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Determinants of Diabetes Mellitus in Productive Age

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Abstract

The International Diabetes Federation (IDF) in 2019 placed Indonesia as the 6th ranked country with DM sufferers which reached 10.3 million people. Predictions from the IDF say there will be an increase in the number of DM sufferers from 10.7 million in 2019 to 13.7 million in 2030. Data from the health office shows that 2.2% or around 13.000 of 12.287 cases of diabetes mellitus in Pekalongan Regency, Central Java, Indonesia, is a diabetes mellitus sufferer of productive age. This is caused by changes in lifestyle, diet, rest patterns and genetics. This study aims to determine the determinants of DM in productive age in Pekalongan Regency, Central Java, Indonesia. The quantitative study used a cross-sectional design approach with a proportional random sampling technique on 158 respondents in three selected areas, namely Tirto I, Kedungwuni I, and Wiradesa Districts by using questionnaires, GPAQ instruments, and self-efficacy scales. The results of the logistic regression test on the determinants of productive age DM obtained the equation model Y = -3.949 - 2.040 history of heredity + 1.932 physical activity + 2.345 perceived benefits + 2.985 knowledge of diabetes mellitus. So it can be concluded that the variables of physical activity, knowledge, perceived benefits influence the incidence of diabetes mellitus at productive age in Pekalongan Regency.

INTRODUCTION

Based on the 2018 Basic Health Research (Riskesdas) report by the Ministry of Health, in Indonesia there has been an increase in the prevalence of DM to 10.9% (Kemenkes RI, 2018). The International Diabetes Federation (IDF) in 2019 placed Indonesia as the 6th ranked country in the number of DM sufferers which reached 10.3 million. Predictions from the IDF state that there will be an increase in the number of DM patients from 10.7 million in 2019 to 13.7 million in 2030(International diabetes federation, 2021)(International diabetes federation, 2022). Lifestyle changes and urbanization appear to be important causes of this problem and will continue to increase in the coming years. The trend of DM cases is increasing in productive age and this statement is in line with several previous studies (International diabetes federation, 2022)(Di et al., 2012). The American Diabetes Association stated that the estimated total cost of diagnosing diabetes in 2017 was $327 billion, including $237

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billion in direct medical costs and $90 billion in lost productivity(Association, 2018). For the cost category analyzed, care for people diagnosed with diabetes accounts for 1 in 4 U.S. health care dollars, and more than half of that expenditure is directly attributable to diabetes. People with a diagnosis of diabetes incur an average medical expenditure of ~$16.750 per year, of which ~$9.600 is attributed to diabetes. People with a diagnosis of diabetes, on average, have medical expenses ~2.3 times higher than those without diabetes. Indirect costs include increased absenteeism ($3.3 billion) and decreased productivity at work ($26.9 billion) for the working population, decreased productivity for those not in the labor force ($2.3 billion), inability to work due to disability disease-related ($37.5 billion), and lost productivity due to 277.000 premature deaths from diabetes ($19.9 billion)(Association, 2018).

DM at productive age is estimated to be the highest cause of death, such as the results of research in India on the impact of diabetes on productivity and the economy in Bangladesh, which found an estimate of 813.807 excess deaths, a loss of 4.0 million years alive (5.5%) and 9.2 million PALYs (20.4%) caused by diabetes. This equates to 0.7 YLL, and 1.6 PALY lost per person. PALY's losses equate to a total loss of US$97.4 billion (US$16,987 per person) in GDP (Afroz et al., 2020). Based on the mapping results, there are three areas in Pekalongan Regency which have the highest prevalence rate, namely Wiradesa (1180 cases), Tirto I (1176 cases), and Kedungwuni (1112 cases). Most of the population has less physical activity, and a diet high in carbohydrates. Knowledge about diabetes mellitus and its complications is not good enough. So from this description it is important to do research on the determinants of DM in productive age so that relevant prevention can be carried out with the risk factors found. This research is expected to increase referrals regarding the overall determinants of diabetes mellitus in productive age which also includes the patient's perception of the possibility of complications.

This study aims to determine the determinants of DM in productive age by examining the independent variables (heredity, physical activity, diet, rest patterns, stress management, age, sex), while the dependent variable is the incidence of diabetes mellitus in Pekalongan Regency, Central Java, Indonesia.

METHODS

Study Design

This quantitative study used a cross-sectional design approach(Kesmodel, 2018)(Thiese, 2014). The research was conducted from 9 August 2022 to 3 October 2022.

Sample and Sampling Technique

The study population included all productive age diabetes mellitus sufferers in Pekalongan Regency, totaling 12.287 people. The selection of three research locations was based on the areas with the highest prevalence of diabetes mellitus in productive age in Pekalongan Regency and these three areas were designated as poverty alleviation laboratories in Pekalongan Regency. The sample was determined by proportional random sampling of 158 respondents taking into account the proportion of the population in the Tirto I area, so a sample of 50 respondents was determined. In the Kedungwuni I area, a sample of 54 respondents was determined, and in the Wiradesa area, a sample of 63 respondents was determined.

Research Instrument

The research instrument used a questionnaire, GPAQ instrument, and self-efficacy scale. Collecting data using interview techniques. The research instrument has been tested for validity and reliability in different areas with the results of all valid and reliable question items.

Data Analysis

The influence of hereditary history variables, physical activity, dietary habit, rest patterns, stress management, self-efficacy scale, perceived benefits, perceived barriers, perceived vulnerability, perceived severity, cues to action, and knowledge of the incidence of diabetes mellitus in productive age were analyzed using chi square and binomial regression test.

Ethical Clearance

This research was approved by the research ethics committee of the Faculty of Medicine, Universitas Sebelas Maret with number 99/ UN27.06.11/KEP/EC/2022.

RESULT AND DISCUSSION

Our study found that the characteristics of the respondents include age, gender, education level, heredity, physical activity, diet, rest pattern, stress management.

It can be concluded that the 158 respondents have a mean age of 51.11 years with the youngest being 31 years old and the oldest being 82 years old. In terms of height, they have an average height of 153.42 cm with a minimum height of 127 cm and a maximum height of 188 cm. The measurement results show that the average body weight of the respondents is 60 kgs, with a minimum body weight of 34 kg and a maximum body weight of 90 kg. The results of measurements of

physical activity using the GPAQ (global physical activity questionaire)(Meh et al., 2021)(Meh et al., 2022)(Meh et al., 2022). By using 14 question items, it was found that the average physical activity score was 19.60 with the lowest physical activity score of 10 and the highest physical activity score of 28.

Based on the results of measuring the eating pattern of the respondents using a questionnaire with 12 question items which included frequency, type, amount and time of eating, the average eating pattern score was 16.98 and the lowest eating pattern score was 12 and the highest was 24. The results of measuring the respondent's resting pattern were measured by 8 questions obtained the average score of the respondent's resting pattern was 12.69 and the lowest score was 8 and the highest was 18. The results of the SES (self efficacy scale) measurement(Oh et al., 2021) (Magon et al., 2023)(Lazemi and Sharifabad, 2023) through the use of a questionnaire with 10 question items that measured the respondent's self-perception for self-care show the average SES result of 14.51, with the lowest score being 9 and the highest score being 20.

Respondents' ability to manage stress was measured using a questionnaire that measures patterns of stress management which include efforts to minimize sources of stress, change psychological responses to stress, modify long-term stress effects, view of illness, social support and coping strategies. The result was an average score of 12.86 with 8 as the lowest score and the highest was 18. Respondents' perceived obstacles as measured by a questionnaire using 6 question items, the results obtained mean the perceived obstacle score was 8.68 with the lowest perceived score of 6 and the highest was 12. For perceived vulnerability, the average score was 8.81, the lowest score was 6 and the highest score was 12. For perceived severity, the average response score of respondents was 7.49 with the lowest score being 5 and the highest being 10. For the variable tendency to act (cues to action), the average answer was 10.02 with the lowest score being 7 and the highest being 14. For the respondent's knowledge variable about diabetes mellitus, the average was 6.78 with the lowest score being 5 and the highest being 10.

The following table presents the results of the bivariate test between the variables studied:

Table 1 above shows that hereditary his-

Table 1. Bivariate Test Results Using the Chi-square Test

Variable	Category	DM Incident		p value	OR (95%CI)
		Normal	DM		
Hereditary History	There is history	23	129	0,024*	0,130 (0,017-1,006)
	No history	3	3		
Physical Activity	Low-medium	13	113	0,000*	6,906 (1,799-26,510)
	High	13	19		
Dietary Habit	Irregular & measurable	15	104	0,023*	0,581 (0,152-2,219)
	Organized & measurable	11	28		
Rest Pattern	Irregular & measurable	12	90	0,032*	3,023 (0,791-11,553)
	Organized & measurable	14	42		
Stress Management	Not enough	12	91	0,026*	0,683 (0,168-2,780)
	Good	14	41		
Self-efficacy Scale	Not enough	21	104	0,820	0,997 (0,274-3,636)
	Good	5	28		
Perceived Benefits	Less useful	21	129	0,000*	10,434 (1,537-70,813)
	Beneficial	5	3		
Perception of Obstacles	Lots of obstacles	9	85	0,005*	1,873 (0,638-5,495)
	Minimal obstacles	17	47		
Perceived Vulnerability	Not vulnerable	23	129	0,024*	1,435 (0,144-14,340)
	Prone to	3	3		
Perception of Severity	Not bad	23	131	0,001*	3,938 (0,257-60,284)
	Critical	3	1		
Cues to Action	Negative	19	116	0,05*	0,497 (0,106-2,239)
	Positive	7	16		
DM Knowledge	Not enough	23	129	0,024*	19,790
	Good	3	3		(2,545-153,866)

Note: *p is significant (<0,05)

tory is associated with the incidence of diabetes mellitus of productive age in Pekalongan Regency, a P value of 0.024 < α = 0.05 with a contingency coefficient value (CC) of 0.177, the strength of the relationship is weak. Physical activity is measured according to the GPAQ (global physical activity questionaire) (Mumu et al., 2017) which measures light, moderate and vigorous activity which includes questions about work activities, moving activities, and recreational activities. The results showed a p value of 0.000 < α = 0.05 with a contingency coefficient (CC) of 0.312 so it can be concluded that physical activity is related to the incidence of diabetes mellitus of productive age in Pekalongan Regency with moderate relationship strength.

The p value is 0.023 < α = 0.05 with a contingency coefficient (CC) of 0.178 so it can be concluded that dietary pattern is related to the incidence of diabetes mellitus in productive age in Pekalongan Regency with a weak relationship strength. The p value is 0.032 < α = 0.05 with a contingency coefficient value of 0.168 so it can be concluded that resting pattern is associated with the incidence of diabetes mellitus of productive age in Pekalongan Regency with a weak relationship strength.

Bivariate analysis showed the results of a p value of 0.026 < α = 0.05 with a contingency coefficient (CC) of 0.175 on the chi square test so that it can be concluded that the stress management variable is related to the incidence of diabetes mellitus in productive age in Pekalongan Regency with a weak relationship strength. In this study, stress management was measured using a questionnaire that asked about mechanisms for eliminating or minimizing sources of stress, mechanisms for changing psychological responses to stress, modifying the long-term effects of stress, views on illness, as well as questions about social support received, and respondents' coping strategies for stressed. The bivariate test using the chi square yielded a p value of 0.820 > α = 0.05 so that the self-efficacy scale ability was not related to the incidence of diabetes mellitus in productive age in Pekalongan Regency. Perceived benefits are related to the incidence of productive age DM with a p value of 0.000 < α = 0.05, with a contingency coefficient (CC) of 0.276. The results of the bivariate test showed a p value of 0.005 < α = 0.05 with a contingency coefficient (CC) of 0.219 so that perceived barriers were related to the incidence of diabetes mellitus of productive age in Pekalongan Regency with a weak relationship strength.

The result is a p value of 0.024 < α = 0.05, with a contingency coefficient (CC) of 0.177 so that there is a relationship between perceptions of vulnerability and the incidence of diabetes mellitus in productive age in Pekalongan Regency with a weak relationship strength. The chi square test yielded a p value of 0.001 < α = 0.05 with a contingency coefficient (CC) of 0.247 so that the perceived severity is related to the incidence of diabetes mellitus of productive age in Pekalongan Regency with a weak relationship strength. The results of the chi square test obtained a p value of 0.05 < α = 0.05 with a contingency coefficient (CC) of 0.154 so that the tendency to act (cues to action) is related to the incidence of diabetes mellitus at productive age in Pekalongan Regency with a weak relationship strength. The p value is 0.000 < α = 0.05 with a contingency coefficient (CC) of 0.177 so it can be concluded that knowledge about diabetes is related to the incidence of diabetes mellitus at productive age in Pekalongan Regency with a weak relationship strength.

Binomial logistic Regression Analysis(Clovis, Pagui and Salvan, 2022)(Barros and Hirakata, 2003) is a regression specifically designed to handle regression analysis with a dichotomous scale dependent variable. The dichotomous scale referred to here is a nominal or ordinal data scale which only has two categories, namely "dm events" (Y=1) and "normal" (Y=0). Binomial Logistic Regression Analysis was used to determine the determinants of the incidence of diabetes mellitus in productive age in Pekalongan Regency. In this study, there are twelve independent variables that are thought to influence the incidence of diabetes mellitus in productive age in Pekalongan Regency. The dependent variable in this study is the DM event, which is a variable that has a value of 1 if the respondent experiences a "DM event" and a value of 0 if the respondent is "normal".

Binomial logistic regression analysis begins with testing the feasibility of the binomial logistic regression model. Next is testing the model as a whole, then testing each independent variable, and finally is the interpretation and discussion of the variables or determinants of diabetes mellitus in the productive age in Pekalongan Regency.

Logistic Regression Model Feasibility Test

The test is carried out by comparing the value of -2 Log Likelihood before the existence of the model with -2 Log Likelihood after the existence of the model. The value of -2 Log Likelihood before the existence of the model can be seen in Block 0: beginning Block. While the value of -2 Log Likelihood after the existence of the

model can be seen in Block 1: method = enter.

Based on the SPSS results, it can be seen that the Iteration history table is in block 0 or when the independent variables are not included in the model: N = 158 to get a value of -2 Log Likelihood: 141.299. Degree of Freedom (DF) = N-1 = 158-1 = 157. Chi square (X2) Table on DF 157 and probability 0.05 = 187.239. Value -2 Log Likelihood: 141.299 < X2 table (187.239) so that it accepts Ho, indicating that the model before entering the independent variable is fit with the data, which means the regression model before including twelve independent variables can predict observation data.

Block 1 iteration history table or when independent variables are included in the model: N=158. Degree of Freedom (DF) = N – number of independent variables – 1 = 158-12-1 = 145. Chi-square (X2) table on DF 145 and prob 0.05 = 174.100. Value -2 Log Likelihood (105.298) < X2 table (174.100) thus accepting Ho, then indicating that the model by including the independent variables is fit with the data, which means the regression model by including twelve independent variables can predict the observation data and is feasible to use. The following are the results of testing the accuracy of the logistic regression model:

Table 2. Predictive Value (Classification Table) Logistic Regression Model

			Predicted		
Observed			DM Incident		
			Normal	DM	Percentage Correct DM Incident
Step 0	DM Incident	Normal	0	26	0,0
		DM	0	132	100,0
Overall Percentage					83,5

Based on table 2, it can be seen that the results of the Classification Table show that the number of samples that have a category of reference dependent variable or bad consequences (code 1), namely "experiencing DM" was 132. Meanwhile, those who are "not experiencing DM" were 26 people. The number of samples was 158 people so that the overall percentage value before the independent variables are included in the model is: 132/158 = 83.5%.

Nagelkerke R Square

The Nagelkerke R Square value was 0.345 and the Cox & Snell R Square value was 0.204, which indicates that the ability of the independent variable to explain the dependent variable is 0.345 or 34.5% and there are 100% - 34.5% = 65.5% other factors outside a model that explains the dependent variable.

Test the Entire Model (Overall Model Fit)

The total test of this model is used to assess if all of the independent variables in the logistic regression procedure influence the variable that is dependent (dm events) at the same period. The results of the Omnibus Tests of Model Coefficients from are provided here. SPSS:

Based on table 3 below, it can be seen that the X2 value is 36.002 > X table on DF 12 (the number of independent variables is 12) which is

Table 3. Omnibus Test Results of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	36,002	12	0,000
	Block	36,002	12	0,000
	Model	36,002	12	0,000

21.026 or with a significance of 0.000 (<0.05) so it rejects Ho, which shows that the addition of independent variables can have a real effect to the model, or in other words the model is declared fit. Therefore the model is declared according to the data, feasible and can be used for further analysis.

Model Fit Test

The SPSS results in the Hosmer and Lemeshow Test section show the model appropriateness test. The Hosmer and Lameshow Test is a goodness of fit (GoF) test which decides whether or not the model formed is correct, more specifically if there is no statistically significant disparity between the model and the observed value. The Chi-Square indicates DF 11 (number of independent variables - 1) in the table at the value of 0.05 of significance is 19.675. Because the Chi-Square value of Hosmer and Lameshow is 6.700, and the Chi-Square table has a significance value of 0.461 (> 0.05), the model can be adopted and hypothesis testing may be performed.

Wald Test (Partial Test)

The Wald test in SPSS is used to test whether there is an effect of the independent variables on the dependent variable partially. The following presents the partial test results from SPSS:

Based on table 4 the results of the partial test (wald test) can be seen from the 12 independent variables. There are four independent variables that have a significant effect on the incidence of DM, namely the variables of heredity history, physical activity, perceived benefits and knowledge DM have a p value of the Wald test (sig) <0.05, meaning that the variables of hereditary history, physical activity, perceived benefits and knowledge of DM have a significant partial effect on the incidence of DM in the model. The hereditary history variable has a wald test p value of 0.051 <0.05, so it rejects Ho or which means that hereditary history influences the incidence of DM, physical activity has a wald test p value of 0.005 <0.05 so it rejects Ho or which means physical activity which has little influence on the occurrence of DM. The perceived benefit variable has a wald test p value of 0.016 <0.05 so that it rejects Ho or which means that the perception of benefits that is not good has an influence on the incidence of DM. The DM knowledge variable has a Wald test p-value of 0.004 <0.05 so that it rejects Ho or which means that DM knowledge that is not good has an influence on DM events.

Table 4. Partial Test Results (Wald Test)

Step 1[a]	Variable	Coefisien	P	OR (IK95%)
	Hereditary History	-2,040	0,051*	0,130 (0,017-1,006)
	Physical Activity	1,932	0,005*	6,906 (1,799-26,510)
	Dietary Habit	-0,543	0,427	0,581 (0,152-2,219)
	Rest Pattern	1,106	0,106	3,023 (0,791-11,553)
	Stress Management	0,381	0,595	0,683 (0,168-2,780)
	Self-efficacy Scale	-0,003	0,997	0,997 (0,274-3,636)
	Perceived Benefits	2,345	0,016*	10,434 (1,537-70,813)
	Perception of Obstacles	0,627	0,253	1,873 (0,683-5,495)
	Perceived Vulnerability	0,361	0,758	1,435 (0,144-14,340)
	Perception of Severity	1,371	0,325	3,938 (0,257-60,284)
	Cues to Action	-0,699	0,375	0,497 (0,106-2,329)
	DM Knowledge	2,985	0,004*	19,790 (2,545-153,866)
	Constant	-3,949	0,107	0,019

*P Significant at α (<0.05)

The eight variables that have no effect on the incidence of DM are: diet, rest patterns, stress management, self-efficacy scale, perceived obstacles, perceived vulnerability, perceived severity, and cues to action.

Variable Interpretation

The following table presents the results of the logistic regression multivariate test with the enter method:

Based on the results of logistic regression testing presented in table 5, the variables of hereditary history, physical activity, perceived benefits and knowledge of dm have a p value of the wald test (sig) <0.05, meaning that the variables of ancestry, physical activity, perceived benefits and knowledge dm have significant partial effect on the incidence of dm in the model(Skyler et al., 2017)(Tosur and Inglis, 2023)(Liese et al., 2022). The ancestry variable has a wald test p value of 0.051 <0.05, so it rejects Ho or which means that hereditary history has an influence on the incidence of DM. the physical activity variable has a wald test p value of 0.005 <0.05 so it rejects Ho or which means physical activity has less influen-

Table 5. Reports the results of the Simple Logistic Regression test

Method	Variable	Coefisien	P	OR (IK95%)
Enter	Hereditary History	-2,040	0,051	0,130 (0,017-1,006)
	Physical Activity	1,932	0,005	6,906 (1,799-26,510)
	Perceived Benefits	2,345	0,016	10,434 (1,537-70,813)
	DM Knowledge	2,985	0,004	19,790 (2,545-153,866)
	Constant	-3,949		

ce on the incidence of diabetes. The perceived benefit variable has a wald test p value of 0.016 <0.05 so that it rejects Ho or which means that the perception of benefits that is not good has an influence on the incidence of DM. The DM knowledge variable has a Wald test p-value of 0.004 <0.05 so that it rejects Ho or which means that DM knowledge that is not good has an influence on DM events.

The hereditary history variable with an OR of 0.130 means that people who have a history of heredity are at greater risk of experiencing diabetes by 0.130 times compared to people who do not have a history of heredity. Physical activity variable with OR 6.906, people who do not carry out regular and measurable physical activity (code 1 independent variable) are more at risk of experiencing DM (code 1 dependent variable) as much as 6.906 times compared to people who do regular and measurable physical activity (code 0 on the independent variable). Value B = Natural logarithm of 6.906 = 1.932. Because the value of B is positive, physical activity has a positive relationship with the incidence of DM.

The perceived benefit variable has an OR of 10.434, so people who have perceived the benefits of self-management to prevent diabetes are not good (code 1 independent variable), are more at risk of experiencing diabetes (code 1 dependent variable) as much as 10.434 times compared to people who have good perceived benefits (code 0 on the independent variable). Value B = Natural logarithm of 10.434 = 2.345. Because the value of B is positive, the perceived benefit has a positive relationship with the incidence of DM.

The DM knowledge variable has an OR of 19.790, so people who have poor knowledge about DM (code 1 independent variable) are more at risk of experiencing DM (code 1 dependent variable) as much as 19.790 times compared to people who have good knowledge (code 0 on the variable independent). Value B = Natural logarithm of 19.790 = 2.985. Because the B value is positive, knowledge has a positive relationship with DM events. Based on the B values in the calculation above, the equation model formed is:

Y = -3,949 - 2,040 history of heredity + 1,932 physical activity + 2,345 perceived benefits + 2,985 knowledge dm.

So that through this logistic regression test it can be concluded that together interacting variables of physical activity, knowledge, perceived benefits have an effect on the incidence of diabetes mellitus in productive age in Pekalongan Regency. Low physical activity, inadequate knowledge about diabetes mellitus, perception of the benefits of prevention of diabetes mellitus and its complications and the perception that diabetes mellitus can lead to good complications can lead to the incidence of diabetes mellitus at productive age in Pekalongan district so that a model of behavioral engineering is needed. The provision of IEC (communication, information and education) as well as motivation and physical exercise interventions that can be applied easily by people with diabetes mellitus of productive age can support better self-management.

The risk factors for DM in productive age are very diverse, including congenital factors and related to habits/behaviors depending on the type of DM suffered(Ceriello and Prattichizzo, 2021)(Caussy, Aubin and Loomba, 2022). Genes are a factor that determines the inheritance of certain traits from a person to their offspring, This is no exception for someone with diabetes mellitus who may be inherited, although not always someone who has a hereditary history of diabetes mellitus will suffer from diabetes mellitus. The heredity factor will be a risk factor that arises when accompanied by a bad lifestyle, this is in accordance with the findings of Febri Yusnanda (2018), who conducted research on the effect of hereditary history on the incidence of pre-elderly diabetes mellitus at the BLUD Meuraxa Hospital, Banda Aceh City in 2017 (Yusnanda, Rochadi and Maas, 2018). While the findings of the physical activity variable have a correlation with the incidence of diabetes mellitus, in line with the findings of Andrea D. Smith's research, who conducted a systematic review study reviewing physical activity and the incidence of diabetes mellitus in the diabetology journal, found that high physical activity would reduce the incidence of diabetes mellitus by 26%, the more regular, measurable and the level of physical activity carried out (low, medium, high) will further increase the percentage reduction in the risk of incident diabetes mellitus in individuals (Smith et al., 2016). When doing physical activity, the body will use glucose in the muscles to be converted into energy. This causes a vacancy of glucose in the muscles. The emptiness that occurs causes the muscles to withdraw glucose in the blood so that the glucose level in the blood will drop. Doing regular physical activity can prevent diabetes by increasing the sensitivity of insulin cells in the body. So when you exercise, less insulin is needed to control blood sugar levels. The correlation of physical activity with the incidence of diabetes mellitus is also in line with the findings of Rifa Fadhilah Lubis's research which showed that aerobic gymnastic exercises determined by volume,

intensity, frequency and repetition can reduce glucose in the blood (Lubis and Kanzanabilla, 2021)(Crespo, Kirwan and Zierath, 2023)(Kumar et al., 2019)(Li et al., 2023).

The sociodemographic characteristics of the people in Pekalongan Regency are that most of them have graduated from elementary school, with an average level of income below the minimum wage, and have poor knowledge about diabetes mellitus. Physical activity which includes work activities, moving activities, recreational activities which include sports at productive age in Pekalongan Regency mostly work in the private sector, traders and farmers. Sports recreational activities are not a habit, and most of the activities of moving places use motorized vehicles.

A diet high in carbohydrates and fat will significantly increase blood glucose levels. The findings of a dietary study are related to the incidence of diabetes mellitus at reproductive age, in accordance with the findings of a systematic review by Lukas, et al (2017), who found that consumption of whole grains, fruit and fruit and milk reduce the risk of diabetes mellitus(Schwingshackl, Hoffmann and Knu, 2017)(Lewgood et al., 2021)(Klin et al., 2023).

The findings of the knowledge variable about diabetes mellitus are significantly related to the incidence of diabetes mellitus in accordance with research conducted by Addisu Getti, et al (2021), who conducted a study on the determinants of diabetes ketoacidosis in the Amhara region, Ethiopia in 2021. In this research, the respondents who did not receive education about diabetes mellitus were shown to be significantly associated with the incidence of diabetic ketoacidosis (Getie et al., 2021). Research conducted by Badescu SV, et al in 2016, found that there was a tendency to increase the incidence of depression in people with diabetes mellitus after a diagnosis was made (Sv et al., 2016). Whereas in the study of the determinants of the incidence of diabetes mellitus, it was also found that poor stress management would tend to increase the incidence of diabetes mellitus of productive age in Pekalongan Regency, so from the findings of the two results of this study, it can be concluded that stress and diabetes mellitus have a significant correlation.

This study linked twelve independent variables (history, physical activity, diet, rest patterns, stress management, self-efficacy scale, perceived benefits, perceived obstacles, perceived vulnerability, perceived severity, tendency to act, and knowledge about diabetes mellitus with the incidence of DM. The strength of this study lies in the complexity of the variables studied. However, the approach chosen is cross sectional so that it is less able to predict the magnitude of each risk factor.

CONCLUSION

The results of the logistic regression test on the determinants of productive age DM obtained the equation model Y = -3.949 - 2.040 history of heredity + 1.932 physical activity + 2.345 perceived benefits + 2.985 knowledge dm. So that through this logistic regression test it can be concluded that together interacting variables of physical activity, knowledge, perceived benefits influence the incidence of diabetes mellitus in productive age in Pekalongan Regency. Low physical activity, inadequate knowledge about diabetes mellitus, no perception of the benefits of preventing diabetes mellitus and its complications and the perception that the condition of diabetes mellitus can lead to complications can lead to the incidence of diabetes mellitus at productive age in Pekalongan district. It is hoped that the results of this study can be useful for DM sufferers, health workers and future researchers to develop research designs and the variables studied.

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REFERENCES

Kemenkes. RI, "Hasil Riskesdas Kemenkes 2018," Kementerian. Kesehatan. RI, 2018.

International diabetes federation, IDF Diabetes Atlas IDF Diabetes Atlas, 10th ed. IDF, 2021.

International diabetes federation, "IDF ATLAS REPORTS," 2022.

Di Iorgi N, Napoli F, Allegri AE, Olivieri I, Bertelli E, Gallizia A, Rossi A, Maghnie M. Diabetes insipidus--diagnosis and management. Horm Res Paediatr. 2012;77(2):69-84. doi: 10.1159/000336333. Epub 2012 Mar 16. PMID: 22433947.

American Diabetes Association. Economic Costs of Diabetes in the U.S. in 2017. Diabetes Care. 2018 May;41(5):917-928. doi: 10.2337/dci18-0007. Epub 2018 Mar 22. PMID: 29567642; PMCID: PMC5911784.

Afroz A, Hird TR, Zomer E, Owen A, Chen L, Ademi Z, Liew D, Magliano DJ, Billah B. The impact of diabetes on the productivity and economy of Bangladesh. BMJ Glob Health. 2020 Jun;5(6):e002420. doi:

10.1136/bmjgh-2020-002420. PMID: 32532757; PMCID: PMC7295429.

Kesmodel US. Cross-sectional studies - what are they good for? Acta Obstet Gynecol Scand. 2018 Apr;97(4):388-393. doi: 10.1111/aogs.13331. PMID: 29453895.

Thiese MS. Observational and interventional study design types; an overview. Biochem Med (Zagreb). 2014;24(2):199-210. doi: 10.11613/BM.2014.022. Epub 2014 Jun 15. PMID: 24969913; PMCID: PMC4083571.

Meh K, Jurak G, Sori M, Rocha P, Sember V. Validity and Reliability of IPAQ-SF and GPAQ for Assessing Sedentary Behaviour in Adults in the European Union: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2021 Apr 26;18(9):4602. doi: 10.3390/ijerph18094602. PMID: 33926123; PMCID: PMC8123682.

Meh K, Sember V, uri S, Vähä-Ypyä H, Rocha P, Jurak G. Reliability and Validity of Slovenian Versions of IPAQ-SF, GPAQ, and EHIS-PAQ for Assessing Physical Activity and Sedentarism of Adults. Int J Environ Res Public Health. 2021 Dec 31;19(1):430. doi: 10.3390/ijerph19010430. PMID: 35010686; PMCID: PMC8744779.

K. Meh, V. Sember, S. Đuri, H. Vähä-ypyä, and P. Rocha, "Reliability and Validity of Slovenian Versions of IPAQ-SF , GPAQ , and EHIS-PAQ for Assessing Physical Activity and Sedentarism of Adults," 2022.

J. Oh, H. Cho, Y. Y. Kim, and S. Y. Yoo, "Validation of the Korean Version of the Nursing Profession Self-Efficacy Scale : A Methodological Study," 2021.

Magon A, Conte G, Dellafiore F, Arrigoni C, Baroni I, Brera AS, Avenido J, De Maria M, Stievano A, Villa G, Caruso R. Nursing Profession Self-Efficacy Scale-Version 2: A Stepwise Validation with Three Cross-Sectional Data Collections. Healthcare (Basel). 2023 Mar 3;11(5):754. doi: 10.3390/healthcare11050754. PMID: 36900758; PMCID: PMC10001547.

Lazemi Z, Barkhordari-Sharifabad M. Translation and psychometric evaluation of the persian version of the "Nursing Profession Self-Efficacy Scale". BMC Nurs. 2023 Jan 25;22(1):24. doi: 10.1186/s12912-023-01182-3. PMID: 36698171; PMCID: PMC9875412.

Mumu SJ, Ali L, Barnett A, Merom D. Validity of the global physical activity questionnaire (GPAQ) in Bangladesh. BMC Public Health. 2017 Aug 10;17(1):650. doi: 10.1186/s12889-017-4666-0. PMID: 28797237; PMCID: PMC5553893.

Kenne Pagui EC, Salvan A, Sartori N. Improved estimation in negative binomial regression. Stat Med. 2022 Jun 15;41(13):2403-2416. doi: 10.1002/sim.9361. Epub 2022 Mar 11. PMID: 35277866; PMCID: PMC9314673.

Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003 Oct 20;3:21. doi: 10.1186/1471-2288-3-21. PMID: 14567763; PMCID: PMC521200.

Skyler JS, Bakris GL, Bonifacio E, Darsow T, Eckel RH, Groop L, Groop PH, Handelsman Y, Insel RA, Mathieu C, McElvaine AT, Palmer JP, Pugliese A, Schatz DA, Sosenko JM, Wilding JP, Ratner RE. Differentiation of Diabetes by Pathophysiology, Natural History, and Prognosis. Diabetes. 2017 Feb;66(2):241-255. doi: 10.2337/db16-0806. Epub 2016 Dec 15. PMID: 27980006; PMCID: PMC5384660.

Tosur M, Huang X, Inglis AS, Aguirre RS, Redondo MJ. Imprecise Diagnosis of Diabetes Type in Youth: Prevalence, Characteristics, and Implications. Res Sq [Preprint]. 2023 May 25:rs.3.rs-2958200. doi: 10.21203/rs.3.rs-2958200/v1. PMID: 37293006; PMCID: PMC10246228.

Liese AD, Reboussin BA, Kahkoska AR, Frongillo EA, Malik FS, Imperatore G, Saydah S, Bellatorre A, Lawrence JM, Dabelea D, Mendoza JA. Inequalities in Glycemic Control in Youth with Type 1 Diabetes Over Time: Intersectionality Between Socioeconomic Position and Race and Ethnicity. Ann Behav Med. 2022 May 18;56(5):461-471. doi: 10.1093/abm/kaab086. PMID: 34570884; PMCID: PMC9116580.

Ceriello A, Prattichizzo F. Variability of risk factors and diabetes complications. Cardiovasc Diabetol. 2021 May 7;20(1):101. doi: 10.1186/s12933-021-01289-4. PMID: 33962641; PMCID: PMC8106175.

Caussy C, Aubin A, Loomba R. The Relationship Between Type 2 Diabetes, NAFLD, and Cardiovascular Risk. Curr Diab Rep. 2021 Mar 19;21(5):15. doi: 10.1007/s11892-021-01383-7. PMID: 33742318; PMCID: PMC8805985.

F. Yusnanda, R. K. Rochadi, and L. T. Maas, "Pengaruh Riwayat Keturunan terhadap Kejadian Diabetes Mellitus pada Pra Lansia di BLUD RSUD Meuraxa Kota Banda Aceh Tahun 2017 The Effect of Heritage History on Dijet Events of Diabet Mellitus in Pre-Scars in BLUD RSUD Meuraxa Kota Banda Aceh 2017," vol. 4, no. 1, pp. 18–28, 2018.

A. D. Smith, A. Crippa, J. Woodcock, S. Brage, and A. D. Smith, Physical activity and incident type 2 diabetes mellitus : a systematic review and dose – response meta-analysis of prospective cohort studies," Diabetologia, pp. 2527–2545, 2016.

R. F. Lubis and R. Kanzanabilla, "Latihan Senam dapat Menurunkan Kadar Glukosa Darah Pada Penderita Diabetes Melitus Tipe II Exercise Can Reduce Blood Glucose Levels in Type II Diabetes Mellitus Patients menurut Kementerian Kesehatan Republik," vol. 1.

Kanaley JA, Colberg SR, Corcoran MH, Malin SK, Rodriguez NR, Crespo CJ, Kirwan JP, Zierath JR. Exercise/Physical Activity in Individuals with Type 2 Diabetes: A Consensus Statement from the American College of Sports Medicine. Med Sci Sports Exerc. 2022 Feb 1;54(2):353-368. doi: 10.1249/MSS.0000000000002800. PMID: 35029593; PMCID: PMC8802999.

Sampath Kumar A, Maiya AG, Shastry BA, Vaishali K, Ravishankar N, Hazari A, Gundmi S, Jadhav R. Exercise and insulin resistance in type 2 diabetes mellitus: A systematic review and meta-analysis. Ann Phys Rehabil Med. 2019 Mar;62(2):98-103. doi: 10.1016/j.rehab.2018.11.001. Epub 2018 Dec 13. PMID: 30553010.

M. Li, M. S. Jeeyavudeen, G. Arunagirinathan, and J. Pappachan, "Is Type 2 Diabetes Mellitus a Behavioural Disorder? An Evidence Review for Type 2 Diabetes Mellitus Prevention and Remission through Lifestyle Modification," no. May, 2023.

Schwingshackl L, Hoffmann G, Lampousi AM, Knüppel S, Iqbal K, Schwedhelm C, Bechthold A, Schlesinger S, Boeing H. Food groups and risk of type 2 diabetes mellitus: a systematic review and meta-analysis of prospective studies. Eur J Epidemiol. 2017 May;32(5):363-375. doi: 10.1007/s10654-017-0246-y. Epub 2017 Apr 10. PMID: 28397016; PMCID: PMC5506108.

Lewgood J, Oliveira B, Korzepa M, Forbes SC, Little JP, Breen L, Bailie R, Candow DG. Efficacy of Dietary and Supplementation Interventions for Individuals with Type 2 Diabetes. Nutrients. 2021 Jul 12;13(7):2378. doi: 10.3390/nu13072378. PMID: 34371888; PMCID: PMC8308746.

Klammer C, Schindler K, Bugl R, Plazek D, Vötter M, Kirchner T, Martino C, Klammer-Martin J, Brix J, Dämon S, Hoppichler F, Kautzky-Willer A, Kruschitz R, Toplak H, Clodi M, Ludvik B. Ernährungsempfehlungen für Menschen mit Diabetes (Update 2023) [Nutrition for diabetic patients (Update 2023)]. Wien Klin Wochenschr. 2023 Jan;135(Suppl 1):62-77. German. doi: 10.1007/s00508-023-02170-y. Epub 2023 Apr 20. PMID: 37101026; PMCID: PMC10133079.

Getie A, Wondmieneh A, Bimerew M, Gedefaw G, Demis A. Determinants of diabetes ketoacidosis among diabetes mellitus patients at North Wollo and Waghimra zone public hospitals, Amhara region, Northern Ethiopia. BMC Endocr Disord. 2021 Feb 18;21(1):26. doi: 10.1186/s12902-021-00692-y. PMID: 33602195; PMCID: PMC7890609.

Badescu SV, Tataru C, Kobylinska L, Georgescu EL, Zahiu DM, Zagrean AM, Zagrean L. The association between Diabetes mellitus and Depression. J Med Life. 2016 Apr-Jun;9(2):120-5. PMID: 27453739; PMCID: PMC4863499.