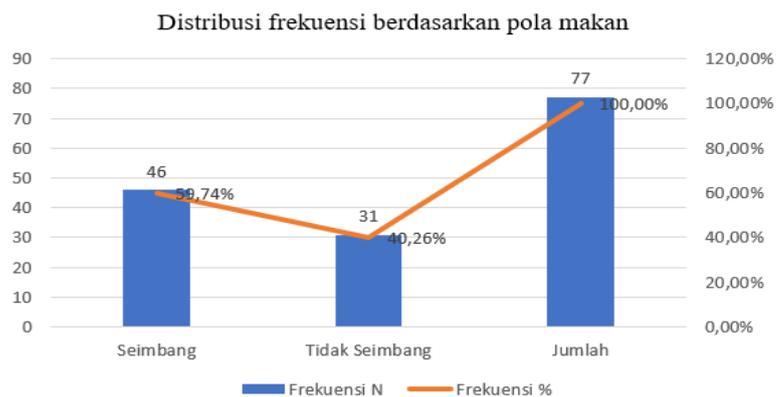
Based on the Histogram, it shows that the respondents who have the most Education Level are at the Bachelor's Level with a percentage of 57.1 (n=44).

d. Frequency distribution of respondents by Occupation



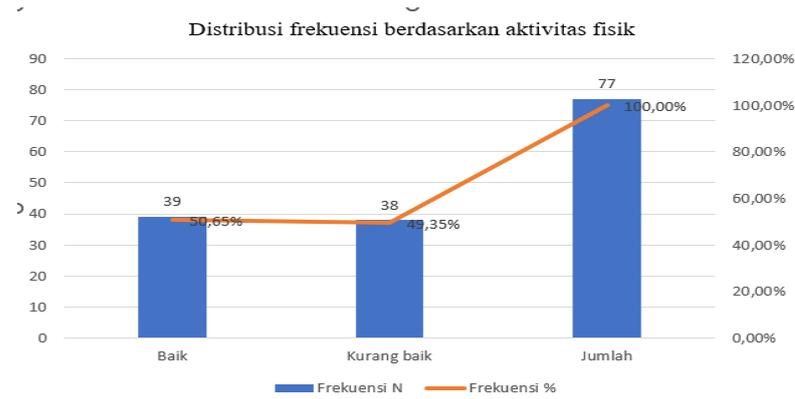
Based on the Histogram, it shows that the respondents who have the most jobs are civil servants with a percentage of 33.8 (n=26).

e. Distribution of respondent frequency by diet



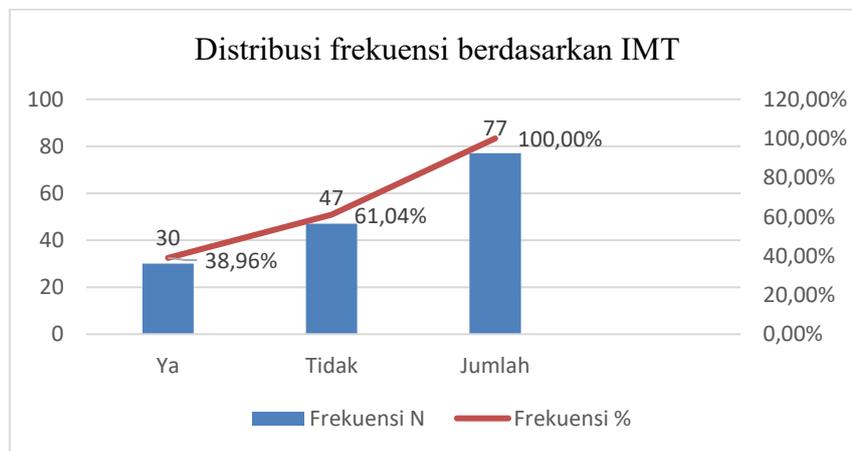
Based on the Histogram, it shows that the frequency of diet of 46 people (59.7%) is categorized as Balanced

f. Distribution of respondent frequencies based on physical activity



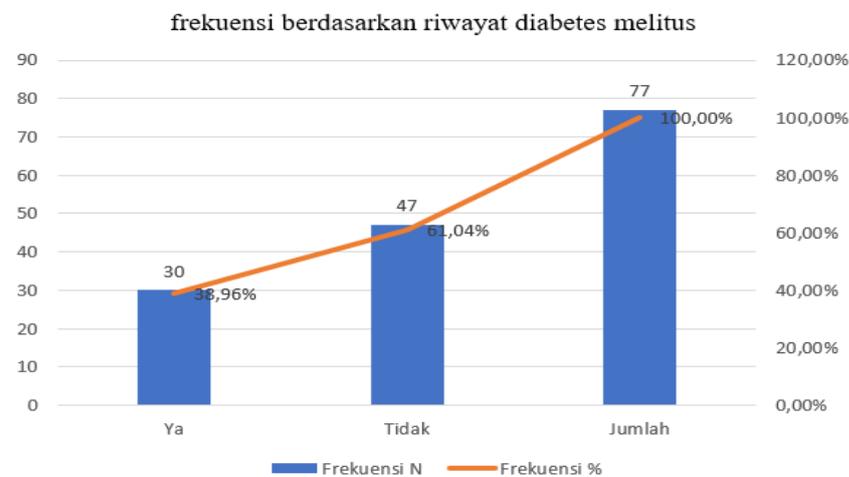
Based on the Histogram, it shows that the frequency of physical activity of 39 people (50.6%) is categorized as good

g. Frequency distribution of respondents based on Body Mass Index



Based on the Histogram, it shows that the frequency of Body Mass Index of 55 people (71.4%) is categorized as normal

h. Distribution of respondent frequency based on history of diabetes mellitus



Based on the Histogram, it shows that the frequency of Diabetes Mellitus history of 47 people (71.4%) is categorized as not

2. Bivariate Analysis

This analysis was carried out on variables that were considered to have a relationship. In this study, an analysis was carried out to find out whether there is a relationship between Diet, Physical Activity and Body Mass Index with the incidence of type 2 Diabetes Mellitus in Moyong Village, Kota Kota, East Bolaang Mongondow Regency. The test used in this study is *the chi-square test* with a 95% (=5%) confidence degree and it is said that there is a significant relationship if a $p < 0.05$ value is obtained.

a. Diet

Table 1. The Relationship of Diet with the Incidence of Type 2 Diabetes Mellitus

Diet	Incidence of Type 2 Diabetes Mellitus		P Value
	Total	Df	
Unbalanced	31	1	0,001
Balanced	46	1	
Quantity	77		

Based on table 11, it is known that the test results *Chi-Square* Obtained a value of $pvalue = 0.001$ is smaller than $\alpha = 0.05$ ($p < 0.05$) which means H_0 is rejected. This shows that there is a the relationship between diet and the incidence of type 2 diabetes mellitus

b. Physical Activity

Table 2. The relationship between physical activity and the incidence of Type 2 Diabetes Mellitus

Physical Activity	Incidence of Type 2 Diabetes Mellitus		P Value
	Total	Df	
Good	28	1	0,003
Less good	39	1	
Quantity	77		

Based on table 12, it is known that the test results *Chi-Square* Obtained a value of $pvalue = 0.003$ is smaller than $\alpha = 0.05$ ($p < 0.05$) which means that H_0 is rejected. This shows that there is a relationship between physical activity and the incidence of type 2 diabetes mellitus.

c. Body Index Period (BMI)

Table 3. The relationship between BMI and the incidence of type 2 diabetes mellitus

IMT	Prevention of Type 2 Diabetes Mellitus		P Value
	Total	Df	
Normal	55	3	0,003
Excessive	18	3	
Obesity	4	1	
Quantity	77		

Based on table 13, it is known that the test results *Chi-Square* Obtained a value of $pvalue = 0.003$ is smaller than $\alpha = 0.05$ ($p < 0.05$) which means that H_0 is rejected. This shows that there is a The relationship between Body Mass Index and the incidence of type 2 diabetes mellitus

DISCUSSION

a. Characteristics of Respondents by Gender

Based on the results of the identification of the characteristics of the Respondents by gender, it was shown that most of the respondents were female with a percentage of 53.2%. The results of this study are in line with research by⁹ who conducted research at the Technical Implementation Unit (UPT) of the Patuk I Gunung Kidul Health Center that 61.2% of patients with diabetes mellitus are female, gender is one of the causes of Diabetes Mellitus¹⁰. The results of the study are the same as the study conducted by¹¹, stating that the number of Diabetes Mellitus in the elderly is more in the female gender, which is 58.7% compared to the male gender, which is 41.3%. Women are at higher risk of suffering from diabetes mellitus after entering old age, there will be a decrease in estrogen so that women are more at risk of suffering from Diabetes Mellitus than men. Gender is an important factor in a person's behavior so that the person can determine good and bad behavior.

b. Characteristics of Respondents by Age

This study shows that the most age groups of 31-40 years and 51-60 with a percentage of 33.8% (n=26) from theory¹² state that age is the most important factor in individual retention and attitude, so that they will tend to have positive behavior compared to their age below. This is further emphasized by the journal of¹³ in its research explained that when you get older, it also affects the level of maturity in thinking and acting. The older you get, the more a person's behavior will be different according to the knowledge that has been obtained. This is in accordance with the opinion expressed by¹⁴, that Diabetes Mellitus is found most in the population aged over 45 years and above with a percentage of 60-70%. This opinion is supported by research¹⁵.

Thus, it can be concluded that the middle adult age group has a higher level of involvement or prevalence in the problems being studied. These findings are relevant to the assumption that age has an effect on certain patterns of behavior or knowledge, so that they can be a significant independent variable in further analysis. Therefore, this age distribution is important to consider in the interpretation of results and in the design of interventions based on demographic data.

c. Characteristics of Respondents Aware of Education Level

The results showed that the respondents who had the most Education Level were at the Bachelor's Level with a percentage of 57.1 (n=44). This research is in line with research conducted by¹⁶ which states that education can determine whether or not a person can easily absorb and understand knowledge, the higher a person's education, the easier it is for a person to receive information. This study is the same as the study conducted by¹⁷, that most of the respondents' education is in the basic education category as much as 78.0%, the same as study¹⁸, reveals that diabetes mellitus is more suffered by respondents with low education level (86.6%).¹⁷ states that education has a significant relationship with the incidence of diabetes mellitus in the Kintamani I Health Center Working Area.

Thus, it can be concluded that most of the respondents have a bachelor's level of education, but these findings are not in line with their level of understanding of Type 2 Diabetes Mellitus disease and its relationship with the risk of obesity. This condition indicates that a high level of formal education does not always guarantee a deep understanding of health issues, especially in the context of rural communities. This lack of understanding may be due to lack of access to relevant health information, low participation in counseling programs, or lack of practical integration of health knowledge into daily life. This shows the need for more targeted educational interventions, not only based on the level of education, but also tailored to the needs and characteristics of the local community so that understanding of the risk of diseases such as Type 2 Diabetes Mellitus can increase.

d. Analysis of the Relationship between Diet and the Incidence of Type 2 Diabetes Mellitus

The results of the study found that pvalue = 0.000 was less than $\alpha=0.05$ ($p<0.05$) diet was associated with the incidence of type 2 DM, people with an unbalanced diet were at risk of suffering from Type 2 Diabetes Mellitus compared to people with a balanced diet. The results of the unbalanced diet research are that more groups consume less fruits and vegetables every day and also consume more staple foods or carbohydrate sources.

Respondents did have an unbalanced diet or more than a balanced portion, respondents did consume excessive sources of carbohydrates and proteins while eating less fruits and vegetables. This causes an increase in blood sugar levels in the blood. Thus, it can be concluded that assuming that diet is indeed closely related to the incidence of Type 2 Diabetes Mellitus, if a person follows a good diet such as low sugar and high fiber consumption (eating more fruits and vegetables) it can reduce the risk of suffering from Type 2 Diabetes Mellitus. Diet is a way or effort to regulate the amount and type of food with certain purposes such as maintaining health, nutritional status, preventing or helping the cure of disease.

Behavior change strategies in the prevention of Type 2 Diabetes Mellitus in Moyongkota Village can be developed by combining the PRECEDE-PROCEED approach and the Logic Model, both of which emphasize the importance of data-driven planning and local culture. Based on the results of the analysis, there was a meaningful relationship between Diet, Physical Activity, and Body Mass Index and the incidence of Type 2 Diabetes Mellitus. Through the PRECEDE approach, it is known that predisposing factors (low knowledge, misperception that fat is healthy), supporting factors (lack of sports and education facilities), and reinforcing factors (lack of support from family and community leaders) are the main obstacles. Therefore, interventions need to be focused on local culture-based education, village health cadre training, and counseling involving community leaders. Within the framework of the Logic Model, activities such as counseling, joint gymnastics, and balanced nutrition education are the main activities that are expected to result in increased awareness, changes in eating behavior and physical activity, as well as a gradual decrease in the incidence of Type 2 Diabetes Mellitus. This strategy strengthens collaboration between health centers, village governments, and communities to create sustainable behavior change.

Daily diet is a person's diet that is related to their daily eating habits. Diet or consumption pattern is the arrangement of the type and amount of food consumed by a person or group of people at a certain time¹⁹. This study is in line with previous research that stated that there is a significant relationship between diet and the incidence of Type 2 Diabetes Mellitus²⁰. Another study stated that a diet high in sugar and low fiber is one of the main risk factors for the occurrence of Type 2 Diabetes Mellitus²¹.

e. Analysis of the Relationship between Physical Activity and the Incidence of Type 2 Diabetes Mellitus

The results of the study were obtained p value = 0.000 less than $\alpha=0.05$ ($p<0.05$) physical activity related to the incidence of Type 2 Diabetes Mellitus. People who are less physically active are at risk of developing Type 2 Diabetes Mellitus compared to people who are physically active enough. The results of the research on the type of physical activity that were most done by the respondents were doing homework. There are only a few respondents who do physical activities such as jogging and cycling. Thus, it can be concluded that physical activity is indeed very closely related to non-communicable diseases, because if a person does not do physical activity for at least 15 minutes per day or 3 times a week, there will be an increase in weight and Diabetes Mellitus will arise, glucose will increase and Type 2 Diabetes Mellitus will occur. Respondents admitted that they did not do any physical activity on a daily basis, because of the busyness of work that only sat in the office and only moved the hand muscles.

This shows that individuals who have good physical activity tend to be more active in taking preventive measures against Type 2 Diabetes Mellitus, such as maintaining an ideal weight, controlling blood sugar, and implementing a healthy lifestyle. Therefore, increasing physical activity needs to be an important part of promotive and preventive interventions to reduce the prevalence of Type 2 Diabetes Mellitus in the community. In a study conducted by²², it was said that eight out of 10 patients with Diabetes Mellitus that occur in old age are caused by four factors of daily habits, one of which is lack of physical activity²³. This study is in line with previous research that stated that there is a significant relationship between physical activity and the incidence of Type 2 Diabetes Mellitus²⁴. Studies that have been conducted in Indonesia state that physical activity is the dominant risk factor for the incidence of Diabetes Mellitus in Indonesia. People who have a habit of only doing light activities have a 2.9 times greater chance of getting Diabetes Mellitus compared to people who have a habit of doing strenuous activities, while people who have a habit of doing moderate activities have a lower chance of getting Diabetes Mellitus, which is compared to strenuous activities. The more intense physical activity is done, the less likely you are to develop Diabetes Mellitus²⁵.

f. Analysis of the relationship between BMI and the incidence of Type 2 Diabetes mellitus

The results of the study p value = 0.000 were smaller than $\alpha=0.05$ ($p<0.05$) and the body mass index was related to the incidence of Type 2 Diabetes Mellitus. People who are obese are at risk of developing Type 2 Diabetes Mellitus compared to people who are not obese. Respondents who suffered from obesity or the patient's Body Mass Index ≥ 25.0 kg/m². Meanwhile, respondents who suffer from obesity are fewer. This proves that the incidence of Type 2 Diabetes Mellitus is indeed greater in obese people. Thus, it can be concluded that obesity is indeed one of the main factors that cause a person to suffer from Type 2 Diabetes Mellitus, this is because if fat accumulates in the body, then the sugar level in the blood will be higher. Obesity occurs due to an imbalance of input and calorie output from the body as well as a decrease in physical activity (sedentary lifestyle) which causes fat accumulation in a number of parts of the body²³. Obesity is a risk factor for diabetes mellitus, people with obesity have an excess calorie intake. The beta cells of the pancreatic gland will experience fatigue and are unable to produce enough insulin to compensate for the excess calorie intake. As a result, blood glucose levels will increase and become Diabetes Mellitus²⁵.

This study is in line with previous research which stated that there is a significant association between obesity and the incidence of Type 2 Diabetes Mellitus^{26 27}. Another study in Cilacap stated that obesity is the most dominant factor affecting the incidence of Type 2 Diabetes Mellitus²⁸.

CONCLUSION

Based on the results and discussion, it can be concluded that most of the respondents are female (53.2%), are in the age group of 31–40 years and 51–60 years (33.8 years respectively), have the last level of undergraduate education (57.1%), and are dominated by work as civil servants (33.8%). The majority of respondents had a balanced diet (59.7%), good physical activity (50.6%), and normal body mass index (BMI) (71.4%). The results of the analysis showed a significant relationship between diet and the incidence of Type 2 Diabetes Mellitus, a significant relationship between physical activity and the incidence of Type 2 Diabetes Mellitus, and a significant relationship between the Body Mass Index category and the incidence of Type 2 Diabetes Mellitus.

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