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Determinants of type 2 diabetes mellitus in agricultural community

Fitria Saftarina, Dian isti Angraini, Diana Mayasari
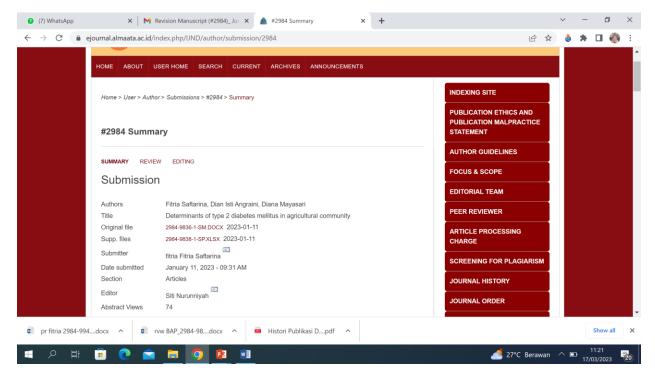
Fakultas Kedokteran Universitas Lampung

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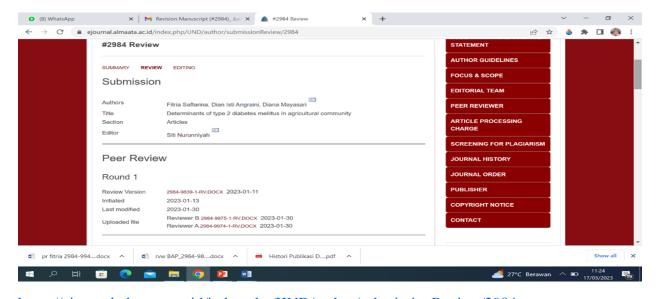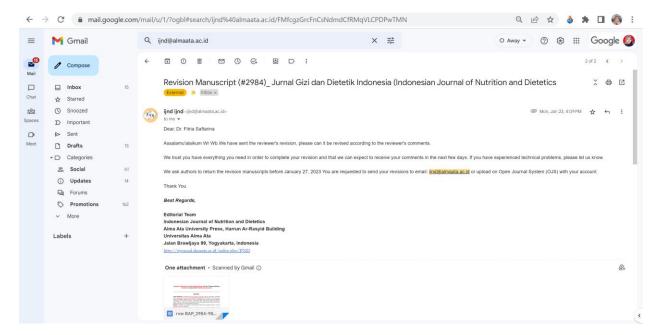
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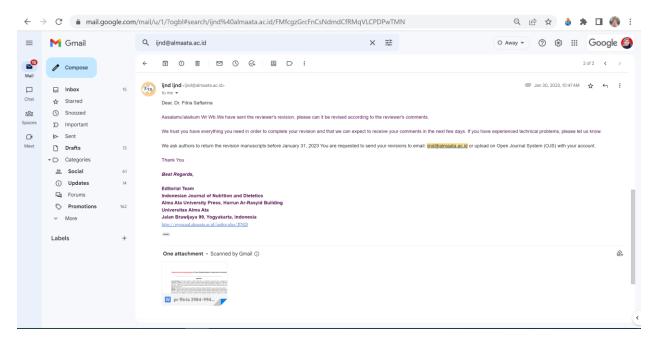https://ejournal.almaata.ac.id/index.php/IJND/author/submission/2984

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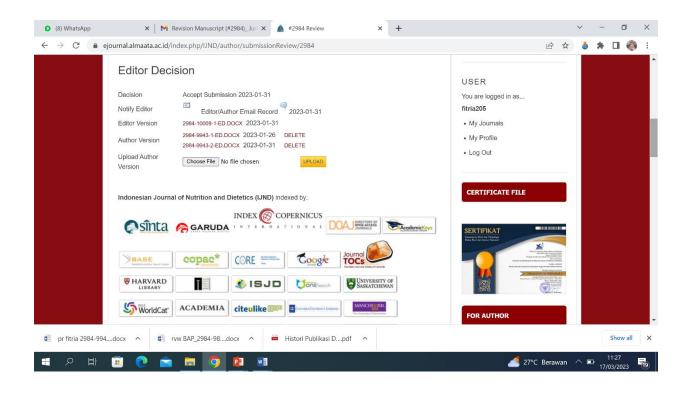https://ejournal.almaata.ac.id/index.php/IJND/author/submissionReview/2984

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~~Analysis of Determinant Factors~~Determinants of Type 2 Diabetes Mellitus ~~Incidence~~ in Agricultural ~~Populations~~Community

ABSTRAK

Latar Belakang: *Prevalensi ~~diabetes mellitus (DM) tipe 2~~DM di perkotaan sebanyak 2,6%, sedangkan ~~dibandingkan~~ di pedesaan sebanyak 1,4%. Namun, ~~hal yang cukup menarik,~~ proporsi Glukosa Darah Puasa Terganggu (GDPT) dan Toleransi Glukosa Terganggu (TGT) pada penduduk di pedesaan lebih tinggi dibandingkan perkotaan, yaitu 3,7% dan 5,4%. Hal ini menunjukkan bahwa penduduk di pedesaan lebih berisiko terkena DM tipe 2 jika tidak dilakukan intervensi.*

Tujuan: *Penelitian ini bertujuan menganalisis determinan kejadian DM tipe 2 pada ~~populasi~~ penduduk agrikultur*

Metode: *Jenis penelitian adalah ~~case control study~~kasus kontrol, dengan sampel penelitian adalah petani yang menderita DM tipe 2 (kasus) dan petani yang tidak menderita DM (kontrol). Penelitian dilaksanakan di Kecamatan Gedong Tataan, Kabupaten Pesawaran dengan jumlah masing-masing kelompok sebanyak 41 orang. Pengambilan data dilakukan dengan mengukur Indeks Massa Tubuh, tekanan darah, wawancara dengan kuesioner IPAQ-SF dan Indeks Brinkmann*

Hasil: *Hasil penelitian didapatkan jumlah jenis pestisida, faktor genetik dan aktivitas fisik merupakan faktor determinan terjadinya DM tipe 2. Responden yang menggunakan pestisida ≥ 2 jenis pestisida memiliki risiko 2,7 kali kemungkinan menderita DM tipe 2 dibanding yang menggunakan satu~~1~~ jenis pestisida (95% CI: …). Responden dengan riwayat keluarga menderita DM tipe 2 memililiki kemungkinan ~~(odds)~~ 16,0~~3~~ kali menderita DM tipe 2 dibandingkan yang tidak memiliki riwayat keluarga DM (95% CI: …). Respoden dengan aktivitas fisik rendah memiliki kemungkinan ~~(odds)~~ 4,2~~154~~ menderita DM tipe 2 dibandingkan responden dengan yang memiliki aktivitas fisik tinggi (95% CI: …).*

Kesimpulan: *Diperlukan upaya promotif dan preventif terutama untuk masyarakat yang menggunakan pestisida ~~≥ 2jenis pestisida,~~ riwayat keluarga menderita DM tipe 2 dan aktivitas fisik rendah.*

KATA KUNCI*: Faktor Risiko, D~~iabetes Mellitus~~M Tipe 2, ~~Populasi~~ Agrikultur, Aktivitas Fisik*

ABSTRACT

Background: *The prevalence of type 2 Diabetes Mellitus (DM) in urban areas was 2.6% compared to 1.4% in rural areas. However, ~~what is quite interesting is that~~ the proportion of disturbed fasting blood glucose (GDPT) and impaired glucose tolerance (TGT) in rural residents ~~wa~~is higher than in urban areas, namely 3.7% and 5.4%, respectively. ~~This shows~~Thus, that rural residents ~~aa~~re more likely to be at risk of developing type 2 DM if no intervention is carried out.*

Objectives: *This study aims to analyze the determinants of ~~the prevalence of~~ type 2 DM in the agricultural ~~population~~community.*

Methods: *This ~~type of~~ research ~~wa~~is a case-control study. Samples ~~, with the sample being~~ were farmers ~~who suffer from~~with type 2 DM (cases) and farmers ~~who do not suffer from~~without type 2 DM (controls). The research was conducted in Gedong Tataan District, Pesawaran Regency with the number of each group as many as 41 people. Data were collected by measuring ~~b~~Body ~~M~~mass ~~i~~Index ~~,~~and blood pressure, ~~interviews with~~ using the IPAQ-SF questionnaire and the Brinkmann Index.*

Results: *The results showed that the number of ~~types of~~ pesticide ~~type~~ss, ~~genetic factors~~family history, and physical activity were the determining factors for ~~the occurrence of~~ type 2 DM. ~~Respondents~~Farmers who used ~~pesticides~~ >2 types of pesticides ~~of pesticides~~ had a 2.7 times risk of suffering from type 2 DM compared to those who used one~~1~~ type of pesticide (95% CI: …)~~e~~. ~~Respondents~~Farmers with a family history of type 2 DM ha~~d~~~~ave~~ a 16.0~~3~~ times possibility of suffering from type 2 DM compared to those without a family history of type 2 DM. ~~Respondents~~Farmers with low physical activity had 4.2~~,154~~ chances of suffering from type 2 DM compared to ~~respondents~~those who had high physical activity (95% CI: …).*

Conclusions: *Promotive and preventive efforts are needed, especially for ~~people~~farmers who use pesticides ~~2 types of pesticides~~, family history of ~~suffering from~~ type 2 DM and have low physical activity.*

KEYWORD: *risk factors, type 2 diabetes mellitus~~of DM~~, agricultural ~~population~~community, physical activity*

INTRODUCTION

Currently, it is estimated that 463 million people in the world suffer from Diabetes Mellitus (DM), especially in low- and middle-income countries. About 1.6 million deaths per year are caused by DM. Currently, Indonesia ranks the 6th largest in the number of DM sufferers (1). Based on the results of the 2018 Basic Health Research, it was found that the proportion of DM sufferers was 10.9%, this result increased compared to the 2013 Riskesdas of 8.5%. This shows that DM is an important health problem (2).

Diabetes Mellitus (DM) Type 2 is the most common type of diabetes compared to other types of diabetes. Approximately 85-90% are type 2 DM of all existing DM cases

(3). The factors that influence the occurrence of type 2 DM are risk factors that cannot be changed/modified and risk factors that can be changed/modified. The non-modifiable risk factors are family history or genetics. While the risk factors that can be changed/modified are obesity, lack of physical activity, smoking, hypertension, dyslipidemia and diet (4).

Based on the epidemiological data of DM, it was found that the cases were more common in urban areas than in rural areas. ResultsRiskesdas (2018), it was found that the prevalence of DM in urban areas was 2.6% compared to 1.4% in rural areas. However, what is quite interesting is that the proportion of disturbed fasting blood glucose (GDPT) and impaired glucose tolerance (TGT) in rural residents is higher than in urban areas, namely 3.7% and 5.4%, respectively. This shows that residents in rural areas are more at risk of developing type 2 DM if no intervention is carried out (Riskesdas, 2018).

From the results of a systematic review, the risk factors for type 2 DM in rural areas are related to the use of pesticides (Hassan, 2020). This is because the chemical compounds contained in pesticides act as Endocrine Disrupting Chemical (EDC) which can disrupt the body's endocrine system. EDC that enters the body affects the pancreas, resulting in a failurefailing to produce the hormone insulin, causing an increase in blood sugar levels (6). Pesticide exposure factors such as a working period of more than 20 years, duration of spraying > 4 hours/s per day, frequency of spraying > 1 time/week, use of Personal Protective Equipment (PPE) and types of pesticides resulted in type 2 DM (Sari et al.,). In addition, personal hygiene behavior affects the accumulation of pesticides in the body which causes damage to pancreatic cells.(Juntarawijit, 2018).

Lampung Province has a land area of around 35,38835 km2 with the main commodity being agriculture (Central Bureau of Statistics Lampung Province, 2018). The prevalenceincidence of type 2 DM in Lampung Province is 22,345 cases or 1.37% and as many as 0.82% of cases are in rural areas (10). Pesawaran Regency, which is an agricultural center, has health problems such as skin dermatitis due to pesticides, infectious diseases such as dengue fever, pulmonary tuberculosis and non-communicable diseases such as hypertension , and diabetes (Central Bureau of Statistics Lampung Province, 2018). Based on data from the Pesawaran District Annual Report, the incidence of DM is 1583 cases and as many as 527 cases are in Gedong Tataan District (Central Bureau of Statistics of Pesawaran Regency, 2019).

Thus, Bbased on the empirical data above, it is necessary to study further the determinants of the incidence of type 2 DM in the agricultural/agricultural community considering the limited research related to this issuematter.

MATERIALS AND METHODS

~~Types of~~ This research used a ~~is c~~Case~~-~~Control ~~Study~~design~~,This approach is used~~ to identify risk factors for pesticide exposure to ~~the incidence of Type 2 Diabetes Mellitus~~type 2 DM ~~among~~in farmers. This design beg~~ins~~an with the ~~effect~~case, namely, type 2 DM which wa~~i~~s identified at ~~this~~ present~~time~~ and then trace~~d~~s the risk factors by comparing the case group and the control group. This research was conducted in the Gedong Tataan Health Center Working Area, Pesawaran Regency and ~~its implementation~~ was implemented for 6 months from May 2022 to July 2022. The population in the study were all farmers in the Gedong Tataan Health Center working area, Pesawaran Regency who suffered from type 2 ~~diabetes~~DM. To overcome the drop out, the number of samples was added by 10% to get 41.23 and rounded up to 41 farmers for each group (the case group was 41 farmers and the control group was 41 farmers).

The sampling method is purposive sampling, with inclusion and exclusion criteria as follows:

a. Inclusion criteria
   1. Case inclusion criteria:
      a. ~~F~~farmers with type 2 DM in the working area of Gedong Tataan Health Center
      b. ~~F~~farmers by checking fasting blood glucose levels 126 mg/dL~~l~~
      c. Farmers taking insulin, oral antidiabetic drugs
      d. Pesticide user for at least one~~1~~ year
   2. Control inclusion criteria:
      a. ~~F~~farmers w~~ho are not patients with~~ithout type 2 DM in the working area of the Gedong Tataan Health Center
      b. ~~F~~farmers with an examination of fasting glucose levels < 126 mg/dL~~l~~
      ~~b.~~c. ~~p~~Patients who ~~seek~~ sought treatment at the Gedong Tataan Health Center and d~~id~~o not suffer from type 2 DM with the work of farmers using pesticides
      ~~c.~~d. Pesticide user for at least one~~1~~ year
b. Exclusion Criteria
   1. The patients ~~has~~ had other types of DM
   2. Patients with hypertension

The variables identified in the study were the dependent variable was DM type 2 DM and the independent variables were: type of pesticide, working period, duration of spraying, spraying frequency, using Personal Protective Equipment and personal hygiene behavior. To identify and measure the research variables, the following research instruments and tools were used:

1. Pesticide Exposure Questionnaire
2. *Glucometer*
3. *Stick* Glucose
4. Lancet

This research was approved by the Research Ethics Committee of the Faculty of Medicine, University of Lampung and the Community Development and Politics Unit (Kesbangpolinmas). In this study, an informed consent form was prepared to protect respondents and researchers when carrying out research. The data obtained wereis processed through the process of editing, coding, scoring, data entry, data cleaning, and data analysis. Univariate analysis was conducted to see the frequency distribution of each variable. Bivariate analysis using Chi-Square (α = 5%) to test the hypothesis and see the risk of the independent variable through the Odd Ratio (OR) value. The analysis continued with the Chi-Suare test. This test is used to prove that pesticide exposure wais a risk factor for type 2 diabetesDM.

RESULTS AND DISCUSSIONS

The characteristics of respondents, namely type 2 DM farmers with and and not without type 2 DM can be seen in Table 1. There is a relationship between age (p=0,021; OR= 0,468; CI = 0,368-0,593) and income (p=0,034; OR=1,349; CI = 0,561-3,246) with the incidence of type 2 DM in farmers, while there is no relationship between education and the incidence of type 2 DM (p=0,503; OR=1,349; CI=0,561-3,246) in farmers in Gedong Tataan Public health Centre, Pesawaran Regency.

Table 1. Characteristics of type 2 DM and not DM farmers in Gedong Tataan Health Centre

No	Characteristics	Type 2 DM		Notn Type 2 DM		Ttotal		p	OR	CI
		n	%	n	%	n	%			
1	Age									
	a. > 40 yearsr	41	53.2	36	46.8	77	93,9	0,021	0,468	0,368-0,5
	b. < 40 years	0	0	5	6.1	5	6,1			
2	Education									

		n	%	n	%	n	%			
	a. Low	25	61	22	53.7	47	57,3	0,503	1,349	0,561-3,246
	b. High	16	39	19	46.3	35	42,7			
3	Income									
	a. Low	23	56.1	32	78	27	32,9	0,034	2,783	1,062-7,2..
	b. High	18	43.9	9	22	55	67,1			

Table 2 Risk Factors of Type 2 DM on Farmers in Gedong Tataan Health Centre, Pesawaran District, Lampung Province

No	Variable	Type 2 DM		Not Type 2 DM		Total		p	OR	CI
		n	%	n	%	n	%			
1	Genetic									
	a. Family history	26	31.7	4	4.9	30	36,6	0,000	16.03	4,77 -53,85
	b. No Family History	15	18,3	37	45,1	52	63,4			
2	Smoking habit									
	a. Smoking	15	18,3	18	22,0	33	40,2	0.499	0.737	0,30-1,7
	b. No Smoking	26	31,7	23	28,0	49	59,8			
3	Nutrition Status									
	a. Malnutrition	13	15,9	10	12,2	23	28,0	0.461	1.439	0,54-3,7
	b. Normal	28	34,1	31	37,8	59	72,0			
4	Hypertension									
	a. Hypertension	22	53.7	29	70.7	51	62,2	0.111	0.479	0,193-1,
	b. Normal	19	23,2	12	14,6	31	37,8			
5	Knowledge									
	a. Bad	34	41,5	37	45,1	71	86,6	0.286	1.781	0,613-5,178
	b. Good	7	8,5	4	4,9	11	13,4			
6	Physical Activity									
	a. Low	28	34,1	0	0	28	34,1	0,000	4.154	2,587-6,671
	b. High	13	15,9	41	50	54	65,9			
7	Amount of Pesticide									
	≥ 2 type	26	31,7	16	19,5	42	51,2	0,027	2,708	1,109-6,615
	1 type	15	18,3	25	30,5	40	48			

Older people awere more at risk of developing type 2 diabetes mellitus than younger people, especially those over 40 years of age. At that age, glucose intolerance begins to increase, reducing the ability of Langerhans cells to produce insulin (12). The results of the study stated that there was a decrease in mitochondrial activity in muscle cells by 35% in older individuals. As a result, fat levels in the muscles will increase by

30%, thus triggering insulin resistance (13). Type 2 diabetes in the elderly appears to be due to several mechanisms including genetic background, long life expectancy leading to decreased insulin secretion, and modification of several factors responsible for the incidence of central obesity (14). However, several recent studies have also demonstrated a role for other factors such as arginine vasopressin (AVP) or a c-terminal fragment, called Copeptin, in the mechanism of DM in the elderly through lower insulin sensitivity and AVP influencing hepatic glycogenolysis and glucagon secretion (6).

Based on Table 2, risk factors of type 2 DM were genetic/family history, physical activity and amount of pesticide. Risk factors of genetic/family history who suffered type 2 DM 26 respondents (31,7%) while not suffer type 2 DM as much as 4 respondents (4,9%). From the results of hypothesis testing, p value = 0.000; OR =16,03; CI = CI 5.77-53.8. It means, there was a significant relationship between genetic factors and type 2 DM, respondents with a family history of DM have a 16.03 times chance (odds) of suffering from type 2 DM compared to those without a family history of DM. This study was in line with a study conducted in rural India, namely family history/genetic factors have a 15.9 times risk of suffering from DM compared to individuals who did not have a family history of suffering from type 2 DM (3). The risk factor for individuals who have one of their parents suffering from DM was 15%, whereas if both parents have DM, the risk of the individual suffering from DM was 75% (15).

Risk factors of low physical activity who suffered from type 2 DM was 28 respondents or (34,1%) have low physical activity, while there were no respondents who do not suffer from type 2 DM. Based on the hypothesis test, p = 0.000; OR = 4,154; CI =2.587-6.671. It means that there is a significant relationship between physical activity and the incidence of type 2 DM and respondents with low physical activity have 4,154 odds (odds) of suffering from DM compared to respondents with high physical activity. The physical activity carried out by respondents was divided into heavy and moderate physical activity, with the definition of sufficient physical activity. Heavy physical activity if you do exercise more than 5 times in 1 week. The intensity of exercise is inversely proportional to the incidence of DM, good exercise / physical activity and more will reduce the risk of developing DM (World Health Organization, 2017; Monika et al., 2019). This research is in line with studies that show this. More intense physical activity will burn more calories, thereby reducing the risk of being overweight and visceral fat which is a risk factor for DM, helping to control blood sugar levels and reducing the risk of heart disease and nerve damage.

Burning calories increases the body's metabolism to release energy, so it can increase insulin sensitivity (Bird and Hawley, 2017).

Physical activity that a person does will be able to affect her/his sugar levels, because the use of glucose by muscles will increase when someone does high physical activity. Endogenous glucose will increase to be able to keep blood sugar levels in balance. Physical activity habits are also associated with the speed of recovery of muscle blood sugar. The muscles in the body will react by using the stored glucose so that blood sugar levels will decrease. Some physical activities such as jogging, carried out for 30-40 minutes can increase the entry of glucose into cells by 7 to 20 times compared to not doing these activities.

Regular physical activity has been shown to improve body composition for example, through decreased abdominal adiposity and improved weight control, improved lipoprotein lipid profile (e.g., through decreased triglyceride levels, increased high-density lipoprotein (HDL) cholesterol levels and decreased low-density lipoprotein (LDL ratio)) to HDL, improve glucose homeostasis and insulin sensitivity, reduce blood pressure, increase autonomic tone, reduce systemic inflammation, reduce blood clotting, increase coronary blood flow, augment cardiac function and improve endothelial function.22 Good nutrition and physical activity are important parts of a healthy lifestyle to prevent diabetes because it they can help maintain blood glucose levels in the body.

For the use of pesticides, in the case group using more than >2 types of pesticides, 26 respondents (31.7%) compared to the control group as many as 16 respondents (19.5%). The results of the analysis showed that farmers who used more than 2 types of pesticides had a significant correlation to the incidence of type 2 DM with a risk of 2.708 times (95% CI = 1.1091-6.6245) compared to farmers who used one type of pesticides of 1 type. The results of this study are in line with farmers in Ngablak Subdistrict, Magelang Regency who use >more than 2 types of pesticides, which haved a significant correlation with pesticides (with OR = 2.03; with 95% CI: 1.58 - 2.61). Sso, it can be concluded that the type of pesticide mixture does not have a significant correlation significantly with the incidence of type 2 diabetes mellitus DM (16). The results of a study on farmers in Thailand whose prevalence of diabetes wais associated with exposure to more than 2 types of pesticides (8).

CONCLUSIONS AND RECOMMENDATIONS

Based on our findings, we can conclude that:

1. The type of pesticide, the frequency of spraying and PPE are determinant factors for ~~the occurrence of~~ type 2 DM in the agricultural ~~population~~ community in Gedong Tataan District.

2. ~~Respondents~~ Farmers who use~~d~~ organochlorine pesticides have ~~4.7 times the odds (odds) of~~ a greater risk of suffering from DM compared to those who do not have a family history of DM.

3. ~~Respondents~~ Farmers with a frequency of spraying $\geq$2 times per week ~~have the probability (odds) of 9.6 times~~ are more likely to suffer from DM compared to respondents who spray <2 times ~~/~~ per week.

4. ~~Respondents~~ Farmers with poor PPE use behavior are ~~have a 5.8 times chance (odds)~~ at a higher risk of suffering from type 2 DM compared to ~~respondents~~ those with good PPE use behavior

~~For Suggestion,~~ Therefore, we suggested that supervision is needed from the Pesticide Commission regarding the circulation of organochlorine pesticides on the market. In addition, promotional efforts are ~~needed regarding~~ key to promoting the use of appropriate pesticides ~~use that are~~ is safe for health. For further research, cross-sectoral cooperation is ~~needed~~ required to maintain the health status of pesticide-using farmers.

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Determinant Factors of Type 2 Diabetes Mellitus in Agricultural Community

ABSTRAK

Latar Belakang: Prevalensi diabetes mellitus (DM) tipe 2 di perkotaan sebanyak 2,6%, sedangkan di pedesaan sebanyak 1,4%. Namun, proporsi Glukosa Darah Puasa Terganggu (GDPT) dan Toleransi Glukosa Terganggu (TGT) pada penduduk di pedesaan lebih tinggi dibandingkan perkotaan, yaitu 3,7% dan 5,4%. Hal ini menunjukkan bahwa penduduk di pedesaan lebih berisiko terkena DM tipe 2 jika tidak dilakukan intervensi.
Tujuan: Penelitian ini bertujuan menganalisis determinan kejadian DM tipe 2 pada penduduk agrikultur
Metode: Jenis penelitian adalah kasus kontrol, dengan sampel penelitian adalah petani yang menderita DM tipe 2 (kasus) dan petani yang tidak menderita DM (kontrol). Penelitian dilaksanakan di Kecamatan Gedong Tataan, Kabupaten Pesawaran dengan jumlah masing-masing kelompok sebanyak 41 orang. Pengambilan data dilakukan dengan mengukur Indeks Massa Tubuh, tekanan darah, wawancara dengan kuesioner IPAQ-SF dan Indeks Brinkmann
Hasil: Hasil penelitian didapatkan jumlah pestisida, faktor genetik dan aktivitas fisik merupakan faktor determinan terjadinya DM tipe 2. Responden yang menggunakan pestisida ≥2 jenis pestisida memiliki risiko 2,7 kali kemungkinan menderita DM tipe 2 dibanding yang menggunakan satu jenis pestisida (95% CI: 1.109-6.615). Responden dengan riwayat keluarga menderita DM tipe 2 memililiki kemungkinan 16,0 kali menderita DM tipe 2 dibandingkan yang tidak memiliki riwayat keluarga DM (95% CI: 4.77-53.85). Respoden dengan aktivitas fisik rendah memiliki kemungkinan 4,2 menderita DM tipe 2 dibandingkan responden dengan yang memiliki aktivitas fisik tinggi (95% CI: 2.587-6.671).
Kesimpulan: Diperlukan upaya promotif dan preventif terutama untuk masyarakat yang menggunakan pestisida, riwayat keluarga menderita DM tipe 2 dan aktivitas fisik rendah.

KATA KUNCI*: Faktor Risiko, Diabetes Mellitus Tipe 2, Agrikultur, Aktivitas Fisik*

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ABSTRACT

Background: *The prevalence of type 2 Diabetes Mellitus (DM) in urban areas was 2.6% compared to 1.4% in rural areas. However, the proportion of disturbed fasting blood glucose (GDPT) and impaired glucose tolerance (TGT) in rural residents was higher than in urban areas, namely 3.7% and 5.4%, respectively. Thus, that rural residents are more likely to be at risk of developing type 2 DM if no intervention is carried out.*
Objectives: *This study aims to analyze the determinants of type 2 DM in the agricultural community.*
Methods: *This research was a case-control study. Samples were farmers with type 2 DM (cases) and farmers without type 2 DM (controls). The research was conducted in Gedong Tataan District, Pesawaran Regency with the number of each group as many as 41 people. Data were collected by measuring body mass index and blood pressure using the IPAQ-SF questionnaire and the Brinkmann Index.*
Results: *The results showed that the number of pesticide, family history, and physical activity were the determining factors for type 2 DM. Farmers who used >2 types of pesticides had a 2.7 times risk of suffering from type 2 DM compared to those who used one type of pesticide (95% CI: 1.109-6,615). Farmers with a family history of type 2 DM had a 16.0 times possibility of suffering from type 2 DM compared to those without a family history of type 2 DM (95%: 4.77 -53.85). Farmers with low physical activity had 4.2 chances of suffering from type 2 DM compared to those who had high physical activity (95% CI: 2.587-6.671).*
Conclusions: *Promotive and preventive efforts are needed, especially for farmers who use pesticides, family history of type 2 DM and have low physical activity.*

KEYWORD*: risk factors, type 2 diabetes mellitus, agricultural community, physical activity*

INTRODUCTION

Currently, it is estimated that 463 million people in the world suffer from Diabetes Mellitus (DM), especially in low- and middle-income countries. About 1.6 million deaths per year are caused by DM. Currently, Indonesia ranks the 6th largest in the number of DM sufferers (1). Based on the results of the 2018 Basic Health Research, it was found that the proportion of DM sufferers was 10.9%, this result increased compared to the 2013 Riskesdas of 8.5%. This shows that DM is an important health problem (2).

Diabetes Mellitus (DM) Type 2 is the most common type of diabetes compared to other types of diabetes. Approximately 85-90% are type 2 DM of all existing DM cases (3). The factors that influence the occurrence of type 2 DM are risk factors that cannot be changed/modified and risk factors that can be changed/modified. The non-modifiable risk factors are family history or genetics. While the risk factors that can be changed/modified are obesity, lack of physical activity, smoking, hypertension, dyslipidemia and diet (4).

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Based on the epidemiological data of DM, it was found that the cases were more common in urban areas than in rural areas. Results Riskesdas (2018), it was found that the prevalence of DM in urban areas was 2.6% compared to 1.4% in rural areas. However, what is quite interesting is that the proportion of disturbed fasting blood glucose (GDPT) and impaired glucose tolerance (TGT) in rural residents is higher than in urban areas, namely 3.7% and 5.4%, respectively. This shows that residents in rural areas are more at risk of developing type 2 DM if no intervention is carried out (Riskesdas, 2018).

From the results of a systematic review, the risk factors for type 2 DM in rural areas are related to the use of pesticides (Hassan, 2020). This is because the chemical compounds contained in pesticides act as Endocrine Disrupting Chemical (EDC) which can disrupt the body's endocrine system. EDC that enters the body affects the pancreas, failing to produce the hormone insulin, causing an increase in blood sugar levels.

Lampung Province has a land area of around 35,38835 km2 with the main commodity being agriculture (Central Bureau of Statistics Lampung Province, 2018). The prevalence of type 2 DM in Lampung Province is 22,345 cases or 1.37% and as many as 0.82% of cases are in rural areas (7). Pesawaran Regency, which is an agricultural center, has health problems such as skin dermatitis due to pesticides, infectious diseases such as dengue fever, pulmonary tuberculosis and non-communicable diseases such as hypertension and diabetes (Central Bureau of Statistics Lampung Province, 2018). Based on data from the Pesawaran District Annual Report, the incidence of DM is 1583 cases and as many as 527 cases are in Gedong Tataan District (Central Bureau of Statistics of Pesawaran Regency, 2019). Thus, based on the empirical data above, it is necessary to study further the determinants of the incidence of type 2 DM in the agricultural community considering the limited research related to this issue.

MATERIALS AND METHODS

This research used a case-control design to identify risk factors for pesticide exposure to type 2 DM among farmers. This design began with the case, namely, type 2 DM which was identified at present and then traced the risk factors by comparing the case group and the control group. This research was conducted in the Gedong Tataan Health Center Working Area, Pesawaran Regency and was implemented for 6 months from May 2022 to July 2022. The population in the study were all farmers in the Gedong Tataan Health Center working area, Pesawaran Regency who suffered from type 2 DM. To overcome the dropout, the number of samples was added by 10% to get 41.23 and rounded up to 41 farmers for each group (the case group was 41 farmers and the control group was 41 farmers).

The sampling method is purposive sampling, with inclusion and exclusion criteria as follows:
a. Inclusion criteria
   1. Case inclusion criteria:

a. Farmers with type 2 DM in the working area of Gedong Tataan Health Center

b. Farmers by checking fasting blood glucose levels 126 mg/dL

c. Farmers taking insulin, oral antidiabetic drugs

d. Pesticide user for at least one year

2. Control inclusion criteria:

    a. Farmers without type 2 DM in the working area of the Gedong Tataan Health Center

    b. Farmers with an examination of fasting glucose levels <126 mg/dL

    c. Farmers who sought treatment at the Gedong Tataan Health Center and did not suffer from type 2 DM with the work of farmers using pesticides

    d. Pesticide user for at least one year

b. Exclusion Criteria

    The farmers had other types of DM

    The variables identified in the study were the dependent variable type 2 DM and the independent variables were:

1. Age define number of age risk of DM >40 years

2. Education define last education junior high school

3. Income define income based on Indonesia Central Bureau of Statistics >1.500.000 (Rp)

4. genetic define family history of diabetes Mellitus (above 2 generation of family)

5. Smoking habit define score Brinkman Index >200

6. obesity define excess body mass based on body mass index (BMI) >25

7. hypertension define Increased systolic blood pressure ≥ 140mmHg and diastolic ≥ 90 mmHg

8. knowledge of DM define skor from questionnaire of DM risk factors >75

9. Phyiscal activity define every body movement made by the respondent during the past week which measured by International Physical Activity Questionaire (IPAQ)

10. number of pesticide define pesticide used by farmers >1

To identify and measure the research variables, the following research instruments and tools were used:

1. Questionnaire of DM, IPAQ

2. *Glucometer*

3. *Stick* Glucose

4. Lancet

5. Microtoise

6. Weight scale

7. tensimeter

This research was approved by the Research Ethics Committee of the Faculty of Medicine No.582/UN26.18/PP.05.02.00/2022. In this study, an informed consent form was prepared to protect

respondents and researchers when carrying out research. The data obtained were processed through the process of editing, coding, scoring, data entry, data cleaning, and data analysis. Univariate analysis was conducted to see the frequency distribution of each variable. Bivariate analysis using Chi-Square (α= 5%, CI=95%) to test the hypothesis and see the risk of the independent variable through the Odd Ratio (OR) value.

RESULTS AND DISCUSSIONS

The characteristics of respondents, namely farmers with and without type 2 DM can be seen in Table 1. There is a relationship between age (OR= 0.468; CI = 0.368-0.593) and income (OR=1.349; CI = 0.561-3.246) with the incidence of type 2 DM in farmers, while there is no relationship between education and the incidence of type 2 DM (OR=1.349; CI=0.561-3.246) in farmers in Gedong Tataan Public health Centre, Pesawaran Regency.

Table 1. Characteristics of type 2 DM and not DM farmers in Gedong Tataan Health Centre

Characteristics	Type 2 DM		Not Type 2 DM		Total		p	OR	95 %CI
	n	%	n	%	n	%			
Age									
a. > 40 years	41	100	36	87.8	77	93.9	0.021	0.468	0,368-0,593
b. ≤ 40 years	0	0	5	12.2	5	6.1			
Education									
a. Low	25	61	22	53.7	47	57.3	0.503	1,349	0,561-3,246
b. High	16	39	19	46.3	35	42.7			
Income									
a. Low	23	56.1	32	78	27	32.9	32.9	2,783	1,062-7,289
b. High	18	43.9	9	22	55	67.1			

Table 2 Risk Factors of Type 2 DM on Farmers in Gedong Tataan Health Centre, Pesawaran District, Lampung Province

Variable	Type 2 DM		Not Type 2 DM		Total		p	OR	CI
	n	%	n	%	n	%			
Genetic									
a. Family history	26	63.4	4	9.8	30	36,6	0,000	16.03	4,77 - 53,85
b. No Family History	15	36.6	37	90.2	52	63,4			

Smoking habit									
a. Smoking	15	36.6	18	43.9	33	40,2	0.499	0.737	0,30-1,78
b. No Smoking	26	63.4	23	56.1	49	59,8			
Nutrition Status									
a. Malnutrition	13	31.7	10	24.4	23	28,0	0.461	1.439	0,54-3,79
b. Normal	28	68.3	31	75.6	59	72,0			
Hypertension									
a. Hypertension	22	53.7	29	70.7	51	62,2	0.111	0.479	0,193-1,19
b. Normal	19	46.3	12	29.3	31	37,8			
Knowledge									
a. Bad	34	82.9	37	90.2	71	86,6	0.286	1.781	0,613-5,178
b. Good	7	17.1	4	9.8	11	13,4			
Physical Activity									
a. Bad	28	68.3	0	0	28	34,1	0,000	4.154	2,587-6,671
b. Good	13	31.7	41	50	54	65,9			
Amount of Pesticide									
>= 2 jenis	26	63.4	16	39	42	51,2	0,027	2,708	1,109-6,615
1 jenis	15	36.6	25	61	40	48			

Older people were more at risk of developing type 2 diabetes mellitus than younger people, especially those over 40 years of age. At that age, glucose intolerance begins to increase, reducing the ability of Langerhans cells to produce insulin (9). The results of the study stated that there was a decrease in mitochondrial activity in muscle cells by 35% in older individuals. As a result, fat levels in the muscles will increase by 30%, thus triggering insulin resistance (10). Type 2 diabetes in the elderly appears to be due to several mechanisms including genetic background, long life expectancy leading to decreased insulin secretion, and modification of several factors responsible for the incidence of central obesity (11). However, several recent studies have also demonstrated a role for other factors such as arginine vasopressin (AVP) or a c-terminal fragment, called Copeptin, in the mechanism of DM in the elderly through lower insulin sensitivity and AVP influencing hepatic glycogenolysis and glucagon secretion (12).

Based on Table 2, risk factors of type 2 DM were genetic/family history, physical activity and number of pesticide. Risk factors of genetic/family history who suffered type 2 DM 26 respondents (63.4%) while not suffer type 2 DM as much as 4 respondents (9.8%). From the results of hypothesis testing, OR =16,03; CI = CI 4.77-53.8. It means, there was a significant relationship between genetic factors and type 2 DM, respondents with a family history of DM had a 16.03 times chance (odds) of suffering from type 2 DM compared to those without a family history of DM. This study was in line with a study conducted in rural India, namely family history/genetic factors had a 15.9 times risk of suffering from DM compared to individuals who did not have a family history of suffering from type 2 DM (3). The risk factor for individuals

who have one of their parents suffering from DM was 15%, whereas if both parents had DM, the risk of the individual suffering from DM was 75% (13).

Risk factors of low physical activity who suffered from type 2 DM was 28 respondents or 68.3% had low physical activity, while there were no respondents who do not suffer from type 2 DM. Based on the hypothesis test, OR = 4,154; CI =2.587-6.671. It means that there is a significant relationship between physical activity and the incidence of type 2 DM and respondents with low physical activity have 4,154 odds (odds) of suffering from DM compared to respondents with high physical activity. The intensity of exercise is inversely proportional to the incidence of DM, good exercise / physical activity and more will reduce the risk of developing DM (14)(15). More intense physical activity will burn more calories, thereby reducing the risk of being overweight and visceral fat which is a risk factor for DM, helping to control blood sugar levels and reducing the risk of heart disease and nerve damage. Burning calories increases the body's metabolism to release energy, so it can increase insulin sensitivity (16).

Physical activity that a person does will be able to affect her/his sugar levels because the use of glucose by muscles will increase when someone does high physical activity. Endogenous glucose will increase to be able to keep blood sugar levels in balance. Physical activity habits are also associated with the speed of recovery of muscle blood sugar. The muscles in the body will react by using the stored glucose so that blood sugar levels will decrease. Some physical activities such as jogging carried out for 30-40 minutes can increase the entry of glucose into cells by 7 to 20 times compared to not doing these activities (17).

Regular physical activity has been shown to improve body composition for example, through decreased abdominal adiposity and improved weight control, improved lipoprotein lipid profile (e.g., through decreased triglyceride levels, increased high-density lipoprotein (HDL) cholesterol levels and decreased low-density lipoprotein (LDL ratio)) to HDL, improve glucose homeostasis and insulin sensitivity, reduce blood pressure, increase autonomic tone, reduce systemic inflammation, reduce blood clotting, increase coronary blood flow, augment cardiac function and improve endothelial function (18) Good nutrition and physical activity are important parts of a healthy lifestyle to prevent diabetes because they can help maintain blood glucose levels in the body.

For the use of pesticides, in the case group using $\geq$2 types of pesticides, 26 respondents (63.4%) compared to the control group as many as 16 respondents (39%). The results of the analysis showed that farmers who used more than 2 types of pesticides had a significant correlation to the incidence of type 2 DM with a risk of 2.7 times (95% CI = 1.11-6.62) compared to farmers who used one type of pesticides. The results of this study are in line with farmers in Ngablak Subdistrict, Magelang Regency who use $\geq$2 types of pesticides, which had a significant correlation with pesticides (OR= 2.03; 95% CI: 1.58 - 2.61). So, it can be concluded that the type of pesticide mixture does not have a significant correlation

significantly with the incidence of type 2 DM (19). The results of a study on farmers in Thailand whose prevalence of diabetes was associated with exposure to more than 2 types of pesticides (20).

CONCLUSIONS AND RECOMMENDATIONS

Based on our findings, we can conclude the determinant risk factors for type 2 DM in the agricultural population in Gedong Tataan District, Pesawaran Regency are a family history of type 2 DM, low physical activity and the number of pesticides.

Our recommendation, promotive, preventive and early detection efforts are needed, especially for people who have a family history of type 2 DM, efforts to increase physical activity programs at individual, family and environmental levels in the agricultural population in Gedong Tataan District and cross-sector collaboration to provide education related to the use of pesticides.

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