

# Ecological Analysis of Diabetes Mellitus in Indonesia

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## Abstract

Diabetes mellitus is a dangerous disease and often causes complications. The study aims to analyze ecologically the factors related to the prevalence of Diabetes Mellitus in Indonesia. The study was designed with an ecological analysis approach, using secondary data from the 2018 Indonesia Basic Health Survey covering all provinces as samples. The dependent variable is the prevalence of diabetes mellitus. The independent variable is the prevalence of obesity nutritional status according to BMI in the adult population (aged >18 years), the proportion of less physical activity in the population aged >10 years, the proportion of sweet drink consumption habits in the population >3 years old more than once per day and the percentage of poor people. Data were analyzed using the scatter plot. The results showed that the higher the prevalence of obesity nutritional status according to BMI in the adult population, the higher the proportion of less physical activity, and the higher the proportion of sweet drink consumption habits in the population more than once per day, the higher the prevalence of diabetes mellitus. Conversely, the higher the percentage of poor people, the lower the prevalence of diabetes mellitus. The study concluded that the four independent variables tested tend to relate to the prevalence of diabetes mellitus.

**Keywords:** ecological analysis, secondary data, diabetes mellitus

## Background

Diabetes Mellitus is a chronic metabolic disease characterized by elevated blood glucose levels (or blood sugar), which over time causes severe damage to the heart, blood vessels, eyes, kidneys, and nerves. The most common type 2 diabetes mellitus is usually in adults, which occurs when the body becomes insulin resistant or does not produce enough insulin. There is a globally agreed target to stop the increase in diabetes mellitus and obesity by 2025. About 422 million people worldwide suffer from diabetes mellitus, and 1.6 million deaths are directly attributed to diabetes mellitus each year. Both the number of cases and the prevalence of diabetes mellitus have increased over the last few decades<sup>1</sup>.

Diabetes mellitus is a disease that the number of sufferers has increased in Indonesia. In 2017, Indonesia was ranked 6th in people with diabetes mellitus, which reached 10.3 million people. There will be an increase in the number of Diabetes Mellitus patients

from 10.3 million in 2017 to 16.7 million in 2045<sup>2</sup>. Meanwhile, the 2018 Indonesia Basic Health Survey reports the prevalence of diabetes mellitus sufferers in Indonesia increased to 2.0% for ≥15 years of age from 1.5% in 2013<sup>3</sup>.

The risk factors for diabetes mellitus in Indonesia are mostly classified as type 2 diabetes mellitus. Based on the 2018 Indonesia Basic Health Survey, 14.5% of the Indonesian population over 18 years is obese. Besides, the proportion of consuming sweet foods in people over three years of age is 40.1%. The ratio of inadequate physical activity of people over ten years of age is 33.5%. The number of poor people in Indonesia in 2018 is 10, 65%<sup>3</sup>.

People with diabetes mellitus often do not realize that they have had diabetes mellitus for a long time, this is very dangerous, and when they are aware, complications have occurred. The complications that cause diabetes mellitus is often called the silent killer<sup>4</sup>. Therefore we

need to know what can be a risk factor for the onset of diabetes mellitus. The number of diabetes mellitus in Indonesia can be reduced, and complications of diabetes mellitus can be prevented as much as possible.

The purpose of this study was to analyze the variable prevalence of obesity nutritional status according to BMI in the adult population (>18 years old), the proportion of less physical activity in the population aged more than ten years, the proportion of the habit of consuming sweetened drinks in the population over three years of age once per day, and the percentage of poor people with the prevalence variable of Diabetes Mellitus.

## Materials and Methods

### Study Design

The author designed the study with an ecological analysis approach. Environmental research focuses on comparisons between groups, not individuals. The data analyzed is aggregate data at a specific group or level, which in this study is the provincial level. Ecologic analysis variables can be in aggregate measurements, environmental measurements, or global measurements<sup>5,6</sup>.

The author designed research as non-experimental research with an ecological analysis study approach (aggregate study) using report data taken from the 2018 Indonesia Basic Health Survey and the 2018 Indonesian Health Profile, released by the Indonesian Ministry of Health, a total of 34 provinces in Indonesia used in this analysis.

### Operational definition

According to Basic Health Research 2018, the prevalence of diabetes mellitus aged  $\geq 15$  years according to doctor's diagnosis in 34 provinces is calculated by the formula:

Household member  $\geq 15$  years with "Fasting blood sugar levels  $\geq 126$  mg/dl" or "2 hours postprandial glucose test  $\geq 200$  mg/dl."

Household members aged  $\geq 15$  years undergoing fasting blood sugar or 2 hours postprandial glucose test or blood sugar at any time

Diabetes mellitus is enforced if the fasting blood glucose level is  $\geq 126$  mg/dl; or two hours postprandial glucose test  $\geq 200$  mg/dl; or random blood glucose  $\geq 200$  mg/dl with frequent hunger symptoms, frequent thirst, frequent urination & large quantities, and weight loss. The study checked blood sugar levels for household members aged  $\geq 15$  years.

The prevalence of nutritional status of obesity according to BMI in adults (aged > 18 years) is an adult nutritional status is an assessment of the nutritional status of the population over 18 years as assessed by the Body Mass Index (BMI). The age group's health status indicators are based on anthropometric measurements of body weight (BW) per height squared presented in Body Mass Index (BMI)<sup>3</sup>. BMI limits used to assess the nutritional status of the adult population (> 18 years) are as follows:

- Underweight category : BMI <18.5
- Normal category : BMI  $\geq 18.5$  - <25.0
- Overweightcategory : BMI  $\geq 25.0$  - <27.0
- Obesity category : BMI  $\geq 27.0$

The proportion of less physical activity among people aged >10 years by province is the number of household members aged >10 years with less physical activity (other than moderate and strenuous). Strenuous physical activity is a physical activity carried out for >3 days per week and MET minutes per week >1500 (MET minute value for strenuous physical activity = 8). MET is a unit of energy expenditure and is used to measure physical activity in minutes. Moderate physical activity is a moderate physical activity carried out for >5 days a week with an average length of activity >150 minutes a week (or >30 minutes per day).

The proportion of sweet food consumption for people aged >3 years, more than once per day, is people aged >3 years who consume more than once a day of sweet food than all household members aged >3 years<sup>3</sup>. Percentage of Poor People is the population with a monthly expenditure level per capita of less than or below the poverty line<sup>7</sup>.

**Data Source**

The author conducts the study using secondary data from the 2018 Indonesia Basic Health Survey and the 2018 Indonesian Health Profile. The Indonesia Ministry of Health issued both reports. All 34 provinces use as a sample.

**Data Analysis**

This study’s dependent variable was the prevalence of diabetes mellitus aged  $\geq 15$  years according to the doctor’s diagnosis. In addition to the dependent variable, there were four independent variables analyzed, namely the prevalence of obesity nutritional status according to BMI in the adult population (aged  $> 18$  years), the proportion of less physical activity in the population aged  $> 10$  years, the proportion of sweet drink consumption habits in the population aged  $> 3$  years more than once per day, and the percentage of poor people.

The data were analyzed bivariate using the scatter plot. The research used a linear line to determine the

relationship between the dependent and the independent variable. The study carried out the analysis with SPSS 21.

**Results and Discussion**

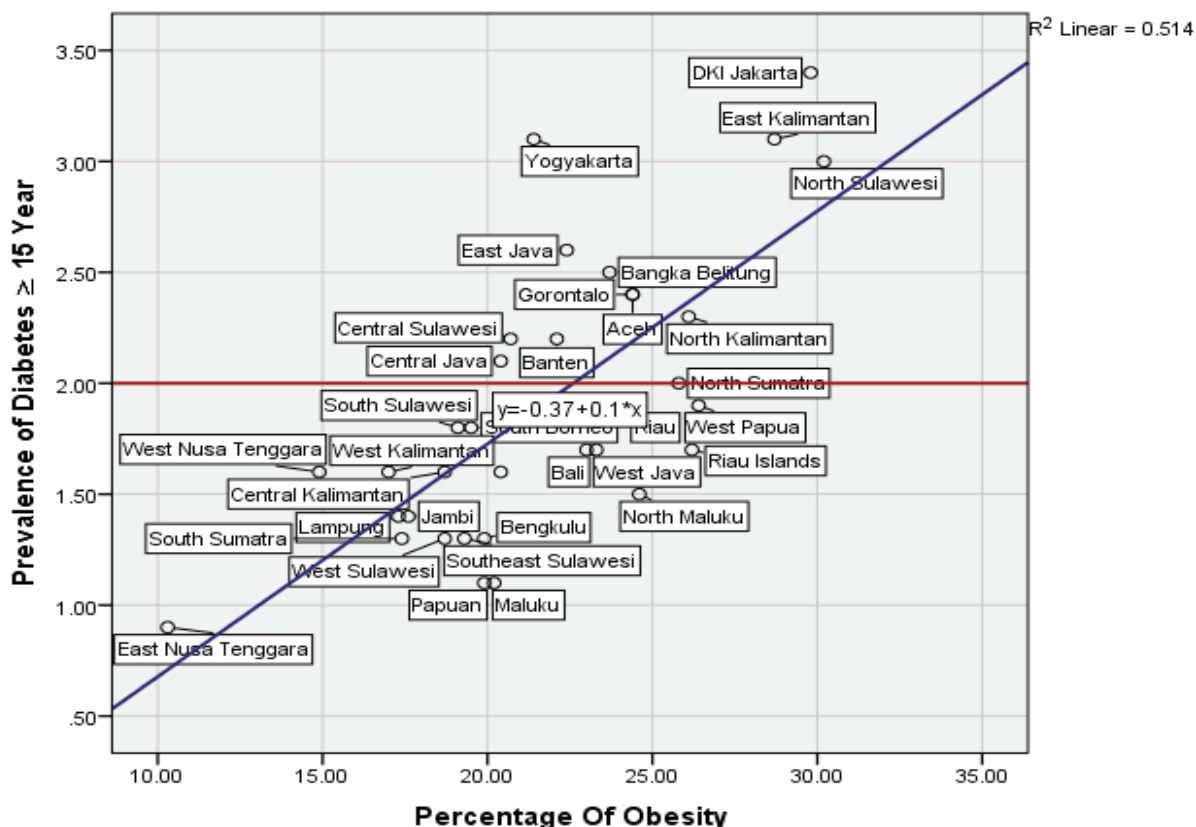
Table 1 shows that the dependent variable’s distribution is the prevalence of Diabetes Mellitus based on a resident doctor’s diagnosis aged  $\geq 15$  years and describes statistically the five variables analyzed in this study. The highest proportion of Diabetes Mellitus based on doctor’s diagnosis in people aged  $\geq 15$  years was Jakarta (3.4%), and the lowest was in East Nusa Tenggara (0.9%).

Figure 1 shows the Scatter Plot results of the prevalence of obesity and diabetes mellitus in Indonesia, indicating that the two variables have a positive relationship. The work means that the higher the population density with obesity nutritional status in a province, the prevalence of diabetes mellitus in the region will also increase.

**Table 1. Descriptive statistics of the prevalence of diabetes mellitus and other variables in Indonesia in 2018**

Descriptive Statistics	Prevalence of diabetes mellitus	The prevalence status of nutrition obesity	The proportion of less physical activity	The proportion of sweet drink consumption	The percentage of the poor people
N	34	34	34	34	34
Mean	1.91	21.70	34.88	40.07	10.65
Median	1.75	21.05	33.95	40.25	8.91
Mode	1.30a	18.70a	33.70	40.20a	7.21
Std. Deviation	0.63	4.28	5.79	6.05	5.67
Variance	0.39	18.32	33.55	36.57	32.19
Range	2.50	19.90	22.60	28.30	23.88
Minimum	0.90	10.30	25.20	26.50	3.55
Maximum	3.40	30.20	47.80	54.80	27.43

Source: the 2018 Indonesia Basic Health Survey and the 2018 Indonesia Health Profile



**Figure 1. Scatter plot of diabetes mellitus prevalence and percentage of prevalence of obesity by the province in Indonesia**

Source: the 2018 Indonesia Basic Health Survey

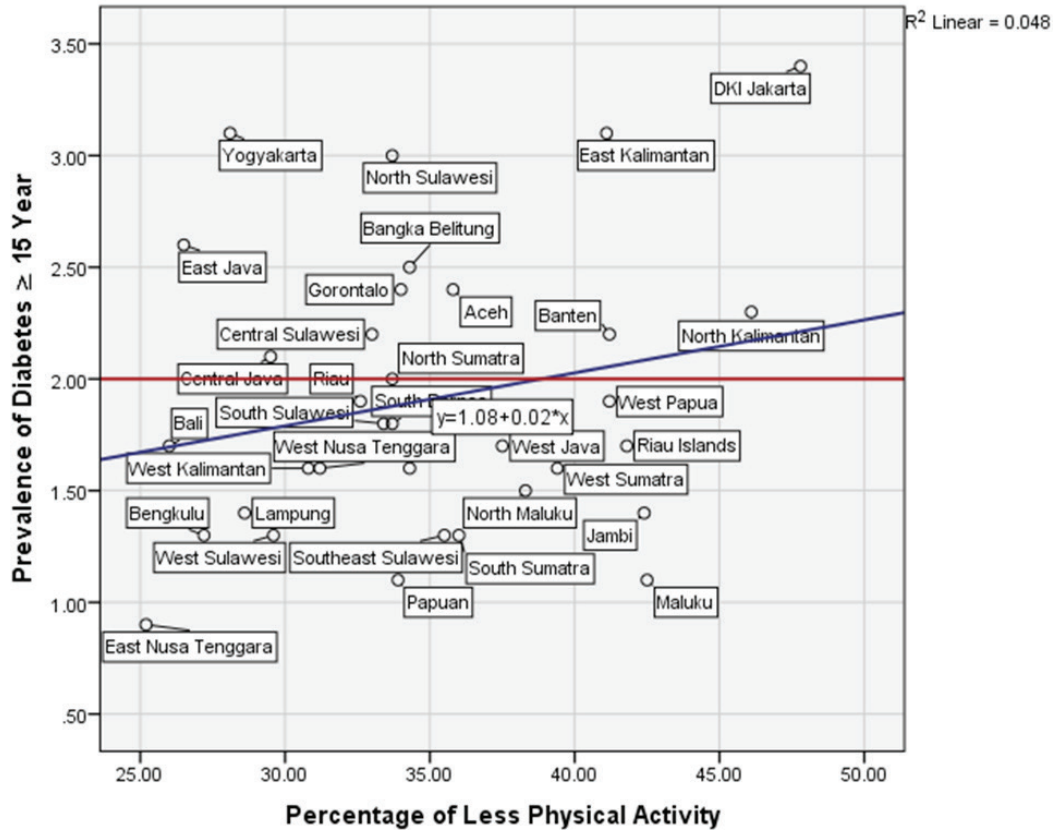
Obese people with a BMI above 25, with each increase in BMI 1 point, will tend to become diabetes by 25%. Increasing the size of the abdomen and pelvis circle, especially in the central type of obesity, causes insulin resistance, a condition where insulin cannot work correctly, then diabetes occurs<sup>8,9</sup>. Several mechanisms involved in the pathogenesis of obesity have been proposed that play an essential role in the development of diabetes by causing insulin resistance or insulin hypersecretion. Excessive fat storage in obese people leads to the excessive release of fatty acids resulting in insulin resistance and hyperglycemia. Insulin resistance is also a consequence of increased secretion of cytokines (TNF- $\alpha$ , IL-6, complement C3, MIF, and leptin) by adipose tissue resulting in the development of diabetes<sup>10</sup>.

Figure 2 shows the relationship between less physical activity and diabetes Mellitus by the province in Indonesia. Based on the Scatter Plot, the model

indicates that the two variables' relationship shows a positive relationship. The result means that the higher the proportion of less physical activity in a province, the prevalence of diabetes Mellitus in that province will also increase.

Physical activity or exercise is directly related to the increase in muscle glucose recovery rate (how much muscle takes glucose from the bloodstream). When exercising, the forces use up the glucose stored in the muscles, and when glucose is reduced, the muscles fill in the gaps by taking glucose from the blood. The situation will result in a decrease in blood glucose, thereby increasing blood glucose control. In people who rarely exercise, the food substances that enter the body are not burned but are stored in the body as fat and sugar<sup>11</sup>. Less physical activity or exercise is one of the factors in the occurrence of type II diabetes mellitus. If someone in his life does not do physical activity or exercise, the reserves of glycogen or fat will remain stored in the body; this is what triggers various degenerative diseases, one of

which is Diabetes Mellitus<sup>12</sup>.



**Figure 2. Scatter plot of the percentage of the population with less physical activity and the tendency of diabetes mellitus by the province in Indonesia**

Source: the 2018 Indonesia Basic Health Survey

Figure 3 shows the Scatter plot results, the proportion of consuming sweet drinks, and the prevalence of diabetes mellitus. Based on Figure 4, the results show that the relationship between the (two variables leads to a positive relationship. The work means that the higher the proportion of sweet drink consumption habits in a province, the prevalence of diabetes mellitus in the area will also increase

The habit of consuming excessive sugar is a known contributing factor to Diabetes Mellitus<sup>13</sup>. The more excessive consumption of sugar, the greater the possibility of developing Diabetes Mellitus, the mechanism of the relationship between sugar consumption habits and

blood sugar levels where the sugar will be broken down and absorbed in glucose. Absorption of sugar causes an increase in blood sugar levels and increases insulin secretion<sup>14</sup>. Sugar-sweetened beverages are added with simple sugars during the production process, increasing energy content but contain few other nutrients. Meanwhile, sugar-sweetened drinks are positively associated with weight gain and obesity, an established risk factor for type 2 diabetes. Sugar-sweetened beverages consumption is significantly associated with an increased risk of type 2 diabetes. Individuals with a higher intake of sugar-sweetened beverages have a greater risk of developing type 2 diabetes<sup>15</sup>.

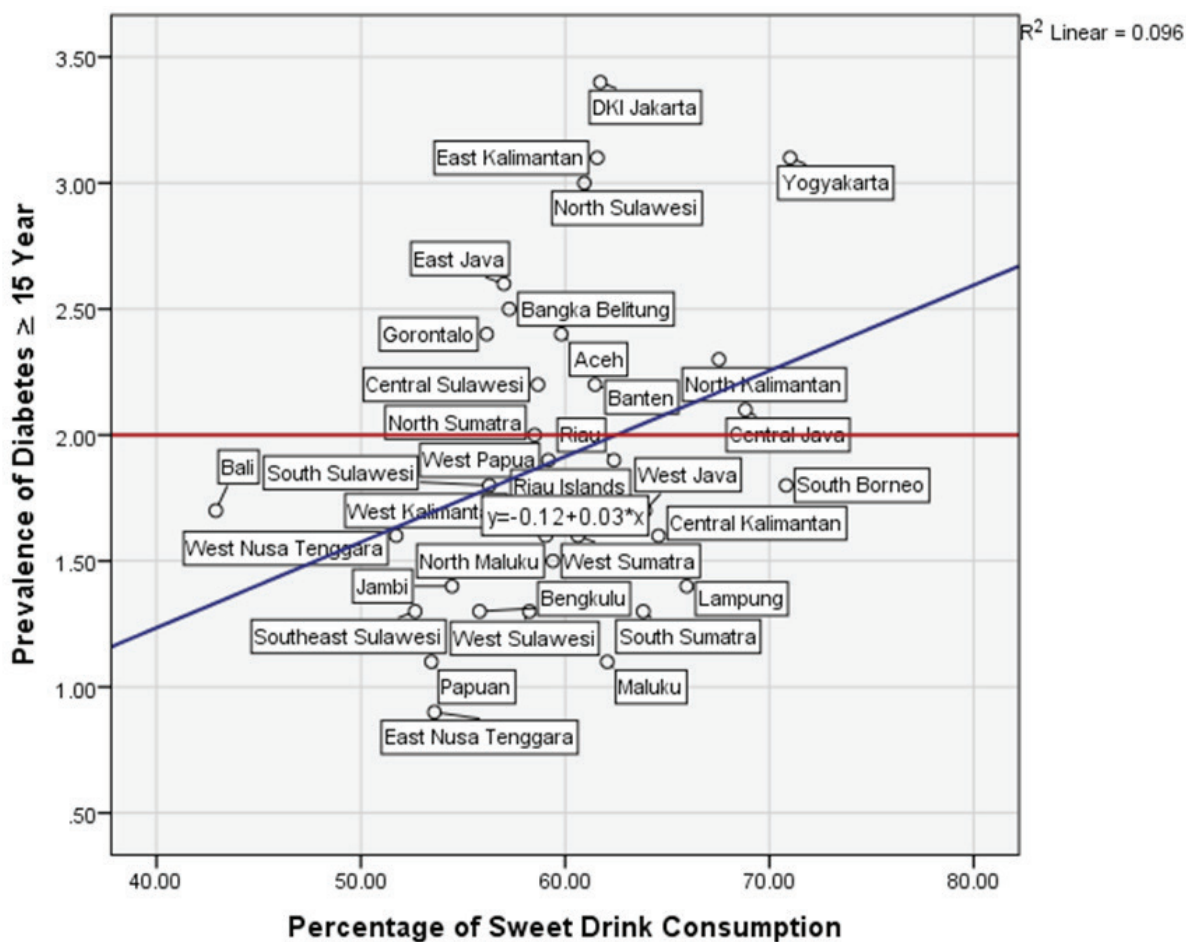


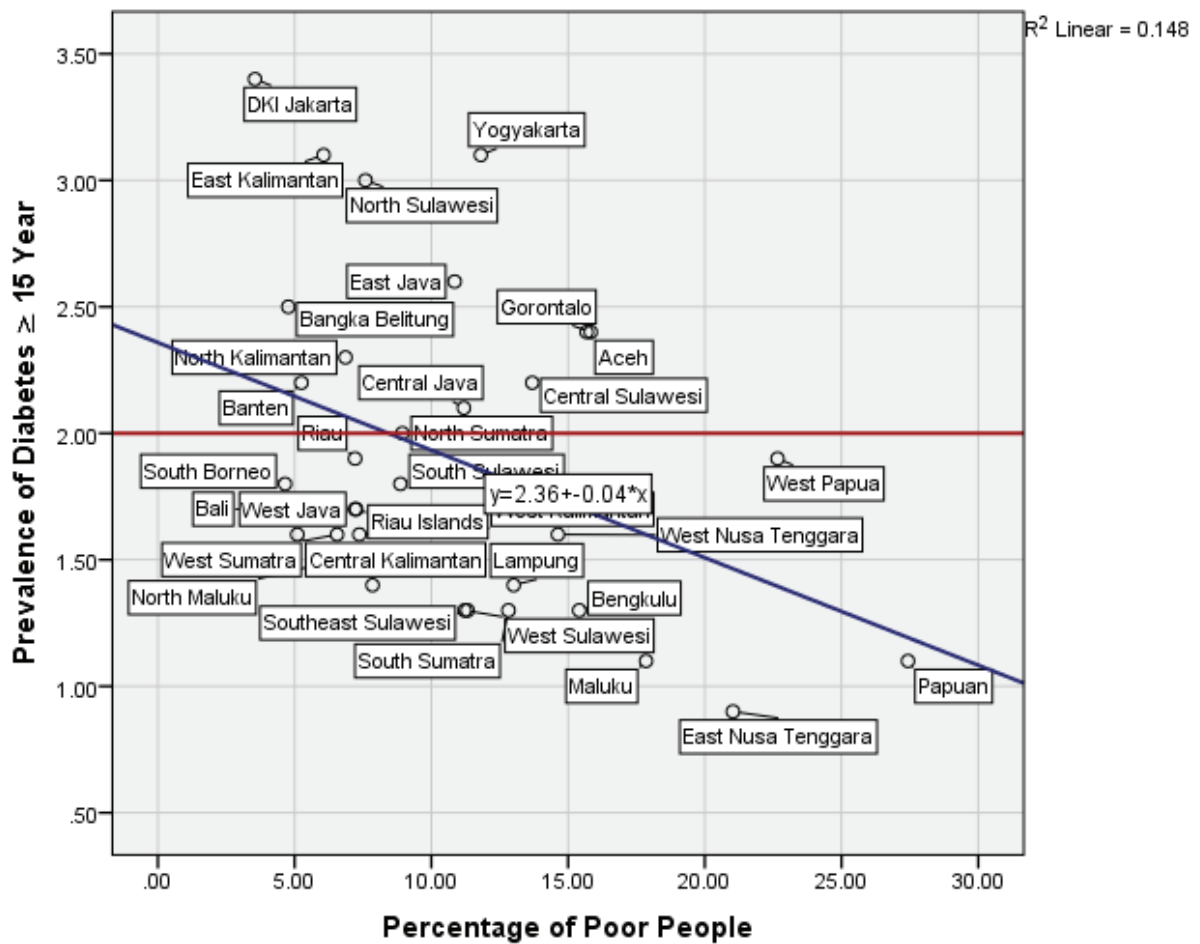
Figure 3. Scatter plot of the proportion of sweet drink consumption and the prevalence of diabetes mellitus by the province in Indonesia

Source: the 2018 Indonesia Basic Health Survey

Figure 4 indicates the relationship between the percentage of poor people and diabetes mellitus in Indonesia. The model shows that the relationship between the two variables shows a negative relationship based on the scatter plot. The connection means that the higher the poor people percentage in a province, the lower the prevalence of diabetes Mellitus in that province.

Worldwide, socioeconomic developments over the past 40-50 years have dramatically changed lifestyle from traditional to modern, causing physical inactivity due to technological advances, prosperity leading to

consumption of foods rich in fat, sugar, and calories, and high mental stress levels. All of these can affect insulin sensitivity and lead to obesity. The group of higher socioeconomic status had a twofold higher prevalence of diabetes than the lower socioeconomic group. The high majority has been linked to unhealthy foods such as foods rich in calories and fat and lack of physical activity. The same study also showed that most insulin resistance syndrome components, including diabetes, hypertension, dyslipidemia, and obesity, are more common among higher economic conditions than those with lower economic conditions<sup>16</sup>.



**Figure 4. Scatter Plot of the percentage of poor people by province and the prevalence of diabetes Mellitus by the province in Indonesia in 2018**

Source: the 2018 Indonesia Basic Health Survey and the 2018 Indonesia Health Profile

Previous research on differences in culture, socioeconomic, attitudes, and behavior of type 2 diabetes mellitus sufferers in urban areas and rural areas shows that there are differences in the incidence of type 2 diabetes mellitus in urban and rural regions obtained p-value = 0.005. The high socioeconomic status in urban areas is related to the high incidence of diabetes mellitus due to urban communities' unhealthy lifestyle changes. In contrast, the low socioeconomic status in rural communities tends to adopt a healthy lifestyle<sup>17</sup>.

**Conclusions**

Based on the study results, the authors concluded a tendency for a positive relationship between the prevalence of obesity, the proportion of less physical activity, and the proportion of sweet drink consumption

habits with diabetes mellitus in Indonesia. Otherwise, a negative relationship between the poor people percentage and the diabetes mellitus prevalence in Indonesia.

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**Conflict of Interests:** Nil

**Ethical Clearance:** The study conducted using secondary data from published reports. Ethical clearance is therefore not required in the conduct of this study.

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