Determinants of Diabetes Mellitus Prevalence in Indonesia

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Submission date: 03-Sep-2021 10:41AM (UTC+0700)
Submission ID: 1640516056
File name: Research_Result_Article.docx (85.57K)
Word count: 5106
Character count: 27775

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Abstract. The number of people with diabetes mellitus worldwide continues to increase. In 2019, Indonesia was the seventh country with the largest number of people with diabetes in the world, where people with diabetes mellitus in Indonesia were dominated by the productive age population. This study aims to determine the variables that affect the prevalence of diabetes in Indonesia in 2018. The unit of analysis used is 34 provinces in Indonesia, where the data used comes from the Health Ministry of Republic of Indonesia and Statistics Indonesia. Graph analysis and multiple linear regression are the methods used in this study. The prevalence of obesity and the prevalence of hypertension have a positive effect on the prevalence of diabetes. Then the percentage of the population smoking, the percentage of the population not exercising, the unemployment rate, and the average length of schooling does not affect the prevalence of diabetes mellitus in Indonesia. The prevalence of obesity and hypertension needs special attention because they affect the prevalence of diabetes mellitus.

Keywords: diabetes mellitus, prevalence, multiple linear regression

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INTRODUCTION

According to the International Diabetes Federation (IDF), diabetes mellitus (DM) is a condition that occurs where the body cannot produce enough insulin for a long time. It is also a condition where the body cannot use the insulin hormone in the body effectively, causing glucose levels in the blood to rise. DM can cause various complications, such as nerve damage, kidney damage, etc. World Health Organization (WHO) claims DM is one of the top ten most common causes of death.

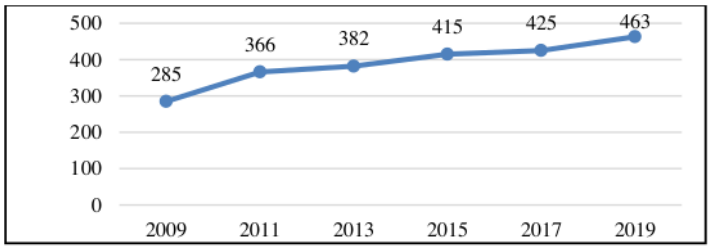

FIGURE 1. The population of the age group 20-79 years with diabetes mellitus in the world in 2009-2019 (millions of people)

Based on Fig. 1, in 2019, the number of people with DM globally is estimated at 463 million people for the population in the 20-79 year age group. The increase in the number of people with DM is expected to continue until 2045, and it reaches 700 million people (IDF, 2019). According to the IDF (2019), the number of deaths from diabetes is estimated at 4.2 million. This number increased from 2017, which was 4 million people.

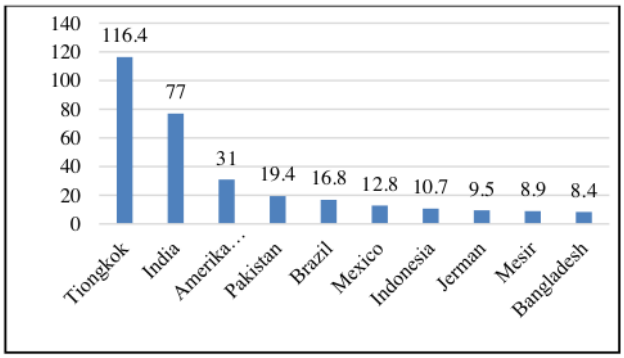

FIGURE 2. Ten countries with populations aged 20-79 years with the largest diabetes mellitus cases in 2019 (million people)

Based on Fig. 2, Indonesia is in the seventh position, with the number of diabetes mellitus cases reaching 10.7 million people. Based on the projections made by the IDF, the increase in the number of DM sufferers will continue until 2045 where the number of DM sufferers in Indonesia is estimated to reach 16.6 million people. Diabetes mellitus is the third highest cause of death in Indonesia for non-communicable diseases, where heart disease is the highest cause, followed by cancer. However, diabetes mellitus is one of the non-communicable diseases that is the target to be achieved in the Sustainable Development Goals, namely reducing complications caused by these non-communicable diseases.

Besides having an impact on early death and lower quality of life, DM can also have a significant economic impact on countries, health systems, and individuals, especially when DM treatment needs to be self-funded by the sufferer for the healing process (IDF, 2019). According to IDF (2019), the total expenditure devoted to DM is estimated at 760.3 billion dollars. This condition is expected to continue to increase. Then DM patients who experience complications can also increase spending for care and treatment to overcome the complications (Abror, Andayani, & Sulistiawaty, 2019).

According to Kemenkes (2018), the prevalence of DM patients aged 15 years and over in Indonesia is 2 percent, where the productive age group population has the highest prevalence of DM when compared to other age groups. One of the human capital to increase productivity is health (Todaro & Smith, 2011). With more DM sufferers in the productive age population, this can affect the quality of the productive age population in Indonesia.

A way to prevent diabetes is to do physical activity such as exercise. According to Boden, Chen, and Stein (2001), moderate-intensity exercise programs provide beneficial effects, including increased insulin sensitivity and improved glycemic control. However, according to the BPS (2018), the awareness of the Indonesian people to exercise is still relatively low. The percentage of the population who do sports during the past week is 35.7 percent. DM can cause so many complications, from disability to death. Based on the results of RISKESDAS data in 2018, only 9.3 percent of DM patients in Indonesia can recover without treatment, 90.7 percent need drugs to treat DM, starting from insulin injections and consume specific medicines. This shows that most people with DM require special treatment.

Isnaini and Ratnasari (2018) find that family history, unhealthy eating patterns, age, education, and obesity are variables that influence the occurrence of diabetes mellitus. In addition, research conducted by Nainggolan, Kristanto, and Edison (2013) states that age, body mass index, hypertension, high LDL cholesterol, high triglycerides, and a family history of DM are variables that influence the occurrence of diabetes. Research conducted by Mongisidi (2014) at the BLU Internal Polyclinic, RSUP. Prof. Dr. R. D. Kandou Manado using the chi-square test resulted in employment status and income level having a relationship with the incidence of type 2 diabetes mellitus. Furthermore, research conducted by Wahyuni and Alkaff (2013) aims to determine the general description and risk factors for diabetes in women of reproductive age in Indonesia using the variables of obesity, lack of physical activity, smoking behavior, frequent consumption of fat, less consumption of fruits and vegetables, and average age. From the results of this study, it is found 3.6 percent of DM patients were women of reproductive age, 29.6 percent were obese, 52.5 percent less

physical activity, 26.9 percent smoked, often consumed 16.7 percent fat, less fruit, and vegetable consumption. 97.3 percent, and the average age of women with diabetes is 32 years.

Sukenty, Shaluhiyah, and Suryoputro (2018) researched in the work area of the Pati II Health Center. The results are body mass index, eating patterns, and smoking habits or passive smoking are factors that affect prediabetes status at Pati II Health Center. Santosa and Rusmono (2016) conducted a study to find the effect of foot exercise on patients with diabetes mellitus. The results show that patients who did leg exercises four times a week experienced a decrease in brachial pressure. They conclude that foot exercise in patients with diabetes mellitus can reduce blood sugar levels and brachial pressure in patients with diabetes mellitus. Research conducted by Rosyada and Trihandini (2013) to determine the determinants of complications of diabetes mellitus in the elderly population finds that age, gender, obesity, smoking, and physical activity, where smoking is a determining factor for the occurrence of diabetes mellitus.

Trisnawati and Setyorogo (2013) conducted a study at the Cengkareng District Health Center, West Jakarta, to determine the factors that influence diabetes mellitus. The variables that influenced diabetes mellitus are age, family history, physical activity, blood pressure, stress, and cholesterol levels. Soetiarto, Roselinda, and Suhardi (2011) conducted a study to see the effect of obesity on diabetes mellitus. The results are obesity with waist circumference criteria plays a greater role in the incidence of diabetes mellitus when compared to obesity with body mass index criteria. The research was conducted by Harsa (2020) to determine the effect of smoking on diabetes mellitus. Nicotine content in cigarettes can cause a decrease in plasma aminopterin levels so that it can cause insulin resistance which can lead to diabetes mellitus. Pahlawati and Hugroho (2019) conducted a study to see the effect of education level and age on the incidence of diabetes mellitus in the work area of the Palaran Health Center, Samarinda City. The results indicate that the level of education and age influence the incidence of diabetes mellitus. People with low levels of education are more at risk of developing diabetes than people with high levels of education. Then the population aged more than 45 years is more at risk for developing diabetes mellitus than the population aged less than 45 years. Previous studies have focused more on research on diabetes mellitus that occurs from the individual side. Thus, this study aims to analyze the prevalence of diabetes mellitus in an area and the factors that determine it.

METHOD

This study uses cross-section data from the Ministry of Health of the Republic of Indonesia and Statistics Indonesia (BPS). The data used are diabetes mellitus prevalence data, obesity prevalence, hypertension prevalence, smoking population percentage, non-exercise population percentage, unemployment rate, and the average length of schooling for each province in Indonesia in 2018. The method used is the multiple linear regression method. Multiple linear regression is an analytical method that aims to find the effect of the independent variable on the dependent variable.

The prevalence of diabetes mellitus based on a doctor's diagnosis in the population aged more than 15 years is the percentage of the population aged more than 15 years who suffer from diabetes mellitus to the population aged more than 15 years. The prevalence of central obesity in the population aged more than 15 years is the percentage of the population aged more than 15 years who suffer from central obesity to the total population aged more than 15 years. The prevalence of hypertension based on a doctor's diagnosis in the population aged over 18 years is the percentage of the population aged more than 18 years who suffer from hypertension based on a doctor's diagnosis of the population with an age of more than 18 years. The percentage of smoking is the percentage of the population who do smoking activities to the total population. The unemployment rate is the percentage of the number of unemployed to the total labor force. The percentage of the population who did not exercise in the last week is the percentage of the population who did not exercise during the past week to the total population. The average length of schooling is the average number of years taken by residents aged 15 years and over to take all levels of education that have been undertaken.

RESULT AND DISCUSSION

Overview of diabetes mellitus prevalence in Indonesia

According to Kemenkes (2018), the prevalence of DM patients aged 15 years and over in Indonesia is 2 percent. By gender, the prevalence of the male population aged 15 years and over who suffers from diabetes mellitus is 1.7 percent. This number is smaller than the prevalence of women aged 15 years and over who suffer from diabetes mellitus, reaching 2.4 percent. Based on the level of education, the prevalence of people with diabetes aged more than 15 years, the population with educational status not completing elementary school has the highest prevalence of 2.9

percent, followed by population with education status who never went to school (2.8 percent) and population with graduated education status (2.8 percent).

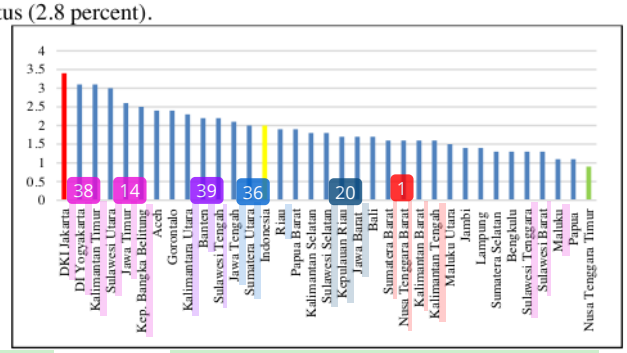

Figure 3. Diabetes Mellitus prevalence based on doctor's diagnosis in the population age 15 years and over by province in Indonesia 2018

Based on Fig. 3, 13 provinces have a higher prevalence of diabetes in Indonesia. DKI Jakarta is a province with the highest prevalence of diabetes prevalence, which is 3.4 percent, followed by DI Yogyakarta (3.1 percent) and East Kalimantan (3.1 percent). Meanwhile, the province with the lowest prevalence of diabetes is the province of East Nusa Tenggara.

According to Tandra (2017), residents who live in urban areas tend to be more at risk for developing diabetes due to unhealthy lifestyles such as consuming excessive carbohydrates, lack of physical activity, smoking, alcohol, etc. For example, according to the BPS (2018), DKI Jakarta is the province with the highest percentage of the population who exercised during the past week in Indonesia (44.93 percent). Based on the number of days to exercise, as many as 71.24 percent of the population who exercised do it only one day in the past week.

Overview of obesity prevalence in Indonesia

According to the Kemenkes (2018), the prevalence of obesity in Indonesia in the population aged more than 15 years is 31 percent. Based on Fig 4, there are 19 provinces with a higher prevalence of obesity in Indonesia. The province with the highest prevalence of obesity was North Sulawesi with 42.5 percent, followed by DKI Jakarta (41.9 percent) and East Kalimantan (37.3 percent). The province with the lowest prevalence of obesity is East Nusa Tenggara, with a prevalence of 19.3 percent.

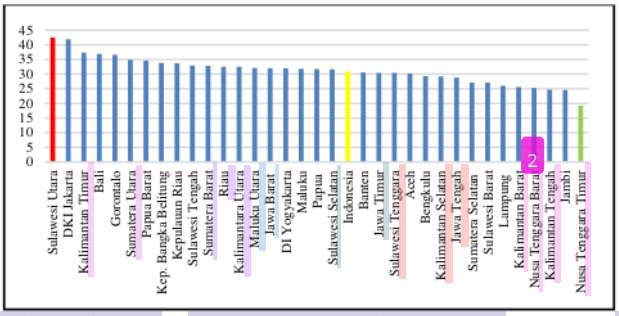

Figure 4. Prevalence of central obesity in the population aged 15 years and over by province in Indonesia in 2018

According to Puspitasari (2018), the factors that influence the incidence of obesity are gender, level of education, history of heredity, physical activity, and calorie intake. Physical activity can be in the form of sports or activities carried out daily. According to the BPS (2018), the number of residents who do sports in North Sulawesi is 28.43 percent. This number is below the national average for people who do sports. Then based on this number, as many as 73.54 percent of the population who exercised only do it for one day in the past week. It means the exercise will be less effective. As the province with the lowest obesity percentage, East Nusa Tenggara has a relatively small

percentage of the population who exercise, 26.19 percent. However, based on the activities carried out by the population in East Nusa Tenggara, most of the population in this province work in fields that require high physical activity, such as agriculture, fisheries, plantations, and industry.

Overview of hypertension prevalence in Indonesia

According to Kemenkes (2018), the prevalence of hypertension in the population aged over 18 years in Indonesia is 8.36 percent. Based on Fig. 5, there are 16 provinces with a higher prevalence of hypertension in Indonesia. North Sulawesi Province, with a prevalence of hypertension of 13.21 percent, is the province with the highest hypertension prevalence in Indonesia, followed by DI Yogyakarta and East Kalimantan. Papua Province has the lowest prevalence of hypertension in Indonesia, with a hypertension prevalence of 4.39 percent.

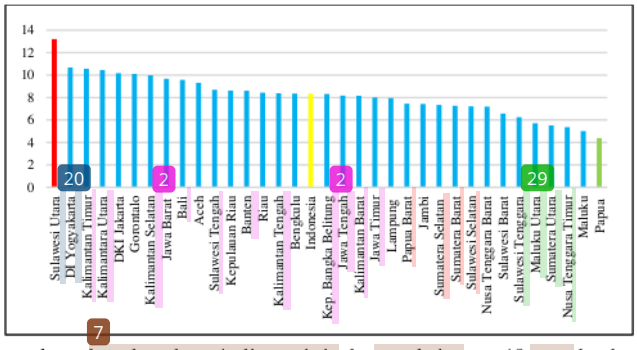

Figure 5. Hypertension prevalence based on doctor's diagnosis in the population age 18 years by the province in 2018

Several factors can cause hypertension, such as smoking habits, coffee consumption, consumption of fatty foods, lack of exercise, and so on (Sari & Livana, 2016). The percentage of the population aged 15 years and over who smokes in North Sulawesi is 32.8 percent, with the average number of cigarettes consumed per week is 82.19 cigarettes. In contrast, the province of Papua as the province with the lowest prevalence of hypertension in Indonesia, has a smoking percentage of 28.97 percent, which is smaller than the national smoking percentage. As one of the factors that can affect hypertension, the percentage of smokers in each province will certainly make a difference in the prevalence of existing hypertension.

Overview of the percentage of smoking population in Indonesia

Based on Fig. 6, the percentage of the smoking population in Indonesia is 32.2 percent. The province in Indonesia with the highest rate of smoking population is Gorontalo province, which is 36.56 percent. Meanwhile, the province with the lowest percentage of the smoking population is DI Yogyakarta, which is 25.8 percent.

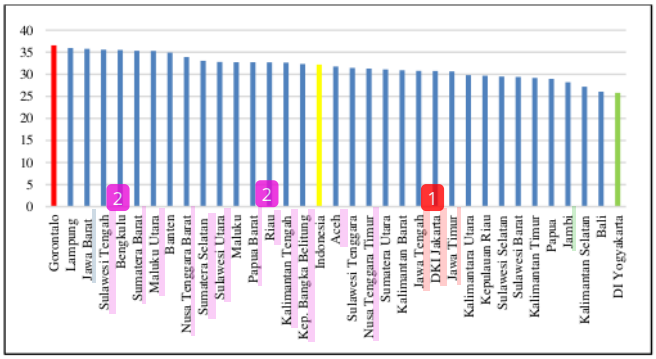

Figure 6. Percentage of smoking in the population aged 15 years by the province in Indonesia 2018

One factor influencing cigarette consumption is excise duty, where every increase in excise tax will reduce the population's interest in consuming cigarettes. In 2018, the cigarette excise tax increased by 10.04 percent, but a decrease does not follow the increase in the percentage of smokers. The number of smokers in 2018 increased compared to the percentage of smokers in 2017, from 29.25 percent to 32.2 percent (Masitho, 2017).

Overview of the percentage of the non-exercising population in Indonesia

According to BPS (2018), the number of people who do not exercise in Indonesia is 64.3 percent. By gender, the male population in Indonesia has a lower percentage of not exercising than the female population, which is 61.77 percent. Papua has the highest percentage of the population who does not exercise in Indonesia, and the lowest is DKI Jakarta at 55.07 percent. Based on the place of residence, urban residents have a percentage of residents who do not exercise at 59.27 percent, lower than rural areas (70.57 percent).

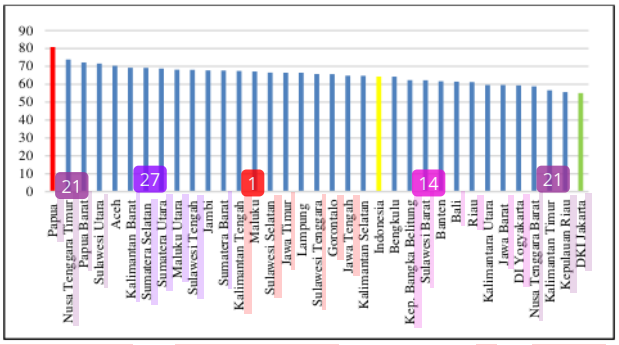

Figure 7. Percentage of population five years and over who do not exercise by the province in Indonesia in 2018

According to Prasetyo (2013), in Australia, one factor that influences people to exercise is the availability of time each individual has. One activity that can take up a lot of time is work. In urban areas in Indonesia, 83.17 percent of the population worked 20-74 hours during the past week. While in rural areas, 78.39 percent of the population has a working hour of 20-74 hours. It shows that in Indonesia, the availability of time does not affect the desire of the population to do sports. The type of work in rural areas, which tends to demand higher physical activity when compared to work in urban areas, can be one of the causes of the lack of interest of rural residents to do sports.

Overview of the Unemployment Rate in Indonesia

According to the BPS (2018), the unemployment rate in Indonesia is 5.13. Based on Fig. 8, thirteen provinces have a higher unemployment rate than the national unemployment rate. The province with the highest unemployment rate in Indonesia is West Java, with an unemployment rate of 8.16, followed by Banten (7.77) and Maluku (7.38).

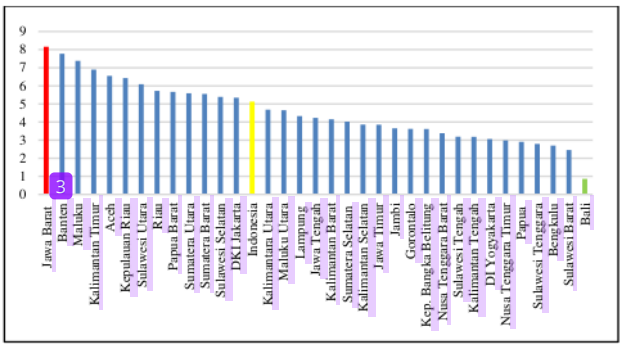

Figure 8. Unemployment rate by the province in Indonesia in 2018

One of the factors that influence the unemployment rate is the level of education. The average length of schooling in the province of West Java is 8.61 years, while Bali, the province with the lowest unemployment rate, has an average length of schooling of 9 years. The population in Bali who graduated from the graduate program is 12.3. This number is greater than West Java, which is only 7.87 percent. In addition to the level of education, population density is also one factor affecting an area's unemployment rate. The higher the population density of an area, the more people in the region, which can cause competition in the world of work to be tough and increase the number of unemployed.

Overview of the Average Length of Schooling in Indonesia

According to BPS (2018), the average length of schooling in Indonesia is 8.58 years. This shows that the average Indonesian population only has an elementary school certificate. This is because, on average, the Indonesian population only attends up to the second grade of junior high school. Based on Fig. 9, DKI Jakarta has the highest average number of years of schooling, which is 11.06 years (high school level). Meanwhile, the province with the lowest average length of schooling is Papua province, with an average length of schooling of 6.66 years (elementary school).

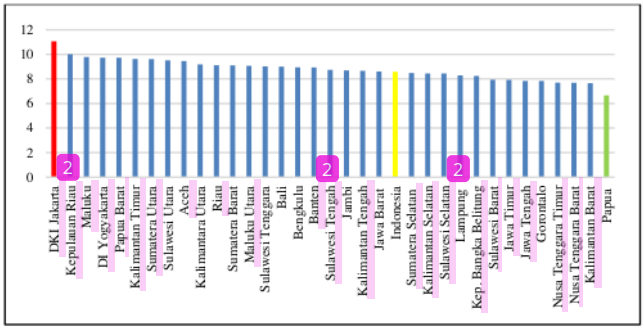

Figure 9. The average length of schooling by the province in Indonesia in 2018

The average length of schooling in Papua can be reflected in the literacy rate of the province of Papua, which is 76.79 percent, where this percentage is the smallest in Indonesia. In addition, only 7.86 percent of the total population of 15 years and over had a graduate level.

Determinants of Prevalence of Diabetes Mellitus

Table 1. Summary of the Results of Multiple Linear Regression

Variabel	B	t-test		VIF	Heteroscedastisity	
		t	Sig.		t	Sig.
Prevalensi_Obesitas*	0.049	2.626	0.014	1.842	1.206	0.238
Prevalensi_Hipertensi*	0.168	3.713	0.001	1.618	0.116	0.908
Persentase_Merokok	-0.025	-0.981	0.335	1.185	-1.515	0.141
Tidak_Olahraga	-0.008	-0.512	0.613	1.497	-1.894	0.069
Tingkat_Pengangguran	0.03	0.626	0.537	1.496	-0.563	0.578
Lama_Sekolah	-0.007	-0.06	0.953	2.067	0.145	0.886

*)Significant at $\alpha = 5\%$
$R^2 = 0{,}627$

Based on Table 1, the model formed is as follows:

$$\widehat{PD}_i = 0{,}194 + 0{,}049PO_i * + 0{,}168PH_i * - 0.025PM_i - 0.008TPT_i + 0.03PTB_i - 0.007RLS_i$$

To test for normality error using the Kolmogorov-Smirnov test. The p-value obtained is 0.200, which is greater than $\alpha = 0.05$, so it can be concluded that the error is normally distributed. To test heteroscedasticity using the Glejser test. P-value obtained for each independent variable is more than 0.05, so it can be concluded that the error variance is constant. To check non-multicollinearity, the VIF (Variance Inflation Factor) value can be used. Based on Table 1, the VIF value of the six independent variables is lower than 10, so there is a non-multicollinearity.

Based on Table 1, the prevalence of obesity and prevalence of hypertension significantly affects the diabetes mellitus prevalence. While the variables of the percentage of the population smoking, the percentage of the population not exercising, the unemployment rate, and the average length of schooling are insignificant. The coefficient of determination is 0.627. It means that the prevalence of obesity, the prevalence of hypertension, the percentage of the population smoking, the percentage of the population not exercising, the unemployment rate, and the average length of schooling can explain the diabetes mellitus prevalence by 62.7 percent.

The prevalence of obesity affects the prevalence of diabetes mellitus with a positive effect. Based on the model, it shows that every one percent increase in the prevalence of obesity will increase the prevalence of diabetes mellitus by 0.049 percent. This is following research conducted by Isnaini and Ratnasari (2018) which shows that obesity affects diabetes mellitus. Excessive consumption patterns can cause fatty acids or Free Fatty Acid (FFA) in cells. The increase in FFA that occurs can cause a decrease in glucose uptake into the plasma membrane and will cause insulin resistance in muscle and adipose tissue. This event can cause fatigue in the pancreas until the pancreas does not produce insulin as needed. This causes an increase in blood sugar levels, and diabetes occurs.

The prevalence of hypertension affects the prevalence of diabetes mellitus with a positive effect. Based on the model, it shows that for every one percent increase in the prevalence of hypertension, it will increase the prevalence of diabetes mellitus by 0.168 percent. These results follow the research conducted by Nainggolan et al. (2013), which states that hypertension is one of the variables that significantly affected diabetes mellitus. In addition, according to Brunner and Suddarth (2002), if your blood pressure is above 120/90 mmHg, you will have a double risk of diabetes than people with normal blood pressure. The effect of hypertension on the incidence of diabetes mellitus is caused by the thickening of the arteries, which causes the diameter of the blood vessels to narrow (Zieve, 2012). The thickening of the blood vessels will cause the process of transporting glucose from the blood to be disrupted (Isnaini & Ratnasari, 2018).

The percentage of the smoking population has no significant effect on the prevalence of diabetes mellitus. This result is in line with research conducted by Nainggolan et al. (2013), which states that smoking behavior does not affect the occurrence of diabetes mellitus. According to research conducted by Harsa (2020), smoking for a long period can cause a decrease in plasma adiponectin levels resulting in insulin resistance which can lead to diabetes mellitus. In Indonesia, 2.08 percent of the population in urban areas and 2.14 percent in rural areas smoke but do not do it daily. The number of cigarettes consumed by the Indonesian population every week is 81.23 cigarettes, which

means that, on average, the Indonesian population consumes 11-12 cigarettes. In addition, there is as many as 12.75 percent of the population who smoke consumes 1-29 cigarettes per week.

The percentage of the population who do not exercise has no significant effect on the prevalence of diabetes mellitus. This result follows research conducted by Isnaini and Ratnasari (2018), which states that there is no effect between physical activity and diabetes mellitus. According to Wahyuni and Alkaff (2013), physical activity is categorized as sufficient if the activity is carried out continuously for at least 10 minutes in one non-stop activity and cumulatively 150 minutes for five days a week. Meanwhile, physical activity is categorized as less if the activity is carried out continuously for less than 10 minutes in one non-stop activity and cumulatively does not reach 150 minutes for five days a week. Based on the population who do sports, the number of people who exercise in Indonesia is 35.7 percent (BPS, 2018). Almost 68.31 percent of the population who exercise do sports only one day a week. When viewed based on the length of exercise, the highest percentage is at 30-60 minutes, which is 48.67 percent. Furthermore, based on the purpose of doing sports, residents who do sports during the past week do more sports to fulfill the curriculum at school. Based on these things, the average exercise performed by the Indonesian population is considered less effective.

The unemployment rate has no significant effect on the prevalence of diabetes mellitus. This research is in accordance with the results of Isnaini and Ratnasari (2018), which states that work has no significant effect on diabetes mellitus. Based on Kemenkes (2018), the unemployed population has the second-highest diabetes prevalence in Indonesia, 3.2 percent. The highest prevalence of diabetes mellitus by type of activity in Indonesia is owned by population groups who work as civil servants. People who have worked can also affect the existing level of diabetes mellitus.

The average length of the school has no significant effect on the prevalence of diabetes mellitus. According to Irawan (2010), people with higher education levels will be more able to accept themselves as sick people, seek help from the health team more quickly, and have more health knowledge. They have awareness in maintaining their health. Based on data released by BPS (2018), people with low levels of education (never attended school, did not finish elementary school, and finished elementary school) tend to have jobs that require high physical activity such as agricultural, plantation, forestry, hunting, fisheries, production workers, and manual labor. High activity can prevent insulin resistance which can lead to diabetes mellitus.

CONCLUSION AND RECOMMENDATION

In 2018, the province in Indonesia with the highest prevalence of diabetes mellitus in Indonesia is DKI Jakarta, while the province with the lowest prevalence of diabetes mellitus is East Nusa Tenggara. Based on the estimation results using multiple linear regression analysis, obesity prevalence and hypertension prevalence have a positive and significant effect on the prevalence of diabetes mellitus. Then for the variables of the percentage of the population smoking, the percentage of the population not exercising, the open unemployment rate, and the average length of schooling has no significant effect on the prevalence of diabetes mellitus. The prevalence of obesity is one variable that significantly affects the prevalence of diabetes mellitus in Indonesia. Poor diet and lack of physical activity are some of the factors that can cause obesity. The local government (Provincial Government) can improve various existing programs to assist the community in maintaining their health. The Healthy Living Community Movement (Germas) is one of the programs to remind the public to maintain their health that the Indonesian Ministry of Health created. This program needs to be improved so that it can reach various groups of people. People are also expected to pay more attention to their lifestyle to reduce obesity. The prevalence of hypertension significantly affects the prevalence of diabetes mellitus. The local government should provide health services regularly, for example, two times a month. It will create public awareness to maintain their level of blood pressure.

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