



## Effect of COVID-19 PPKM on BMI, Glucose Levels, and HbA1c in Patients DM Type 2 di Demak Regency

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### Abstract

Implementing COVID-19 Community Activity Restrictions (Pemberlakuan Pembatasan Kegiatan Masyarakat/PPKM) affects community activities, including type-2 Diabetes mellitus patients in Demak Regency. BMI and HbA1c are risk factors for increased blood glucose levels of DM type 2. This research aims to determine the impact of COVID-19 PPKM against BMI, Glucose Levels, and HbA1c in Type 2 DM Patients in Demak Regency. This study used secondary data from the Chronic Disease Management Program (PROLANIS) in three health centers (Pusat Kesehatan Masyarakat/Puskesmas) in Demak Regency. Which was grouped into measurements before PPKM (October 2019 and February 2020), the PPKM period (August 2021), and the end of PPKM (March 2022). The complete variables were incorporated into the final analysis. A total of 164 respondents were spread across in Wonosalam 1 (n=64), Bonang 2 (n=49), and Wedung 1 (n=51). The results of the Analysis of Friedman and the Wilcoxon post hoc showed that there was an influence of COVID-19 PPKM on Glucose Levels (p=0.000) and HbA1c (p=0.000). There was no influence on BMI (p=0.108) in Dm Type 2 patients in Demak Regency, meaning on the variable levels of FBS and HbA1c, there are at least two different measurements in October 2019, February 2020, August 2021, and March 2022 measurements. Special attention is needed in DM patients to control changes in BMI, Glucose levels, and HbA1c during the implementation of COVID-19 PPKM.

### Introduction

Coronavirus-2019 disease (COVID-19) has become a global pandemic and a world public health emergency (Chu et al., 2020; Haleem & Javaid, 2020; Mills et al., 2020; Salathé et al., 2020; WHO, 2020b). The World Health Organization (WHO) declared the COVID-19 outbreak caused by SARS-CoV-2 as a global pandemic on March 11, 2020. In 2020 there were 21,294,845 confirmed cases globally, with the most cases in the European and American regions and 761,779 deaths (WHO, 2020a). Most deaths occur in old age and chronic diseases such as diabetes mellitus (DM), hypertension, obesity, chronic kidney disease, cardiovascular disease, and cancer (Ojo et al., 2022; Viswanathan et al., 2021). The

number of DM cases in Demak Regency in 2019 reached 18,116, and in 2020 the number of dm people reached 18,529. In addition, Demak Regency is one of the districts with a high level of COVID-19 transmission (Demak Regency Health Office, 2021).

The high rate of transmission of COVID-19 has forced many countries, such as China, Italy, and India, to go into lockdown. However, some countries did not implement lockdowns for several reasons. The Ministry of Health of the Republic of Indonesia implements a policy of Enforcing Restrictions on Community Activities (PPKM) in districts and cities in Indonesia, including the Demak Regency (Ministry of Health of the Republic of Indonesia, 2020). The implementation of

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PPKM impacts community activities, including patients with chronic diseases in the face of limited access to health services, routine medical control checks, and drug procurement (Consonni et al., 2021). Prolonged COVID-19 PPKM resulted in an increase in BMI, waist circumference, and triglyceride levels in diabetic patients in Turkey, as well as an effect on fasting glucose and postprandial levels of type 2 DM patients (Önmez et al., 2020).

It is well known that managing blood glucose and other metabolic parameters is quite challenging for diabetic patients. It can be exacerbated by changes in lifestyle and daily routines, such as diet, exercise, insulin adjustment, emotions, stress, social relationships, and work activities. Lifestyle changes, such as lack of physical activity and increased food intake, can increase BMI, which has implications for insulin sensitivity and glycemic control (Ojo et al., 2022; Viswanathan et al., 2021). In addition to food intake, a parameter that can be trusted as an indicator of successful control of blood glucose levels of DM type 2 is the level of glycosylated hemoglobin (HbA1c). Based on the American Diabetes Association, the glycemic control of diabetic patients is said to be good when the glycated hemoglobin A1c (HbA1c) value is less than 7% (Alakhali & Mohammad, 2014).

Significant changes in daily life due to COVID-19 PPKM can significantly impact the health of BMI and HbA1c (Alakhali & Mohammad, 2014; Farhane et al., 2021; Fernández et al., 2020; Ruissen et al., 2021). In this sense, changes in behavior patterns and daily life, including exercise levels, stress, and anxiety, affect the self-management of diabetes and glycemic control (Farhane et al., 2021). These changes significantly affect clinical outcomes during PPKM (Farhane et al., 2021). This study aims to determine the effect of COVID-19 PPKM on BMI, Glucose Levels, and HbA1c in Type 2 DM Patients in Demak Regency.

## Method

This study was an analytical observational study with a cross-sectional retros-effective approach, where this study aims to analyze the effect of COVID-19 PPKM on BMI,

glucose levels, and HbA1c levels of DM type 2 patients in Demak Regency, using primary data obtained from fill sheets, and secondary data from the results of Medical Records in Puskesmas for hyperglycemia markers. The population of this study was Chronic Disease Management Program (Prolanis) patients at the Demak Regency Health Centers (Puskesmas). The study samples were prolanis patients in Puskesmas Wonosalam 1, Bonang 2, and Wedung 1, Demak Regency. The site selection was based on the distribution of a large number of incidences of Type 2 Diabetes mellitus and non-communicable disease (NCD) screening. The inclusion criteria for this study were all patients with normal blood sugar levels > in the three puskesmas areas of Demak Regency. Even the Exclusion Criteria for this study are patients with complications in multiple organs.

The consecutive sampling method was by recording registered patients, and according to the arrival of patients in prolanis activities according to the inclusion and exclusion criteria until they meet the analysis requirements. The variables in this study are the Implementation of Community Activity Restrictions (PPKM); Body Mass Index (BMI); Glucose Levels; and HbA1c Levels. and the variable Stress Level in DM patients, defined as the body's response experienced by Diabetes Mellitus patients due to the disease suffered. Data were collected using questionnaires created based on existing literature. The questionnaire in the form of questions about stress levels based on the DASS (Depression Anxiety Stress Scale) instrument consists of 14 questions related to the incidence of stress, other data using respondent's medical checkup sheets which include: the respondent's identity, anthropometric data including weight measurement, and height and Body Mass Index (BMI), blood pressure examination, triglyceride examination, and blood sugar examination fasting and postprandial. Category data was presented in frequency and percentage based on the area of the public health center (Puskesmas), and numerical data was delivered from the average, minimum, and maximum values. The follow-up analysis used The Friedman-Mann test → Wilcoxon's post hoc. All by SPSS 22.0 (IBM Corporation, NY, USA). This research has received ethical approval from the health

research ethics committee at Semarang State University. Research ethics permit in 2022 number 060/KEPK/EC/2022.

## Results and Discussions

Tabel 1. Characteristics of Respondents Based on Puskesmas Region

Characteristics	PUSKESMAS			P-Value
	Wonosalam 1 (n=64)	Bonang 2 (n=49)	Wedung 1 (n=51)	
<b>Age</b> (Years, mean; min-max)	54.05 (34-74)	57.12 (36-74)	58.24 (42-75)	0.059
<b>Gender</b> (n; %)				0.592
Man	12; 18.8	8; 16.3	6; 11.8	
Woman	52; 81.3	41; 83.7	45; 88.2	
<b>Education Level</b> (n; %)				0.315
Not Finished Elementary School	7; 10.9	4; 8.2	7; 13.7	
Elementary School	49; 76.6	34; 69.4	37; 72.5	
Junior high school	7; 10.9	8; 16.3	6; 11.8	
Senior High School	1; 1.6	3; 6.1	1; 2.0	
<b>Employment Status</b> (n; %)				0.128
Not Working	40; 62.5	37; 75.5	40; 78.4	
Work	24; 47.5	12; 24.5	11; 21.6	
<b>Stress Level</b> (n; %)				0.815
Mild Stress	7; 10.4	4; 8.2	4; 7.8	
No Stress	57; 89.1	45; 91.8	47; 92.2	
<b>BMI</b> (mean; min-max)				
October 2019	23.39 (16-38)	22.56 (18-31)	24.20 (17-38)	0.061
February 2020	23.10 (15-39)	22.22 (18-31)	23.53 (17-37)	0.314
August 2021	23.45 (15-39)	22.58 (18-30)	23.59 (17-37)	0.947
March 2022	23.43 (16-39)	22.77 (19-31)	23.45 (16-37)	0.083
<b>FBS</b> (mean; min-max)				
October 2019	210.25 (93-396)	249.65 (93-554)	219.35 (88-431)	0.934
February 2020	238.73 (78-509)	236.78 (94-465)	245.47 (79-551)	0.790
August 2021	214.96 (13-511)	293.94 (79-527)	231.32 (72-472)	0.214
March 2022	249.72 (91-497)	360.45 (108-744)	250.37 (92-527)	0.000
<b>HbA1c</b> (mean; min-max)				
October 2019	11.33 (5-17)	11.23 (6-16)	11.21 (5-15)	0.618
February 2020	10.07 (5-16)	10.27 (6-15)	9.94 (15-39)	0.354
August 2021	10.73 (5-15)	11.09 (6-16)	10.64 (6-15)	0.000
March 2022	10.88 (5-16)	11.12 (6-15)	11.03 (6-15)	0.955

**Source:** Medical Record of PROLANIS Puskesmas Activities

Based on table 1 of respondents' characteristics based in the puskesmas area, the number of respondents to the Wonosalam 1, Bonang 2, and Wedung 1 health centers is 64, 49, and 51, respectively, with an average age of respondents of 54.05, 57, .12, and 58.24 this shows that the average respondent is elderly, while the majority of respondents are women, namely the Wonosalam health center 1 (81.3%), Bonang 2 (83.7%), and Wedung 1 (88.2%). The majority of respondents have an education level

up to elementary school, namely Wonosalam health center 1 (76.6%), Bonang 2 (69.4%), and Wedung 1 (72.5%). More respondents did not work than respondents who worked, namely puskesmas Wonosalam 1 (62.5%), Bonang 2 (75.5%), and Wedung 1 (78.4%). And most respondents did not show stress. Puskesmas Wedung 1 respondents have a high average BMI compared to other puskesmas respondents in each month of measurement, namely October 2019 (24.20); February 2020 (11:53 p.m.);

August 2021 (11:59 p.m.); March 2022 (11:45 p.m.). The GDP level in each puskesmas varies, but all puskesmas show that the average GDP level in March is a higher average than in other months, namely the Wonosalam 1 health center (249.72), Bonang 2 (360.45), and Wedung 1 (250.37). Meanwhile, the average HbA1c of each health center varies from time to time of measurement.

Table 2. Test differences in BMI, GDP, and HbA1c based on the measurement period

Measurement Period/ Variables	IMT		GDP		HbA1c	
	Median (Min-Max)	p-value	Median (Min-Max)	p-value	Median (Min-Max)	p-value
<b>October 2019</b> (Before PPKM)	22.98 (16-38)	0.108	211.50 (88-554)	0.000	11.75 (5-17)	0.000
<b>February 2020</b> (Beginning of PPKM)	22.66 (16-39)		224.50 (78-551)		9.90 (5-16)	
<b>August 2021</b> (Post PPKM Level 4)	22.85 (15-39)		232.00 (13-527)		10.90 (5-16)	
<b>March 2022</b> (PPKM Level 1, End of PPKM)	22.90 (16-39)		262.50 (91-744)		11.50 (5-16)	

\*Friedman → Wilcoxon's hoc post

Source: Medical Record of PROLANIS Puskesmas Activities

Table 3 shows that the significance value obtained at each measurement period is that only the BMI variable has a significance value of  $> 0.005$ . While other variables have a significance value  $< 0.005$  meaning that

in the variables of GDP and HbA1c levels, there are at least two different measurements. The measurements that show significance differences are as follows:

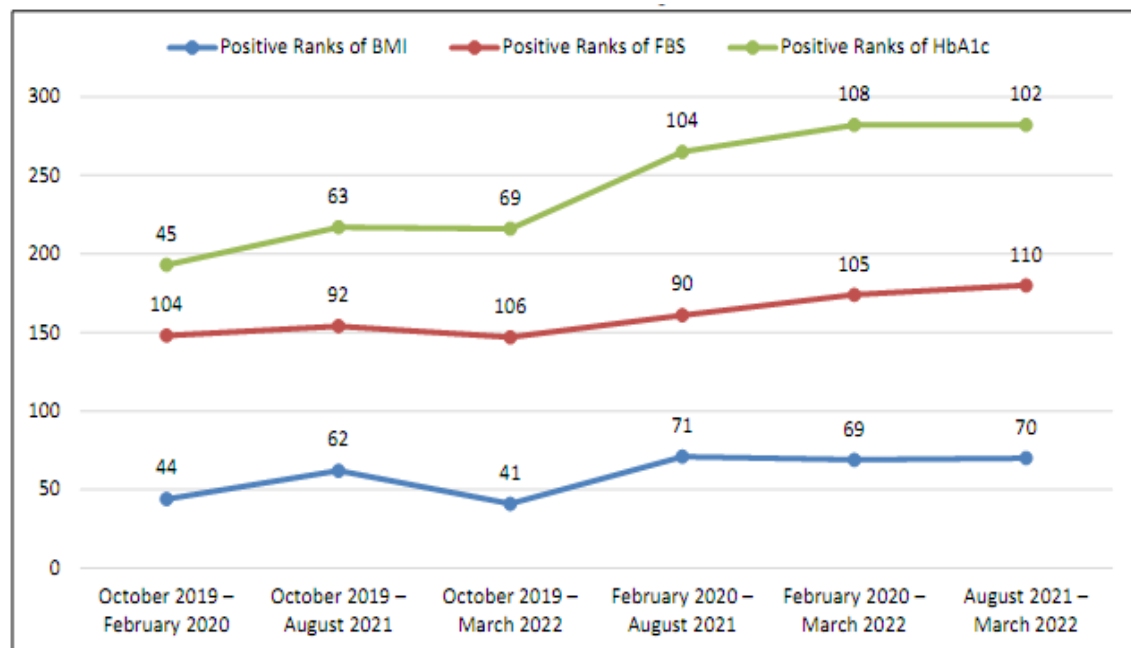
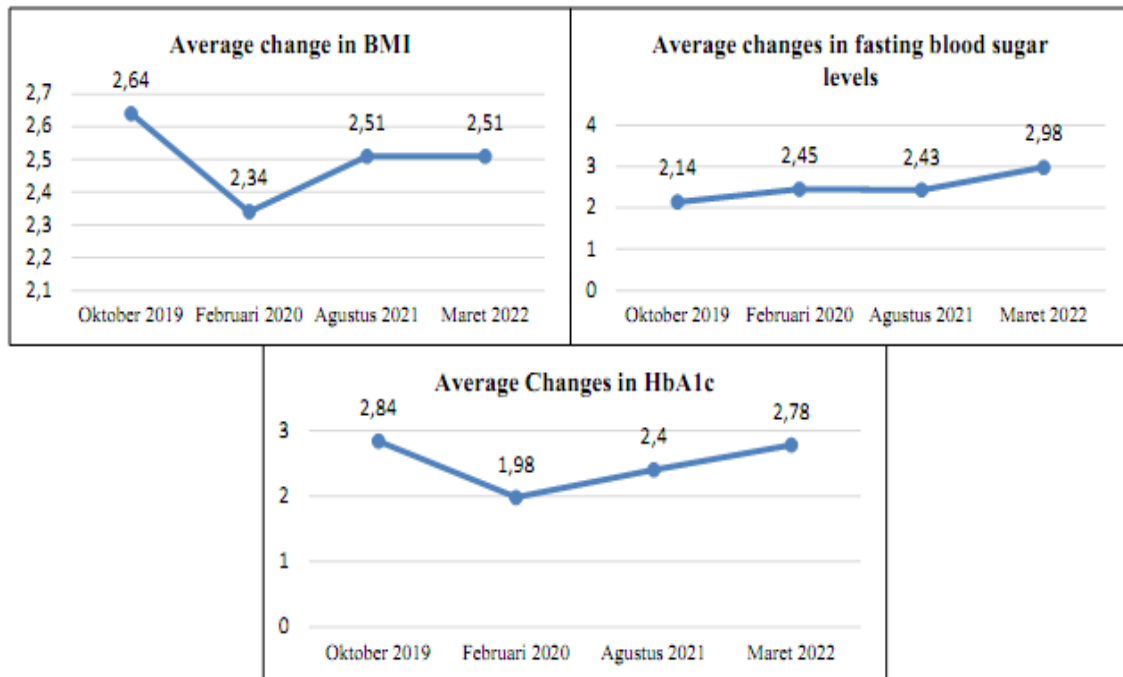


Figure 1. Changes in the value of Positive Ranks BMI, FBS, and HbA1c

The figure above shows the analysis results of the four measurement periods, which show significant differences in BMI measurements in October 2019 and February 2020 with a p-value  $< 0.005$ . Positive Ranks shows February 2020  $>$  October 2019 as many as 44 respondents. Significant differences in all

measures of GDP with p-value  $< 0.005$  only the February 2020 – August 2021 measurements did not have a significant difference. Significant differences in all HbA1c measurements with a p-value  $< 0.005$ , although the measurements from October 2019 to March 2022 showed a p-value of 0.075. The results of all HbA1c

measurements had differences in each measurement period. The graph of the average change for each measurement is in the graphic chart below:



**Figure 2.** Average Changes in BMI, FBS, and HbA1c During the PPKM Period

The analysis showed that the FBS and HbA1c in patients with DM increased significantly during the COVID-19 PPKM. The average change in FBS levels from the four consecutive measurement periods was 2.14, 2.45, 2.43, and 2.98. The average change in HbA1c is 2.84, 1.98, 2.40, and 2.78. The results of this study are in line with the research report meta-analysis, which shows a difference in the average HbA1c of 0.05% (95% CI 0.31 - 0.21) as a result of BMI; some studies report no significant difference of only + 0.3 kg. PPKM COVID-19 is a change in health care and people's daily lives and impacts the management of patients with DM. Lifestyle changes (e.g., dietary changes, consumption of calorie-dense foods, lack of physical activity, and the addition of BMI (Lippi et al., 2020), are part of the management of DM patients on insulin therapy (Tan et al., 2019).

HbA1c is significantly improved on the reports of several studies. It is a promising finding given the fact that reasonable glycemic control reduces the risk of comorbidities and complications, as well as the development of micro-and macrovascular consequences in DM patients (In-Dalmazi et al., 2020; Kleinwechter,

2020). DM patients may be able to balance diet, exercise, and insulin needs to counteract the consequences of COVID-19 PPKM, such as physical inactivity and psychosocial impacts (Pla et al., 2020). Furthermore, changes in FBS levels during PPKM COVID-19 in this study showed an increase in each measurement period. Still, some studies showed that the FBS level during PPKM COVID-19, which is better or controlled, could lie in a more regular daily lifestyle and strict daily routine, including a meal schedule (Brenner et al., 2020; Capaldo et al., 2020; Longo et al., 2020; Mesa et al., 2020). Several other studies have shown changes in better and controlled FBS levels. Generally, the treatment of DM patients is more intensive during COVID-19 PPKM (Eberle et al., 2021; Eberle & Stichling, 2021), such as better adherence to medicines as well as digital and dietary solutions during COVID-19 PPKM despite reduced exercise. On the contrary, other studies show worsening glycemic values. It could be due to increased stress and decreased physical activity. One study from India (Verma et al., 2020) redirected findings on the unavailability of insulin/glucosuria during the

PPKM-COVID-19 period.

Other studies have shown an emphasis on lifestyle changes during COVID-19 PPKM (Ghosh et al., 2020; Ruiz-Roso et al., 2020), increased consumption of vegetables, sweet foods, and snacks. They found a link between food consumption and snack consumption and the high percentage of physical activity before the covid-19 PPKM that increased. Other causes may be lack of sleep, lack of dietary restrictions, increased sitting time, increased socioeconomic difficulties altering healthy nutrition (Biancalana et al., 2021; Karatas et al., 2021), inability to visit hospitals or pharmacies, and increased anxiety and stress (Ghosh et al., 2020; Lippi et al., 2020).

In addition, local governments' strategies and restrictive measures in overcoming the COVID-19 pandemic differ from region to region (Desvars-Larrive et al., 2020). Some are more, and some are less stringent, as well as having different periods that can cause other effects on the health system and people's lives (Ghosh et al., 2020). Prolonged COVID-19 PPKM increased BMI in the type 2 diabetes group, but the increase in BMI did not differ significantly during the four measurement periods. These results are in line with a survey study of 1,200 participants who self-quarantined. 22% experienced a BMI results from lack of sleep, snacking after dinner, lack of dietary restrictions, eating in reaction to stress, and reduced physical activity (Zachary et al., 2020). Another survey study found an average increase of 1.5 kg after one month of the COVID-19 PPKM period. Self-reported BMI and depression were risk factors for BMI increase (Pellegrini et al., 2020). Also, another recent study reported an increase in BMI after COVID-19 PPKM began among obese people associated with snacking habits (de-Luis Román et al., 2020). An analysis of nutrition and exercise surveys during the pandemic in Spain showed that the consumption of snacks and sweet foods and physical activity increased and aggravated by home confinement in patients with type 2 diabetes (Ghesquière et al., 2021), Limited social interaction and reduced social eating replaced by emotional eating will also cause this (Robinson et al., 2013).

Increasing socioeconomic difficulties al-

ter healthy nutrition and create an obesogenic environment of energy foods that are cheap, easy to prepare, or accessible with less healthy ingredients. An increase in sitting time in a day could lead to a decrease in caloric expenditure in all populations (Ammar et al., 2020; Espeland et al., 2017). The limitation of this study was that it could not compare DM Type 2 and 1 patients or non-DM patients. The study focused on the differences in BMI, FBS, and HbA1c at the four measurement periods and did not observe factors that cause these differences. So subsequent studies can analyze the monitoring data of DM patients during the implementation of PPKM COVID-19.

### Conclusion

In conclusion, there is an increase in FBS and HbA1c, and the difference in BMI, although not significant during the COVID-19 lockdown, is noteworthy. In our opinion, worsening glycaemic parameters during this lockdown are related to the limitations that enter daily life due to an extraordinary phenomenon. Exposure to special situations will inevitably result in the patient experiencing various physical, mental, and mental problems. Considering that the COVID-19 pandemic is continuing, patients need to be supported emotionally, mentally, and physically, in addition to controlling biochemical parameters.

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