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Analysis of the Determinants of Exercise Habits, Diet, and Heredity History with the Incidence of DM in Productive Age at Tirto 1 Health Center, Pekalongan Regency, Indonesia

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A B S T R A C T

Degenerative disease in the form of diabetes mellitus which spreads to the elderly because there is a decrease in the function of the body's organs. The industrial revolution 4.0 affects diet and lifestyles which are estimated to increase the risk of diabetes mellitus in productive age. This study aimed to determine the relationship between exercise habits, diet and hereditary history with the incidence of diabetes mellitus in productive age. The research was carried out in April - May 2023 on 51 respondents each with analysis techniques using the Chi – square test and logistic regression. The results of the study showed that there was no relationship between exercise habits (p =0.269, OR=3.267), there is a relationship between diet based on food ingredients including the variable carbohydrate consumption habits (p =0.001, OR = 6.3), and soft drinks (p = 0.031, OR = 5.976) which is a risk factor. While animal protein (p= 0.001, OR=0.001), vegetables (p=0.003, OR = 0.17), fruits (p= 0.003, OR = 0.26) is a protective factor. The results of the analysis of food ingredients that did not show any relationship with the incidence of diabetes mellitus (DM) in productive age included vegetable protein (p = 1,000, OR = 1,000), dairy (p = 1,000, OR=1,000), nuts (p = 0.454, OR=1.654) and snacks (p = 0.523, OR = 1.87) as well as family history (p = 0.029, OR=2.636). Apart from that, it was found that there was a relationship between hereditary factors and the incidence of DM in productive age and became a risk factor in the research. In conclusion, protein is the most dominant influencing variable and protective factor in this research.

1. Introduction

Degenerative disease is known as a disease that occurs due to a process of gradual decline in cell function. This condition will cause cells that previously worked normally to be disturbed and damaged until they no longer function.[1] Until the disease, it disrupts and affects an individual's daily life and causes rapid cell death. Previous research conducted on adolescents (15-20 years) in Sidoarjo provided research results showing that the prevalence of pre-diabetes risks in adolescents in Sidoarjo was around 42%, with an average glucose level of 104.35 ± 13.01 mg/dl. Thus, it can show evidence that degenerative diseases can gradually become threatening and can spread to people of productive age.[2]

Centers Of Disease Control and Prevention (CDC) states that diabetes mellitus not only occurs in adulthood but also occurs at a young age. Apart from that, based on CDC data, the prevalence rate for DM incidents in 2015 - 2016 in the 20 – 44 year age group reached 3.2%. This figure has increased compared to 1999 - 2000, with a prevalence rate of 2.7% in diagnosed DM cases. by the doctor.[3] Based on the results of Basic Health Research (Riskesdas), the prevalence of DM based on blood sugar checks

increased from 6.9% in 2013 to 8.5% in 2018. Data from the Health Office of Pekalongan Regency in 2020 estimated the number of DM sufferers in the Pekalongan Regency was recorded at 13,116 people. The results of calculating the prevalence of diabetes mellitus at the Tirto 1 Health Center have also increased over the last 2 years. It was recorded that in 2020, the prevalence of diabetes mellitus was 10.34%, then increased in 2021 to 15.63%.

The rise of fast food and dessert innovations is now very popular with all age groups, whether young, old, or small. Practical, instant packaging and various variations are the main attraction.[4] However, people's consumption patterns do not yet fully understand the impact that occurs if they consume this type of food without taking wise steps to control the consumption of this type of food. Era 4.0 towards 5.0, with a reflection of progress, technology has achieved a multisectoral aspect.[5] This also contributes to an increase in individuals' feelings of laziness in carrying out activities because the majority of activities can be supported and even controlled by technology. An increase in laziness will lead to a reduction in the individual's level of physical activity and exercise, which can lead to various diseases such as obesity, diabetes mellitus, etc. Apart from that, DM is a disease that can be passed on to the next generation.[6] According to research, a family history of diabetes is a factor that has a significant relationship; the risk of someone who has a family history of suffering from DM is 12.5 times more risky than someone who has no family history of suffering from DM.[7] This study aimed to determine the relationship between exercise habits, diet and hereditary history of DM with the incidence of diabetes mellitus that strikes in the productive age group. The research was carried out at the Tirto 1 Health Center, Pekalongan Regency, Indonesia.

2. Methods

This research uses a research design case-control study with a sampling method in the form of purposive sampling[8], with 102 research respondents, including 51 cases (DM) and 51 controls (Non-DM). The population in this study were people who lived in the working area of the Tirto 1 Health Center, had their blood sugar levels checked, and were in the 15 - 50-year age group.

Checking blood sugar levels is carried out using screening and also the results of the GSS examination during POSBINDU activities. The research period will be carried out from April – May 2023, either during POSBINDU activities or online door-to-door using a structured questionnaire research instrument in the form of SQ-FFQ[9] and the WHO questionnaire Stepwise chapter recreation[10], which is then analyzed in stages by univariate analysis, bivariate analysis using Chi–square test, and multivariate analysis using logistic regression tests.

3. Results and Discussion

Table 1 explains that the scope of characteristics of respondents in this study has a proportion of all respondents in the productive age group (15-50 years), and the majority are women, which means that based on this data, the majority have jobs as housewives and as laborers with an educational level. the majority are in the DM and Non-DM groups at the primary school level. Apart from that, based on the data, it can also be seen that the distribution of respondents is in each work area of the Tirto 1 Health Center, Pekalongan Regency, totaling 12 villages, with the most respondents in Silirejo Village with 14 respondents.

Table 2 shows the results of bivariate analysis using Chi–square tests which states the research results as follows, and there is a relationship shown p – value < 0.05, so based on the results of the bivariate test research, it shows that there is a relationship, namely the dietary pattern variable found in carbohydrate consumption habits (p = 0.000), animal protein (p = 0.000), vegetables (p = 0.003), fruits (p = 0.003), and soft drinks (p = 0.031) as well as on the variable DM heredity history (p = 0.029). Meanwhile, based on the results of bivariate tests that have no relationship with the incidence of diabetes mellitus in productive age in this study, namely, exercise habits (p = 0.269), and in the dietary variable, the habit of consuming vegetable protein (p = 1,000), dairy (p =

1,000), nuts (p = 0.455), and snacks (p = 0,523).

Table 3 shows the results of the multivariate analysis, which shows that the variable animal protein consumption habits have a p-value of 0.001 (p < 0.05), which means that animal protein consumption habits are the most dominant factor influencing the incidence of diabetes mellitus in productive age in the work area of the Tirto 1 Health Center.

The results of this study are not in line with research[11], which states that there is a relationship between exercise habits and the incidence of diabetes mellitus (DM) from the results of bivariate test analysis Chi-square. Other research that is in line, namely[12] states that there is a significant relationship between cardiorespiratory fitness and the incidence of diabetes mellitus in productive age in this study. The results of this research can be influenced by the type of work and the perspective of the respondents themselves. The majority of people have jobs as laborers so that can influence the daily activities carried out. Based on Law No. 13 of 2003, a laborer/worker is every person who works and receives wages or other forms of compensation in accordance with the workload carried out.[13] with a fairly small amount of wages to meet daily needs. Apart from that, the monotonous and incidental workload is a major factor in the lack of time for exercise.

Exercise is a type of activity that can improve health and is beneficial for life. If exercise activities can be carried out well and regularly, it can improve the function of the body's organs so that they can run well and regularly and also help in maintaining the body's immunity.[14] So that with routine training or sports activities, you can control blood sugar levels.[12]

The results of this study are in line with research[9], which states that there is a relationship between carbohydrate consumption habits and the incidence of diabetes mellitus (DM). Apart from that, other research.[15] Carbohydrates are a factor that causes an increase in blood sugar levels, namely consumption of foods high in simple carbohydrates, high in fat, and lack of physical activity and exercise. There is a correlation between high consumption of carbohydrates and fat and increased blood sugar levels.

The results of this study are supported by the theory of metabolic disorders in the body in terms of processing carbohydrates.[16] Diabetes mellitus (DM) can cause degeneration of the vessel walls and affect the body's organs, and it is not uncommon for glucose to be found in the bladder to be carried along with the urine. Apart from that, it can also cause blindness (degeneration of visual function). This is due to disruption in the transport of glucose into the body's cells due to the lack of insulin hormone so that the oxidation process that produces glycogen cannot occur. So that the energy formation process does not take place optimally. Apart from that, there is glucose in the urine because acetyl-CoA cannot be converted into energy but is converted into aceto-acetate so that glucose absorption does not occur, then it is excreted in the urine.[16]

The results of research on animal protein consumption habits can influence the incidence of diabetes mellitus (DM) in productive age and as a dominant variable in the final results of multivariate analysis. However, this research is not in line with research by Daffa et al.,[9] stated that there was no relationship between protein consumption and the incidence of diabetes mellitus (DM). In addition, based on bivariate results, it shows that the habit of consuming animal protein can be a protective factor as indicated by the value results odd ratio, which is < 1. The results of this study are supported by the theory of protein metabolism[9], where the main function of protein is as a building agent and renewing or replacing damaged cells. So, the use of protein as an energy source only occurs if the nutrients, carbohydrates, and fats are not met.

In this research, the habit of consuming animal protein is a protective factor (reducing blood sugar levels) for diabetes mellitus sufferers if they follow a high protein and low carbohydrate diet. Implementing a low carbohydrate diet and high protein intake in diabetes sufferers can increase the concentration of the insulin hormone. Apart from that, based on

research by Ganon et al,[17] Implementation of a high protein diet results in slightly lower glucose concentrations after meals in diabetes mellitus sufferers.

The habit of consuming vegetable protein is not related to the incidence of DM in productive age. However, this research is in line with research conducted by Dafa et al.,[9] stated that there was no relationship between protein consumption and the incidence of diabetes mellitus (DM). There are several significant differences in the amino acid content of animal protein and vegetable protein. Vegetable protein is missing one or more essential amino acids, so it does not contain complete amino acids. The protein content in animals is also accompanied by the content of other food ingredients such as Vit B12, Vit D, and DHA.[18]

The protein metabolism theory put forward is that high protein intake in the body will be followed by high-fat levels as well.[9] So, excess protein can be a factor in the incidence of diabetes mellitus and obesity and also influence an increase in blood glucose levels. Apart from that, there is a system glycosylase protein, which is a non-enzymatic event[18] that occurs due to the presence of glucose and protein bonds, which are proportional to the levels of glucose, hemoglobin, albumin, and lipoprotein.

The results of the research show that there is no relationship between the habit of consuming processed milk and the incidence of diabetes mellitus (DM) in productive age. This research is in line with research conducted by Daffa et al.[9], which stated that there was no relationship between protein consumption and the incidence of diabetes mellitus (DM). However, this research is not in line with the theory of several food ingredients that need to be limited as has been explained, such as food ingredients that contain a lot of saturated fat and trans fat, including fatty meat and whole milk, while the recommendation for cholesterol consumption is less than 300. mg/day.[18] The recommended percentage of protein intake is 10 – 20% of total calorie needs. Good sources of protein are seafood (fish, shrimp, squid), lean meat, skinless chicken, low-fat dairy products, nuts, tofu, and tempeh.

Apart from that, adding sugar to drinks or processed milk will increase the sugar content in the blood. This is supported by the fact that there is pure glucose formed by milk in the form of a single sugar formed with sucrose. Processed milk or food ingredients made from milk can increase blood sugar levels, so it is necessary to do this restriction on daily milk intake.

The results of the study showed that there was no relationship between the habit of consuming nuts and the incidence of diabetes mellitus (DM) in productive age. It is known that nuts, because they contain carbohydrates, protein, and fat, produce the highest levels of fat. Fat in the body will be broken down into fatty acids and glycerol, which will then be stored to become an energy reserve. Nuts are a food that contains carbohydrates and is high in fat. The glucose in the blood will be converted into fat components in the form of triglycerides and cholesterol.

If there is high blood sugar, it will result in an excess of glucose and cholesterol (insoluble fat) and cause it to precipitate on the walls of blood vessels so that the blood vessel cavity narrows and the blood supply to the organs cannot be sufficient (obstructed). Obstruction of blood supply can cause strokes, diabetes mellitus, obesity etc., so limiting the consumption of nuts is necessary for people with diabetes mellitus.[19] This theory is in line with research[9], which states that there is a relationship between dietary patterns in terms of adequate fat and the incidence of diabetes mellitus (DM).

The results of the research show that there is a relationship between vegetable consumption habits and the incidence of diabetes mellitus (DM) in productive age as well as numbers odd ratio (OR), which leads to a protective factor in this study, which means that the habit of frequent vegetable consumption is able to prevent the incidence of diabetes mellitus (DM) in productive age. This research is in line with the research[20] study by Jiang et al., who stated that implementing a diet high in fruits and

vegetables has an important role in preventing diabetes mellitus.[21]

Vegetables are rich in fiber, but fiber cannot be absorbed by the body or intestines, so the energy-creation process does not occur.[22] However, in the stomach, foods with high fiber will take longer to process so that you feel full for longer. Apart from that, it increases the volume of feces and increases the laxative effect. In this way, preventing stomach emptiness and reducing hunger and food consumption can be reduced gradually and maintain blood sugar levels.[22] Prolonged absorption of fiber can have a hypoglycemic effect, which will have an effect on declining blood sugar, which can be beneficial in diabetes mellitus sufferers.[23] Vegetables also contain vitamins that are useful and needed by the body, even in small amounts.

The results of the study show that there is a relationship between the habit of consuming fruit and the incidence of diabetes mellitus (DM) in productive age as well as a protective factor in this study, which means that the habit of consuming vegetables at high intensity can prevent the incidence of diabetes mellitus (DM) in productive age. This research is in line with research[24], which states that there is no relationship between vitamin C and E intake and blood sugar levels and does not cause an increase in blood sugar levels in patients.

Fruit is a food high in fiber and vitamins needed by the body. Fiber is a type of nutrient that cannot be absorbed by the body or intestines because it does not produce energy.[22] Fiber metabolism will last longer, and influence signals of hunger in a person, so consuming fruit can be part of a diet to prevent diabetes mellitus.[21] Apart from that, it will also affect the volume of feces, where the feces will be denser. In this way, food intake can be reduced gradually, and maintain blood sugar levels.[22] Apart from that, fruit is a food source of vitamins. The need for vitamins in the body is indeed at relatively small levels, but they have quite an important role and benefits in the body, so meeting vitamin needs is also important for humans.

The research results show that there is no relationship between snack consumption habits and the incidence of diabetes mellitus (DM) in productive age. However, snacks are foods that are high in carbohydrates, fat, and glucose, which can affect blood glucose levels or increase the risk of diabetes mellitus. This is in line with research[9], which states that there is a relationship between carbohydrate consumption habits and the incidence of diabetes mellitus (DM). Research by Aswir et al.,[15] states that carbohydrates are a factor causing an increase in blood sugar levels due to consumption of foods high in simple carbohydrates, high in fat and processed foods, and lack of physical activity and exercise. Snack food ingredients contain carbohydrates and are high in fat, and glucose will be converted into fat components in the form of triglycerides and cholesterol. The condition of high blood sugar and cholesterol levels causes deposits on the walls of blood vessels so that the blood vessel cavity narrows and the blood supply to the organs cannot be sufficient (obstructed). Obstruction of blood supply can cause strokes, diabetes mellitus, and obesity, so limiting snack consumption needs to be done in diabetes mellitus sufferers.[19]

The results of the research show that there is a relationship between the habit of consuming packaged drinks and the incidence of diabetes mellitus (DM) in productive age and grades odd ratio (OR) or high level of risk. The results of this research are in line with research by Soniya et al.,[25] which stated that there were changes in blood sugar levels in mice that were treated by giving carbonated drinks to 3 groups at different doses for 30 days. Study[26] states that the intake of tea and carbonated drinks has a direct relationship with the incidence of metabolic syndrome (MetS), dyslipidemia (DL), diabetes mellitus (DM), and hypertension (HTN).

Soft drinks in this study included carbonated drinks (Sprite, Coca-Cola, and Fanta), coffee, tea, and other drinks. according to research.[25] Carbonated drinks, one type of drink with a fairly high sugar content, namely HCSF and aspartame sweeteners. The effect of HCSF-type ingredients is that it is able to

induce lipogenesis, which results in an increase in fatty acid levels and triglyceride levels, which also includes an increase in blood sugar levels. Apart from that, the habit of consuming coffee and tea every day with sugar also results in an increase in blood sugar levels. Based on the literature by Dewi et al[19], an increase in blood sugar levels will stimulate the pancreas to produce insulin to reduce blood sugar levels. However, if the increase in blood sugar levels occurs continuously, it will result in an extra workload for the pancreas and cause insulin resistance.[27]

The results of the study show that there is a relationship between hereditary history and the incidence of diabetes mellitus (DM) in productive age, and the value results in odd ratio (OR) is also high. This research is in line with research by Anisah et al.,[28] which states that there is a relationship between family history (genetics) and the incidence of diabetes mellitus (DM) in productive age. Apart from that, other research from Yulia et al.,[29] states that there is a relationship between family history (genetics) and the incidence of diabetes mellitus (DM). As well as research by Himanshu D et al.,[27] shows that there is a genetic relationship between family history and the incidence of diabetes mellitus, where the risk will increase to 40% if a family member has a phenotypic gene indicating the presence of DM.

The results of this study are in line with the theory of hormone metabolism related to pancreatic β cells[18]. Pancreatic beta cells may experience dysfunction due to a combination of genetic and environmental factors.[30] In adulthood, the number of β cells is adaptive to changes in metabolic homeostasis, and the number of β cells can adapt to increased metabolic load caused by obesity and insulin resistance.

Table 1. Results of univariate analysis and characteristics of respondents.

Respondent characteristics	**Blood sugar levels**			
	>200 mg/dl (DM)	**%**	**<200 mg/dl (NO – DM)**	**%**
Age				
15 – 50 years	51	100,0%	51	100,0%
<15 years or >50 years	0	0,0%	0	0,0%
Gender				
Male	10	19,6%	10	19,6%
Female	41	80,4%	41	80,4%
Recent education				
Not schooling/Graduating from primary school	3	5,9 %	3	5,9 %
Primary school	31	60,8 %	24	47,1 %
Junior high school	9	17,6 %	10	19,6 %
Senior high school	7	13,7 %	11	21,6 %
College	1	2,0 %	3	5,9 %
Occupation				
Employee	2	3,9 %	5	9,8 %
Farmer	0	0,0 %	1	2,0 %
Laborer	22	43,1 %	14	27,5%
Housewife	24	47,1 %	17	33,3 %
Traders/Entrepreneurs	3	5,9 %	11	21,6 %
Other	0	0,0 %	3	5,9 %
Residence				
Wuled	1	2,0 %	1	2,0 %
Ngalian	1	2,0 %	1	2,0 %
Pandanarum	3	5,9 %	3	5,9 %
Karanganyar	6	11,8 %	6	11,8 %
Silirejo	14	27,5 %	14	27,5 %
Pucung	1	2,0 %	1	2,0 %
Sidorejo	4	7,8 %	4	7,8 %
Curug	1	2,0 %	1	2,0 %
Samborejo	3	5,9 %	3	5,9 %
Tanjung	4	7,8 %	4	7,8 %
Pacar	6	11,8 %	6	11,8 %
Dadirejo	7	13,7 %	7	13,7 %

Table 2. Relationship between exercise habits, diet, and hereditary history with the incidence of DM.

No.	Independent variable	Blood sugar levels		P-value	OR (95% CI)
		> 200 mg/dl (DM)	< 200 mg/dl (Non-DM)		
1.	Exercise habits				
	Seldom Often	49 (96,1%) 2 (3,9%)	45(88,2%) 6 (11,3%)	0,269	3,267 (0,267–17,021)
2.	Dietary habit				
	Carbohydrate Often Seldom	 37 (72,5%) 14 (27,5%)	 15(29,4%) 36 (70,65%)	0,000	 6,343 (2,682–15,002)
	Animal protein Often Seldom	 1 (2,0%) 50 (98,0%)	 15 (29,4) % 2 (3,9%)	0,000	 0,001 (0,001 – 0,009)
	Vegetable protein Often Seldom	 50 (98,0%) 1 (2,0%)	 50 (98,0%) 1 (2,0%)	1,000	 1,000 (0,061 – 16,435)
	Dairy processed Often Seldom	 1 (2,0%) 50 (98,0%)	 1 (2,0%) 50 (98,0%)	1,000	 1,000 (0,061 – 16,435)
	Nuts Often Seldom	 12 (23,5%) 39 (76,6%)	 8 (15,7%) 43 (84,3%)	0,455	 1,654 (0,612 – 4,469)
	Vegetables Often Seldom	 34 (66,7%) 17(33,3%)	 47 (92,2%) 4 (7,8%)	0,003	 0,170 (0,053 – 0,551)
	Fruits Often Seldom	 13 (25,5%) 38 (74,5%)	 29 (56,9%) 22 (43,1%)	0,003	 0,260 (0,112 – 0,600)
	Snack Often Seldom	 7 (13,7%) 44 (86,3%)	 4 (7,8%) 4 (7,8)	0,523	 1,869 (0,512 – 6,828)
	Soft drinks Often Seldom	 10 (19,6%) 41 (80,4%)	 2 (3,9%) 49 (96,1%)	0,031	 5,976 (1,238 – 28,833)
3.	DM ancestry history				
	Yes No	29 (59,6%) 22 (43,1%)	17 (33,3%) 34 (66,7%)	0,029	2,636 (1,180 – 5,889)

Table 3. Multivariate analysis results.

Variable	B	Wald	P -value	OR Adj	95% CI	
					Lower	Upper
Animal protein	-7,111	32,824	0,000	0,001	0,000	0,009

4. Conclusion

This research reveals that there is a relationship between diet, especially the habit of consuming types of food such as carbohydrates, animal protein, vegetables, fruit, and soft drinks, and hereditary history with the incidence of diabetes mellitus in productive age in the working area of Tirto 1 Health Center, Pekalongan Regency**.**

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