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Prevalence of Type 2 Diabetes in Women Farm Worker: Study in Horticulture Area, Bandungan, Semarang Regency, Indonesia

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Abstract: ***Nowadays, there are scientific evidences correlates between environmental exposure to type 2 diabetes. Environmental pollution such as pesticides in agriculture area also play a role in the development of type 2 diabetes. This study aims to determine the prevalence of type 2 diabetes in women farm worker in the horticulture farming area. The study was conducted on 52 respondents in Bandungan District, Semarang Regency, Central Java Province, Indonesia. Cross sectional design are used to assess the prevalence of type 2 diabetes in exposed women farm worker. The results showed that there were significant relationship between work period, frequency of spraying plants, and use of personal protective equipment (PPE) with the incidence of type 2 diabetes. There was no association between the length of work with the incidence of type 2 diabetes.***
Keywords: Pesticide exposure, type 2 diabetes, woman farm worker.

I. INTRODUCTION

Diabetes mellitus (DM) is currently one of the biggest health problems in Indonesia and even in the world with a projected increase in new cases. DM is a chronic disease that occurs due to metabolic disorders in the body characterized by high blood glucose levels (hyperglycemia).[1] The World Health Organization (WHO) reported an increase in diabetics from 108 million people in 1980 to 422 million in 2014. The global prevalence of diabetes aged >18 years also increased from 4.7% in 1980 to 8.5% in 2014 The prevalence of diabetes is increasing faster in developing countries such as Indonesia. Diabetes is a major cause of blindness, kidney failure, heart attacks, strokes, and lower limb amputations, even death.[2] Diabetes mellitus is known as the silent killer because this disease is often not realized by the sufferer and is only known after complications occur. Over the past few years, scientific evidence has emerged that environmental contaminants are thought to play a role in the pathogenesis of type 2 diabetes. Pesticides are a source of environmental pollution which is increasingly widespread and some have the potential to accumulate in the body either through direct exposure or through chains food. Referring to the results of a review conducted by Evangelou et al. (2016), that from 22 reviewed studies showed an association between exposure to pesticides and the incidence of diabetes (OR = 1.58; 95% CI = 1.32–1.90, p = 1.21×10^{-6}, I^2 = 66.8%), and there was a correlation between pesticide exposure and type 2 diabetes (OR = 1.61; 95% CI = 1.37-1.88, p = 3.51×10^{-9},I^2=0%). Analysis based on the type of pesticide resulted in an increased risk of diabetes for dichlorodiphenyldichlorethylene (DDE), heptachlor, hexachlorobenzene (HCB), dichlorodiphenyltrichloroethane (DDT), and trans-nonchlor or chlordane. In a review conducted by Mohamed et al. (2014) showed that organophosphate pesticides damage glucose homeostasis and cause insulin resistance in type 2 diabetes. [3 4] Farmers use excessive and uncontrolled amounts of pesticides. Farmers override health aspects as a negative impact of exposure to these chemical pesticides. The phenomenon of pest resistance and resurgence that occurs causes farmers to increase the volume of pesticides at disproportionate doses, meaning that the pesticide mixture used is based on estimates only without looking at the recommended dosage printed on the bottle or pesticide packaging. The increasing mix of types of pesticides, the volume used, and the increase in the frequency of spraying further increases the level of pesticide exposure to farmers. Farmers will continue to use pesticides in an effort to avoid crop failures due to pests and diseases which risk the damage to crops and crop failure. Today, scientific research and publications begin to explain the link between exposure to pesticides and the incidence of various types of non-communicable diseases, one of which is type 2 diabetes. This research was conducted in the horticulture farming area in Bandungan Subdistrict, Semarang Regency. Bandungan is located at an altitude of 892-915 msl with topography in the form of a slope or peak so that the environmental conditions are very suitable for horticulture cultivation. The lack of research that explains the association of pesticide exposure with type 2 diabetes in Indonesia has

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led researchers to be interested in conducting this study, given the increasing cases of type 2 diabetes that are in line with the increasing use of pesticides each year.

Emerging scientific evidence showed that diabetes can be affected by exposure to pollutants in the environment. Research conducted by Azandjeme et al in 2013 showed that exposure to pesticides, especially organochlorines and their metabolites, is thought to provide a higher risk of developing type 2 diabetes.[5] The negative effects of pesticide exposure on type 2 diabetes can occur through mechanisms of glucose homeostasis destruction and cause insulin resistance in type 2 diabetes. Homeostasis is the body's ability to maintain an internal environment in a constant or balanced state as an adaptation to internal or external conditions that are constantly changing. Glucose homeostasis is the body's mechanism to maintain blood glucose levels within a certain range (70-110 mg/dL) by regulating the balance of glucose production in the liver and glucose uptake by peripheral tissues such as muscle tissue and fat tissue. Glucose homeostasis is regulated primarily by the secretion of pancreatic hormones, namely insulin and glucagon. Insulin resistance is a complex metabolic disorder that causes the body to not be able to use blood glucose properly. The formation of advanced glycation end products, accumulation of lipid metabolites, activation of inflammatory pathways and oxidative stress are involved in the pathogenesis of insulin resistance. Ultimately, this molecular process activates a series of stress pathways involving the serine kinase group which in turn has a negative effect on insulin signaling.[4] This study aims to determine the prevalence of type 2 diabetes in female farmers in the Bandungan horticulture farming area, Semarang, Indonesia.

II. METHODOLOGY

The type of this research was observational analytic with cross sectional approach. The total sample of this study were 52 subjects. Sampling was done by non-probability sampling with purposive sampling technique. The criteria for consideration in sampling were female farmers who actively work in the agricultural area and are willing to take blood samples. This research was conducted in October 2018 to January 2019 in the horticultural agriculture area of Bandungan Subdistrict, Semarang Regency.

The independent variables of this study were duration of work, length of work, frequency of spraying plants, use of PPE, while the dependent variable was the incidence of type 2 diabetes. Analysis of the relationship between independent variables and dependent variables using chi square analysis. Analysis of relationships on 2x2 tables with a sample number> 40 using chi square correction continuity.

Subjects with type 2 diabetes were diagnosed with fasting blood glucose criteria of ≥126 mg/dl and accompanied by typical diabetes symptoms such as polyuria, polydipsia, polyphagia, and others. Taking serum samples was tested by the glucose oxidase-pap method (GOD-PAP). Independent variables were obtained from respondents through interviews using questionnaires.

III.RESULT AND DISCUSSION

The World Health Organization (WHO) has provided guidelines for classifying body weight status based on the Body Mass Index (BMI). Men and women who have a BMI of 30 kg/m^2 are considered obese and are generally at higher risk for type 2 diabetes than people with excess body weight (BMI between 25.0 and 29.9 kg/m^2) or thin (BMI between 18.5 and 24.9 kg/m^2).[6] The results indicated that on average respondents had excessive BMI and there were 15 respondents included in the obesity category. This showed that respondents belonging to the obese group have a greater chance of suffering from type 2 diabetes (Table 1).

Body fat distribution is also an important risk factor for obesity-related diseases. Excess abdominal fat (also known as central fat or upper body) is associated with an increased risk of cardiometabolic diseases including type 2 diabetes. Waist circumference is often used as an indicator of abdominal fat mass, because this waist circumference correlates with abdominal fat mass (subcutaneous and intra abdominal). Women who have a waist circumference of more than 88 cm are considered a higher risk for type 2 diabetes.[6] The results showed the average waist circumference of the respondents > 88 cm (57.7%). Respondents who have a waist circumference > 88 cm have a greater chance of suffering from type 2 diabetes (Table 1).

Passive smoking is associated with an increased risk of type 2 diabetes. Tobacco smoke consists of nearly 5,000 chemical compounds, including 43 carcinogens, carbon monoxide, nicotine, and other toxic substances. Nicotine is an important element in cigarette smoke which can cause insulin resistance by influencing insulin action. Animal studies have also shown that prenatal or neonatal nicotine exposure will cause a loss of pancreatic β cell function. Smokers both actively and passively are associated with oxidative stress, systemic inflammation, and endothelial dysfunction, which are very involved in insulin resistance and increase the risk of type 2 diabetes.[7] The results of this study indicated that the average respondents were passive smokers (80.8%). Respondents who included passive smoking had a greater chance of developing type 2 diabetes (Table 1).

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TABLE 1
FREQUENCY DISTRIBUTION OF RESPONDENTS CHARACTERISTICS

	Frequency (f)	Percentage (%)
Age		
17-25 years	7	13,5
26-35 years	16	30,8
36-45 years	16	30,8
46-55 years	10	19,2
56–65 years	3	5,8
Total	52	100,0
Body mass index		
Normal (20-24,9)	17	32,7
Overweight (25-29,9)	20	38,5
Class I obesity (30-34,9)	11	21,2
Class II obesity (35-39,9)	4	7,7
Total	52	100,0
Waist circumference		
> 88 cm	30	57,7
≤ 88 cm	22	42,3
Total	52	100,0
Passive smoker		
Yes	42	80,8
No	10	19,2
Total	52	100,0
Family history of diabetes		
No	48	92,3
Yes	4	7,7
Total	52	100,0

Based on the result, it was obtained that from 52 respondents it was known that 27 respondents worked ≥20 years and 48 respondents worked <20 years. The proportion of the incidence of type 2 diabetes in respondents whose work period ≥20 years was 29.6% and those without diabetes was 70.4%. While the proportion of the incidence of type 2 diabetes in respondents whose working period <20 years was 4% and those who do not have diabetes were 96%. Chi square continuity correction statistic test results obtained p-value=0.038<α=0.05, it was proven that there was a significant relationship between years of service with the incidence of type 2 diabetes (table 2).

Table 2 showed that from 52 respondents it was known that 44 respondents worked >40 hours per week and 8 respondents worked ≤40 hours per week. The proportion of the incidence of type 2 diabetes in respondents whose work duration was >40 hours per day was 15.9% and those without diabetes was 84.1%. While the proportion of the incidence of type 2 diabetes in respondents who work long was ≤40 hours per week by 25% and those without diabetes by 75%. The data showed that the proportion of the incidence of type 2 diabetes was greater among respondents who worked longer than 40 hours per week, and the proportion of respondents who did not suffer from diabetes was greater in respondents with a length of work >40 hours per week. Chi square continuity correction statistic test results obtained p-value=0.907>α=0.05, the hypothesis was rejected which means there was no relationship between the length of work with the incidence of type 2 diabetes.

The results of the study showed that from 52 respondents it was known that as many as 13 respondents the frequency of spraying the plants was high and 39 respondents the frequency of spraying the plants was low. The proportion of the incidence of type 2 diabetes in respondents whose frequency of spraying was high was 46.2% and those without diabetes was 53.8%. While the proportion of the incidence of type 2 diabetes in respondents whose frequency of spraying plants was low by 7.7% and those without diabetes was 92.3%. Chi square continuity correction statistic test results obtained p-value=0.006<α=0.05, it was proven that there was a significant relationship between the frequency of spraying plants and the incidence of type 2 diabetes (table 2).

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The results showed that from 52 respondents it was known that 24 respondents had poor practice of using PPE and 28 respondents used good PPE. The proportion of the incidence of type 2 diabetes in respondents with poor use of PPE was 33.3% and those without diabetes was 66.7%. While the proportion of the incidence of type 2 diabetes in respondents who used their PPE was 3.6% and those without diabetes were 96.4%. Chi square continuity correction statistical test results obtained p-value = 0.014 <α = 0.05, it was proven that there was a significant relationship between the use of PPE and the incidence of type 2 diabetes (table 2).

TABLE 2
BIVARIATE TEST RESULT

	Type 2 diabetes						*p-value*	PR (95% CI)
	Yes		No		Total			
	n	%	n	%	n	%		
Duration of work								
≥20 years	8	29,6	19	70,4	27	52	0,038	7,407
<20 years	1	4	24	96	25	48		(0,996-
Total	9	17,3	43	82,7	52	100		55,086)
Length of work								
>40 hours per week	7	15,9	37	84,1	44	84,62	0,907	0,636 (0,160-2,527)
≤40 hours per week	2	25	6	75	8	15,38		
Total	9	17,3	43	82,7	52	100		
Frequency of spraying plants								
>1 times per week	6	46,2	7	53,8	13	25	0,006	6,000 (1,744-20,643)
≤ 1 times per week	3	7,7	36	92,3	39	75		
Total	9	17,3	43	82,7	52	100		
Use of PPE								
Poor	8	33,3	16	66,7	24	46,15	0,014	9,3 (1,255-69,386)
Well	1	3,6	27	96,4	28	53,85		
Total	9	17,3	43	82,7	52	100		

Exposure to pesticides can cause disruption of glucose metabolism which increases the risk of diabetes. This work period showed the length of time in units of a person working as a farmer. The longer a person works as a farmer and is followed by activities that are at risk of being exposed to pesticides, so this can be said as chronic exposure. Long-term exposure to pesticides is associated with diabetes. Exposure to insecticides, especially from the organophosphate group for a long time can reduce the expression of muscarinic receptors, where the receptor mediates insulin production in pancreatic β cells. So that a decrease in muscarinic receptors can cause a decrease in insulin production.[8]

The use of PPE when spraying greatly affects the amount of pesticide particles entering the farmer's body. Pesticides can be absorbed into the body through the epidermis. The average skin cell is 25-40 µm in size. Absorption rates can also be affected by higher skin temperatures. Higher temperatures will also increase skin blood flow which causes the circulation of pesticides in the body.[9] The relative absorption rate of your palm is 1.3. [10]

IV. CONCLUSIONS

There were significant relationship between work period, frequency of spraying plants, and use of PPE with the incidence of type 2 diabetes. There was no association between length of work with the incidence of type 2 diabetes. Subsequent research can be done by checking pesticide biomarkers such as dialkyl phosphate (DAP) and 3-Phenol benzoate (3-PBA) metabolites in the body and analyzing their effects with other diabetes parameters such as HbA1C and HOMA IR.

V. ACKNOWLEDGMENT

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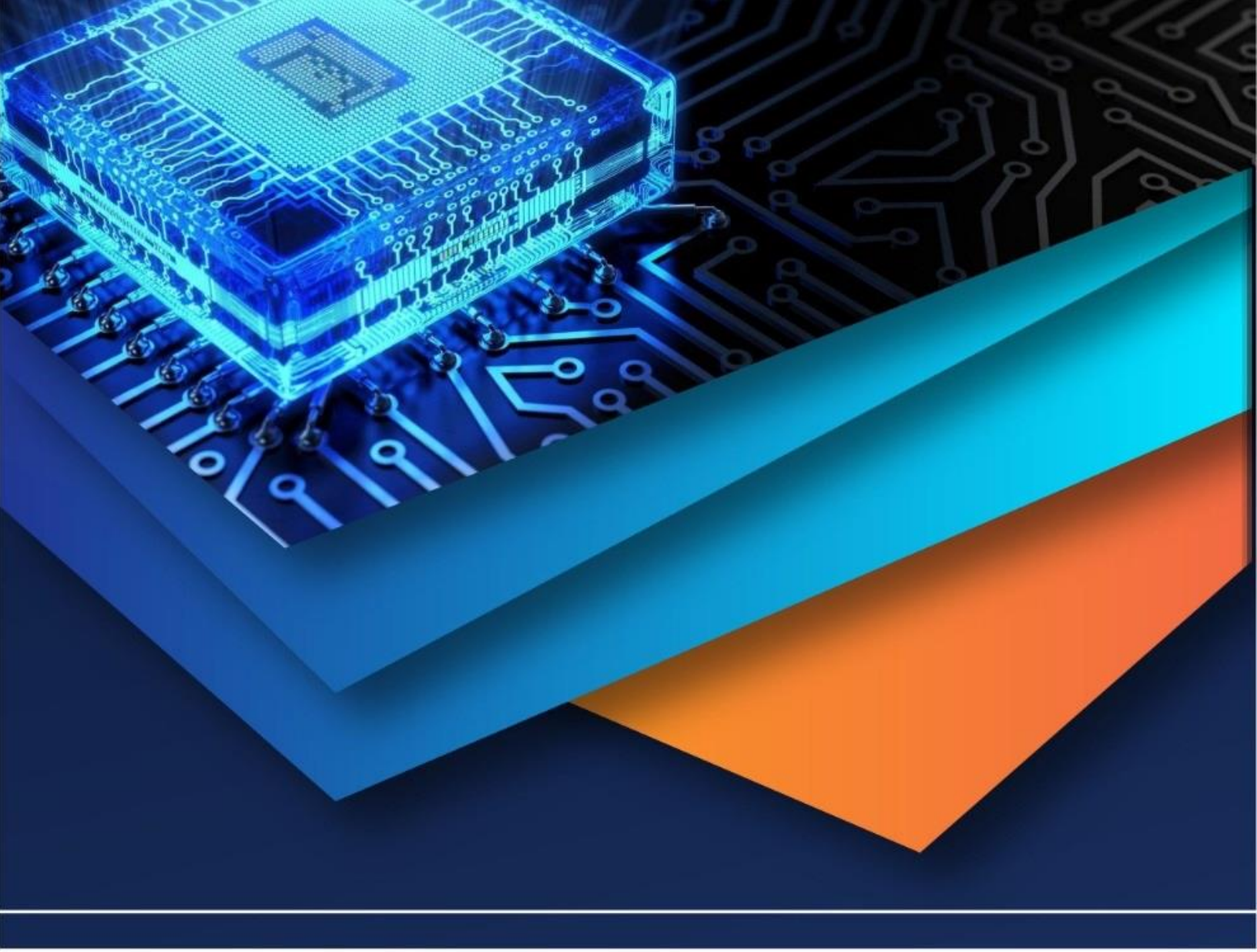

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