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Determinants of Diabetes Mellitus Prevalence in Indonesia

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Abstract

The number of people with diabetes mellitus (DM) worldwide continues to increase. In 2019, Indonesia was the seventh country with the largest number of people with DM worldwide. The people with DM in Indonesia were dominated by the productive age population. This study aims to determine the variables affecting the prevalence of DM in Indonesia in 2018. The analysis unit used is 34 provinces in Indonesia, where the data comes from the Health Ministry of the Republic of Indonesia and Statistics Indonesia. Graph analysis and multiple linear regression are the methods used in this study. DKI Jakarta has the highest DM prevalence in Indonesia, reaching 3.4 percent. The prevalences of obesity and hypertension have a positive effect on the prevalence of DM. The result shows that every one percent increase in the prevalence of obesity will increase the prevalence of DM by 0.049 percent. While, every one percent increase will increase the prevalence of DM by 0.168 percent. The percentage of the population smoking, not exercising, the unemployment rate, and the average length of schooling does not affect the prevalence of DM in Indonesia.

Introduction

According to the International Diabetes Federation (IDF), diabetes mellitus (DM) is a condition that occurs when 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.

DM contributes in increase morbidity and mortality worldwide. DM can cause serious health problems such as neuropathy, nephropathy, and retinopathy when not treated and managed wisely (Alanazi, 2021). In 2019, the number of people with DM globally is estimated at 463 million in the 20-79 year age group. For ten years, these cases continue to increase by about 6.24 percent annually. Based on IDF data, the increase in the number of people with DM is expected to continue until 2045 and will reach 700 million people. The number of deaths from diabetes is estimated at 4.2 million. This number increased from 2017, which was 4 million people.

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, when 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

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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. Based on IDF data, 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 on care and treatment to overcome the complications. People with DM incurred higher inpatient costs (averaging US$1,912 per episode of admission (Malone et al., 2014).

According to data from the Health Ministry of the Republic of Indonesia, 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. The social determinants in which people are born, grow, work, and age has a powerful influence on health problem (Brady et al., 2021; Cummings et al., 2018; Kolak et al., 2019). To date, social determinants of health associated with DM include health literacy and related to individual education (Quartuccio et al., 2018). Many of the social determinants contribute to DM, including structural determinants (such as race and ethnicity) and individual-level determinants (such as smoking) (Fenelon, Chinn, & Anderson, 2017; Lariscy, Hummer, & Hayward, 2015; Marquez, Calman, & Crump, 2019; Rodríguez & Campbell, 2017; Sáenz & Garcia, 2021). Cartwright (2021) uses education level as demographic control to the diabetes disparity.

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, 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, and 90.7 percent need drugs to treat DM, starting with insulin injections and consuming specific medicines. It shows that most people with DM require special treatment. Family history, unhealthy eating patterns, age, education, and obesity are variables that influence the occurrence of diabetes mellitus (Stetson, Minges, & Richardson, 2017). 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 affecting the occurrence of diabetes.

Physical inactivity is estimated to cause almost 6-10% of non-communicable diseases like DM (Lee et al., 2012). The research was conducted by Śliwińska-Mossoń and Milnerowicz (2017) 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. Shang et al. (2013) conducted a study to see the effect of education level and age on the incidence of diabetes mellitus among Chinese adult men and women. The results show that people aged 18-59 years with low levels of education are more at risk of developing diabetes than people with high levels of education. Previous studies have focused more on research on diabetes mellitus that occurs from the individual side. Biradar and Singh (2020) also found that education had a positive influence on DM. 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 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 of the total population. The unemployment rate is the percentage of the number of unemployed in the 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

Based on data from the Health Ministry of the Republic of Indonesia in 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, and the population with educational status not completing elementary school is the highest with 2.9 percent. Then, followed by the population with education status who never went to school (2.8 percent) and the population with graduated education status (2.8 percent).

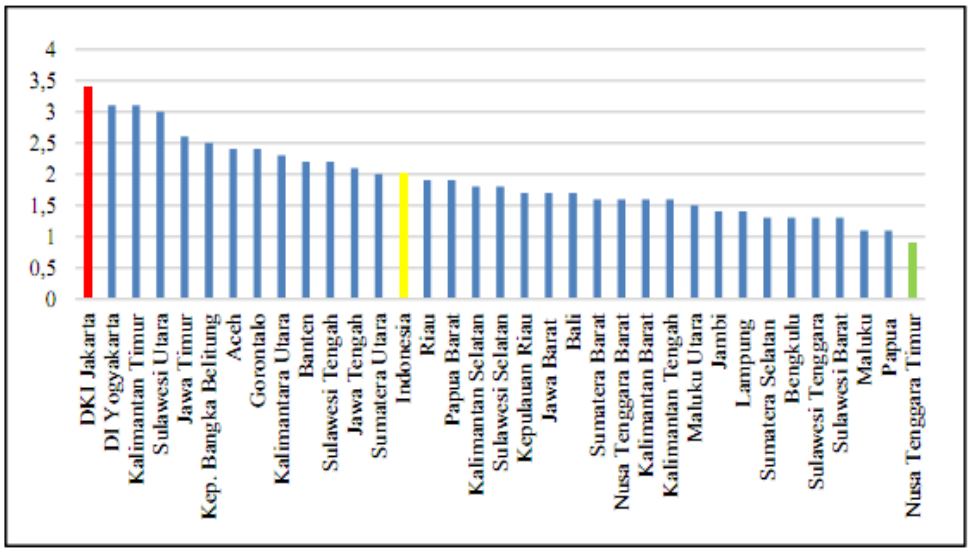

Figure 1. Diabetes Mellitus Prevalence Based on Doctor's Diagnosis in the Population Age 15 Years and Over by Province in Indonesia 2018

Based on Fig. 1, 13 provinces have a higher prevalence of diabetes in Indonesia. DKI Jakarta is the highest, with 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. 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, in 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. Gothankar and Patil (2011) found that obesity was associated with DM. In 2018, the prevalence of obesity in Indonesia in the population aged more than 15 years was 31 percent. 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 19.3 percent.

According to Hruby et al. (2016), the factors affecting the incidence of obesity are sugar-sweetened beverages, poor diet quality, physical inactivity, prolonged screen time, short sleep duration or shift work, and built environment characteristics. Physical activity can be in the form of sports or activities carried out daily. 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 did 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, most in this province work in fields that require high physical activity, such as agriculture, fisheries, plantations, and industry.

The prevalence of hypertension in the population aged over 18 years in Indonesia in 2018 was 8.36 percent. North Sulawesi Province, with 13.21 percent, is the highest 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. Several factors can cause hypertension, such as age, sex, marital status, education, wealth index, working status, ecological zone, province of residence, place of residence, body mass index, drinking alcohol, and caffeine (Hasan et al., 2018). The percentage of the population aged 15 years and over who smokes in North Sulawesi is 32.8 percent, with the average number consumed per week being 82.19 cigarettes. In contrast, the province of Papua, 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.

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. 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 did not follow the increase in the percentage of smokers. The number of people who did not exercise in Indonesia in 2018 was 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).

The factor that influences people to exercise is the availability of time each individual has. 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. Feldman et al. (2020) showed evidence of a positive association between DM and unemployment. In 2018, the unemployment rate in Indonesia was 5.13. 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).

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, 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 higher 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.

Feldman et al. (2020) found that prevalence decreased with increasing educational attainment. The average length of schooling in Indonesia in 2018 was 8.58 years. It shows that the average Indonesian population only has an elementary school certificate. It is because, on average, the Indonesian population only attends up to the second grade of junior high school. 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 is Papua province, with an average length of schooling of 6.66 years (elementary school). 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.

Based on Table 1, the prevalence of obesity and the prevalence of hypertension significantly affect 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.

Table 1. Summary of the Results of Multiple Linear Regression

Variables	B	t-test		VIF	Homoscedasticity	
		T	Sig.		t	Sig.
Obesity Prevalence (PO)*	0.049	2.626	0.014	1.842	1.206	0.238
Hypertension Prevalence (PH)*	0.168	3.713	0.001	1.618	0.116	0.908
Smoking Percentage (PM)	-0.025	-0.981	0.335	1.185	-1.515	0.141
Non-exercising Percentage (PT)	-0.008	-0.512	0.613	1.497	-1.894	0.069
Unemployment Rate (PTB)	0.03	0.626	0.537	1.496	-0.563	0.578
Length of Schooling (RLS)	-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:

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

Using the Kolmogorov-Smirnov test, the p-value obtained is 0.200. It is higher than α = 0.05, so the error is normally distributed. Using the Glejser test, the p-value obtained for each independent variable is more than 0.05, so 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 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. The following research conducted by Stetson et al. (2017) shows that obesity affects diabetes mellitus. Excessive consumption patterns can cause fatty acids or Free Fatty Acids (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. It causes an increase in blood sugar levels, and diabetes occurs. Biradar and Singh (2020) also found that overweight people showed the strongest association with DM.

Parsa, Aghamohammadi, and Abazari (2019) found that 54.1% of DM patients suffered from comorbidities. The prevalence of hypertension affects the prevalence of diabetes mellitus with a positive effect. Research by Pham and Eggleston (2016) also found that hypertension was associated with a higher prevalence of DM. 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 affect diabetes mellitus. In addition, according to Cheung and Li (2012), if your blood pressure is above 120/90 mmHg, you will have a double risk of diabetes than people with normal blood pressure. The thickening of the blood vessels will cause the process of transporting glucose from the blood to be disrupted.

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 Śliwińska-Mossoń and Milnerowicz (2017), cigarettes contain 7357 chemical compounds and 1015 to 1017 free radicals and 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, 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. 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 five days a week. Based on the population who do sports, the number of people who exercise in Indonesia is 35.7 percent. 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. Based on data from the Health Ministry of the Republic of Indonesia in 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 Stetson et al. (2017), people with higher education levels will have behavior change concepts and theories and have more health knowledge. They have an awareness of maintaining their health. Less educated people may lack resources and have difficulties accessing information, especially nutrition, which can cause DM (Vasconcelos et al., 2020). More years of education people also prevent DM complications (Rovner, Haller, Casten, Murchison, & Hark, 2015). 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. Like agriculture, plantation, forestry, hunting, fisheries, production workers, and manual labor. High activity can prevent insulin resistance which can lead to diabetes mellitus.

Conclusion

Obesity and hypertension prevalence have a positive and significant effect on the prevalence of diabetes mellitus, while the percentage of the smoking population, the percentage of the population not exercising, the unemployment rate, and the average length of schooling has no significant effect. Poor diet and lack of physical activity are some of the factors that can cause obesity. The local government can improve various existing programs to assist the community in maintaining its 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 to reach various groups of people. People are also expected to pay more attention to their lifestyles to reduce obesity. The local government also 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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