J u r n a l   B e r k a l a
EPIDEMIOLOGI
PERIODIC EPIDEMIOLOGY JOURNAL

ORIGINAL RESEARCH

CORONAVIRUS-RELATED ANXIETY WITH HYPERGLYCEMIA IN TYPE 2 DIABETES PATIENTS

Kecemasan terkait Coronavirus dengan Hyperglycemia pada Pasien Diabetes Tipe 2

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ABSTRACT

Background: COVID-19 might predispose individuals to elevated blood glucose levels as an effect of anxiety. Blood glucose level is an important risk factor for the prognosis of disease among diabetes patients. **Purpose:** This study aimed to assess the effect of Coronavirus-related anxiety with hyperglycemia incidence among type 2 diabetes patients. **Methods*:*** A cross-sectional study was conducted among 143 individuals with type 2 diabetes mellitus, from 25 January to 29 February 2021. This study was conducted both online and by assessing archives of medical records using random samples. **Results:** A total of 143 respondents completed the questionnaire, with 59.44% females and 40.56% males. More than half of the respondents (55.94%) who reported hyperglycemia showed COVID-19 anxiety, and 51.05% of them experienced ≥ 8 years of diabetes. COVID-19 anxiety was associated positively with the risk of hyperglycemia among type 2 diabetes patients (PR>1). Severe worry about the pandemic had the highest risk of hyperglycemia compared to moderate and mild anxiety. This finding is confounded by diabetes duration (PR discrepancy >10% and PR>1 for ≥8 years long-duration). **Conclusion:** This study suggests a positive association between COVID-19 anxiety and hyperglycemia while the degree of anxiety is associated with an increased risk of hyperglycemia.

ABSTRAK

Latar Belakang: *COVID-19 dapat mempengaruhi individu untuk mengalami peningkatan kadar gula darah sebagai efek dari kecemasan. Kadar glukosa darah merupakan faktor risiko penting untuk prognosis penyakit pada pasien diabetes.* ***Tujuan:*** *Penelitian ini bertujuan untuk menilai pengaruh kecemasan terkait COVID-19 dengan kejadian hiperglikemia pada pasien diabetes tipe 2.* ***Metode:*** *Studi potong lintang dilakukan pada 143 orang dengan diabetes mellitus tipe 2, dari 25 Januari hingga 29 Februari 2021. Penelitian ini dilakukan secara online dan dengan menilai arsip rekam medis menggunakan sampel acak.* ***Hasil:*** *Sebanyak 143 responden mengisi kuesioner, dengan 59,44% perempuan dan 40,56% laki-laki. Lebih dari separuh responden (55,94%) yang melaporkan hiperglikemia menunjukkan kecemasan COVID-19, dan 51.05% di antaranya mengalami diabetes selama 8 tahun. Kecemasan COVID-19 berhubungan positif dengan risiko hiperglikemia pada pasien diabetes tipe 2 (PR>1). Kecemasan dengan level berat tentang pandemi memiliki risiko hiperglikemia tertinggi dibandingkan kecemasan sedang dan ringan. Hasil ini melibatkan durasi diabetes sebagai variabel pengganggu (beda PR >10% dan PR>1 untuk durasi 8 tahun).* ***Kesimpulan:*** *Penelitian ini menunjukkan hubungan positif antara kecemasan COVID-19 dan hiperglikemia dimana tingkat kecemasan dikaitkan dengan peningkatan risiko hiperglikemia.*

INTRODUCTION

The rising global prevalence of diabetes has been a major concern among other chronic diseases. The prevalence of Diabetes Mellitus (DM) is increasing at an alarming rate in developing countries (Terzic & Waldman, 2020). It is responsible for 4% of all global deaths (WHO, 2018). It is also projected that by 2030, cases will have risen to 552 million cases. The number of people with type 2 diabetes is increasing throughout the globe, and among those, about 80% of people with diabetes live in low and middle-income countries. A potentially explosive increase in the prevalence of diabetes is predicted, especially in developing countries like Indonesia.

Indonesia is the world's fourth most populous country and has the sixth-largest number of people with diabetes (>10 million diabetics). The number of individuals with diabetes mellitus in Indonesia is around 10 million with a growth pace of 6.2%. It has become one reason for death in Indonesia (WHO, 2018). According to these statistics, Indonesia is in the top ten countries for escalating occurrence of diabetes.

Type 2 diabetes is the most widely recognized type of diabetes, representing 90% to 95% of all diabetic patients. It is predicted to increase to 439 million by 2030. In Indonesia, around 10.3 million people are living with type 2 diabetes, among whom, 7.3 million are undiagnosed (International Diabetes Federation, 2019). The most dramatic increase in type 2 diabetes has occurred in populations with rapid and major changes in lifestyle (Wondemagegn et al., 2017). It demonstrates the significant role of lifestyle and the potential for reversing the global epidemic.

The current COVID-19 pandemic has triggered anxiety and stress due to uncertainties among the general community. Meanwhile, people with comorbidities, such as diabetes, are at risk of having multiple stress loads. People with diabetes are already at risk of psychological problems, moreover, people with severe mental illness are more likely to have diabetes than the general population (Lucy, Oliveira, Felipe, Braga, & Gomes, 2020). Stress caused from COVID-19 related anxiety is caused by fear of infection with the COVID-19 virus and a higher risk of death among COVID-19 patients with hyperglycemia and obesity in type 1 and type 2 diabetes (Hillson,

2020). Perceived health anxiety and fear of illness could affect the capacity to self-oversee. Therefore, stress, inadequate social support, and negative feelings towards any new change in life can impact glycemic control (Mukhtar & Mukhtar, 2020). The claim has received widespread publicity. It has been causing reasonable dread and anxiety among individuals with diabetes, particularly when numerous nations are still struggling with the COVID-19 pandemic.

Chronic stress can take a toll on people's health. Moreover, stress can be considerably more unsafe for diabetics since the body obstructs its own delivery of insulin, a chemical that directs glucose levels (Ugwueze, Ezeokpo, & Nnolim, 2020). Even the ordinary pressure of daily life can influence the patient's insulin and glucose function, which can worsen their diabetes. The previous study also stated that people with diabetes, hypertension, and extreme weight (BMI >40 kg/m^2) are bound to be affected and are at a higher risk of complications and death from COVID-19 (Yang et al., 2020). Additionally, COVID-19 could prompt extra pulmonary appearances like diabetes mellitus and hyperglycemia (Al-kuraishy, Al-Gareeb, Guerreiro, Cruz-Martins, & Batiha, 2021). It may raise the anxiety and fear of being infected with COVID-19 among diabetes patients. Furthermore, stress can put people with diabetes at risk of weight gain and elevated cholesterol, both of which can lead to hyperglycemia (Wong, Singh, Go, Ahluwalia, & Guerrero-go, 2019).

According to the PERKENI (Indonesian Endocrinology Society) consensus, hyperglycemia is defined as blood glucose levels of more than 125 mg/dL while fasting, more than 200 mg/dL for random blood sugar tests, and HbA1c of less than 6.5 %. Left untreated, hyperglycemia can lead to a variety of life-threatening complications, including damage to the eye, kidneys, nerves, heart, and peripheral vascular system. As a result, hyperglycemia must be closely monitored to maintain stable blood glucose levels and avoid complications (Hammer et al., 2019).

Uncontrolled blood glucose or hyperglycemia affects people of all ages and socioeconomic class. Not only can this lead to risk of diabetes and complications but can lower quality of life and thus must be avoided and controlled. Diabetic patients who are anxious during the COVID-19 pandemic are more likely to develop unstable blood glucose levels, potentially putting them at risk. To address the problem, researchers must determine whether pandemic anxiety contributes to diabetic patients developing hyperglycemia.

Numerous studies have assessed the role of stress in increased blood glucose levels. However, no previous research has linked COVID-19-related anxiety to the possibility of uncontrolled blood glucose levels (hyperglycemia) in type 2 diabetes patients. Furthermore, confounding factors such as the use of blood glucose-raising drugs and the presence of hypertension-free individuals are controlled in this study. Thus, the primary goal of this study was to determine the relationship between COVID-19 anxiety and hyperglycemia.

METHODS

This is a cross-sectional study that took place in Kitamura Clinic in Pontianak City, West Kalimantan Province, Indonesia, from January 25 to February 29, 2021. Data were collected mainly through an online survey by providing a Google Form link to fill and submit the questionnaire. The online survey was conducted by collecting following variables: coronavirus-related anxiety, physical activity, smoking, strict diet, history of anxiety, diabetes duration, and socio-demographic characteristics (age, sex, weight, height, and occupation).

The information on physical activity was obtained with the International Physical Activity Questionnaire (IPAQ). The metabolic equivalent of the task (MET-minute/week) was calculated from the frequency and duration of occupation, commuting, recreation, and sitting physical activity in a week. The total physical activity was grouped into two categories: low (<600 MET-minute/week) and moderate to vigorous ($>=600$ MET-minutes/ week).

We adopted components of Silva's (2020) validated Coronavirus-related Anxiety Scale to identify possible cases of dysfunctional anxiety related to the COVID-19 crisis (Silva, de Sampaio Brito, & Pereira, 2020). Participants were asked to rate how well the items reflected their behavior in the previous two weeks and how frequently they experienced the anchored scale on a 4-point scale. (0 = not applicable to me; 1 = hardly ever applicable to me; 2 = sometimes applicable to me; and 3 = very applicable to me). The questionnaire contained seven anxiety items related to experiencing COVID-19 anxiety symptoms. The items included: feeling bad when thinking about COVID-19, heart racing when reading about COVID-19, feeling anxious about COVID-19,

being uneasy when reading news about COVID-19, having trouble relaxing when thinking about COVID-19, panicking when seeing updates about COVID-19, and being afraid of infection with COVID-19. The items' comprehensibility was examined with 18 subjects. All items showed a correlation value >0.3. Thus, all questions were considered valid to be included in the questionnaire. The study instrument used to measure the Coronavirus-related anxiety variable has a Cronbach's alpha of 0.907, so it can be said that it is reliable. Not anxious if the average score was <1, while anxious if ≥1. This study divided anxiety levels into mild (average score = 1), moderate (average score= 2), and high (average score=3) categories (Magano, Vidal, Sousa, Dinis, & Leite, 2021).

Other variables were demographic characteristics (sex, age group, occupation), diabetes duration, obesity, smoking, physical activity, and strict diet. One of the independent variables was the duration of diabetes mellitus (in years). The WHO classifies diabetes duration with 10-year cut-offs, but this study chose to use the variable's mean. Therefore, the current study's diabetes duration cut-off was 8 years.

Questions about smoking, such as whether the respondents were smokers or nonsmokers, were included to determine smoking status. Smoking information was obtained by asking respondents whether smoking currently at the time of conducting the study. This study only classified the data into yes and no without considering former smokers.

In the survey, information related to diet was assessed using a question about whether the patient was on a diet set by health professionals. We also included respondents with prior anxiety diagnoses before the data collection. They are already getting treatment and declared cured by health professionals. To identify their Body Mass Index, we asked respondents their height and weight. Obesity is defined as body mass index (BMI) cut-offs >30 kg/m2 according to WHO guidelines. Meanwhile, the characteristics of respondents such as age, sex, and occupation were determined through simple questions.

Hyperglycemia data was obtained from medical records of type 2 diabetes mellitus patients, namely the latest measurement (2 weeks) of random blood glucose levels. Respondents were asked not to do physical activity such as exercise, smoking, and eating, for at least 30 minutes before doing a blood pressure measurement. Respondents were also asked to sit and rest for at least 5-10 minutes before measurement. Hyperglycemia is defined as plasma glucose levels greater than 200 mg/dL at any given time in hospitalized patients who were known to have type 2 diabetes.

All patients with diagnosed type 2 diabetes from April 2020 - January 2021 and still on outpatient treatment at the clinic. The survey opened for 21 days to maximize the number of participants in study sample and accordingly, 143 of 147 total patients completed the study questionnaire. Respondents filled out an informed consent form on Google Form, and their responses were kept anonymous and confidential. Non-pregnant adults diagnosed with type 2 diabetes who were willing to participate in the survey were eligible. We excluded patients who had taken blood glucose-raising medicine in the previous three months, such as corticosteroids, antidepressants, diuretics, cyclosporine, and nicotine/niacin acid. Participants with a history of hypertension or who were on antihypertensive medication were also excluded.

The data were analyzed with STATA Version 16.0, and the Prevalence Ratio (PR) and test-based 95 % Confidence Interval were used to estimate the risk of hyperglycemia for COVID-19 related anxiety in type 2 diabetes patients. The adjusted prevalence ratio (PR) with a 95 % confidence interval was used to estimate the relationship between COVID-19 anxiety and hyperglycemia. We included confounding factors such as diabetes duration in the final model because they changed the risk estimate by 10% or more. This study was reviewed and approved by the Ethical Committee of the Faculty of Public Health, Universitas Indonesia (Approval Number: Ket-118/UN2.F10.D11/PPM.00.02/2021).

RESULTS

A total of 143 people took part in this study and completed the questionnaire, with more than half (59.44%) being female and (40.56%) male. Average age of participants was 55 years with (52.45%) being the percentage of those aged 55 years. In terms of occupation, the majority of patients were active workers (51.05%). As shown in Table 1, the majority of hyperglycemia cases were physically active (70.63%), nonsmokers (59.44%), and had a normal BMI (89.51%). Participants with hyperglycemia without a history of anxiety made (93.01%) of sample whilst (74.83%) did not adhere to a strict diet by health

professionals. Those with diabetes for more than 8 years had a higher prevalence of hyperglycemia (51.05%), with 55.94% reporting no anxiety during the pandemic. Specific characteristics of subjects can be seen in Table 1.

Table 1
Characteristics of Patients with Type 2 Diabetes

Variables	Hyperglycemia		Total	p-value
	Yes (n=71)	No (n=72)		
Gender				
Male	27 (38.03)	31 (43.06)	58 (40.56)	0.54
Female	44 (61.97)	41 (56.94)	85 (59.44)	
Age				
≥ 55	37 (52.11)	38 (52.78)	75 (52.45)	0.93
< 55	34 (47.89)	34 (47.22)	68 (47.55)	
Obesity				
Yes	7 (9.86)	8 (11.11)	15 (10.49)	0.80
No	64 (90.14)	64 (88.89)	128 (89.51)	
Occupation				
Actively working	36 (50.70)	37 (51.39)	73 (51.05)	0.93
Not working	35 (49.30)	35 (48.61)	70 (48.95)	
Physical activity				
Low (<600 MET-min/week)	23 (32.39)	19 (26.39)	42 (29.37)	0.43
Moderate to vigorous (≥600 MET-min/week)	48 (67.61)	53 (73.61)	101 (70.63)	
Current smoker				
Yes	30 (42.25)	28 (38.89)	58 (40.56)	0.68
No	41 (57.75)	44 (61.11)	85 (59.44)	
Previous anxiety diagnosis				
Yes	8 (11.27)	2 (2.78)	10 (6.99)	0.00*
No	63 (88.73)	70 (97.22)	133 (93.01)	
Diet				
Yes	15 (21.13)	21 (29.17)	36 (25.17)	0.26
No	56 (78.87)	51 (70.83)	107 (74.83)	
Diabetes duration (years)				
≥ 8	45 (63.38)	28 (38.89)	73 (51.05)	0.00*
< 8	26 (36.62)	44 (61.11)	70 (48.95)	
COVID-19 anxiety				
Anxious	35 (49.30)	28 (38.89)	63 (44.06)	0.21
Not anxious	36 (50.70)	44 (61.11)	80 (55.94)	

*) statistically significant; chi-square test

Table 2 shows the risk of hyperglycemia based on COVID-19 anxiety and diabetes duration. After controlling for confounding variables, the overall risk of hyperglycemia due to COVID-19 anxiety was 1.16 (95% CI=0.72-1.84). People with diabetes for more than 8 years were 1.63 (95% CI= 0.99-2.64) more likely to have hyperglycemia than those with diabetes for less than 8 years. Even though the confidence intervals overlap, the difference between these two groups is statistically significant (p 0.05). Furthermore, the proportion of hyperglycemia with 8 years or longer diabetes duration was higher than with short diabetes duration, according to the visual assessment. Meanwhile, people with COVID-19-related anxiety and hyperglycemia had slightly lower blood sugar levels than those who did not have anxiety.

Table 2
Final Risk of Hyperglycemia in Relation to Status of COVID-19 Anxiety and Controlled by Diabetes Duration

Factor	Hyperglycemia		PR
	Yes	No	(95% CI)
Anxiety status			
No	36 (50.70)	44 (61.11)	*Ref.[a]*
Yes	35 (49.30)	28 (38.89)	1.16 (0.72-1.84)
Diabetes duration (years)			
< 8	26 (36.62)	44 (61.11)	*Ref.[b]*
≥ 8	45 (63.38)	28 (38.89)	1.63 (0.99-2.64)

[a]*Ref.,* [b]*Ref. Reference category*

Table 3 displays the risk of hyperglycemia based on the level of anxiety. More than half of those feeling anxious identified mild anxiety; however, due to the small sample size within the strata, there were overlapping confidence intervals for all categories and large intervals for severe and moderate levels of anxiety. The overlapping confidence intervals make it difficult to determine whether anxiety is a risk factor or a protective factor against hyperglycemia.

Table 3
Risk of Hyperglycemia in Relation to Status and Level of COVID-19 Anxiety

Anxiety	Hyperglycemia		PR
	Yes	No	(95% CI)
Never	36 (50.70)	44 (61.11)	*Ref.[a]*
Anxious	35 (49.30)	28 (38.89)	1.16 (0.72-1.84)
Level of anxiety			
Severe	3 (4.23)	1 (1.39)	3.67 (0.37-36.78)
Moderate	6 (8.45)	4 (5.56)	1.83 (0.48-6.99)
Mild	26 (36.62)	23 (31.94)	1.38 (0.67-2.82)

[a]*Reference category for all PRs is never anxious*

DISCUSSION

The COVID-19 pandemic has triggered an unprecedented global health crisis. Millions of people's lives in Indonesia have already been disrupted. Many people's mental health has suffered as a result of the COVID-19 pandemic and the subsequent health issues. Anxiety and depression, for example, have created new obstacles for people who are already ill. Pandemic constraints, such as social and physical isolation, have made regular health checkups for those with mental health issues more difficult, if not impossible (Kaligis, Indraswari, & Ismail, 2020).

This study aims to identify the correlation between anxiety symptoms during the pandemic and hyperglycemia in adults with type 2 diabetes. Understanding the relationship between those variables can help in planning effective random blood glucose control among type 2 diabetes patients during the outbreak. Moreover, to the best of our knowledge, no previous study assessed the effect of Coronavirus-related anxiety by using the COVID-19 anxiety scale on the significant increase of random blood glucose levels (hyperglycemia) among one of the most vulnerable groups, type 2 diabetes patients.

Anxiety was measured on a scale of 0 to 3. Almost half of the respondents reported feeling anxious about recent conditions as the number of confirmed cases of COVID-19 grows. Results were stratified according to the potential confounders of anxiety and hyperglycemia. Researchers found that those with anxiety during the pandemic had a higher risk of hyperglycemia (49.30%) compared to those who were not anxious. Even when the CIs are overlapping slightly (PR=1.16; 95% CI: 0.72-1.84), it does not necessarily imply that there is no statistically significant difference between the two groups (Tan & Tan, 2010). These overlapping results make it impossible to accurately conclude the role of anxiety in hyperglycemia as a risk or protective factor. Although it is impossible to estimate the magnitude of the effect, we can compare these findings to most other findings.

Previous research has found a link between general anxiety and hyperglycemia (Herzer & Hood, 2010). Many factors, including stress, can cause people with type 2 diabetes to have a higher risk of hyperglycemia. Studies have repeatedly shown that emotional stress can cause blood sugar to spike, whether it is related to work or another aspect of life. Stress raises blood glucose levels and even causes hyperglycemia in hospitalized patients. In some cases, hyperglycemia is caused by type 1 or type 2 diabetes, but in the majority of cases, it is caused by the stress associated with illness (McAllister et al., 2015).

Stress stimulates the release of various hormones, which can result in elevated blood glucose levels (McAllister et al., 2015). Severe mental depression can cause sufficient stress for the body to produce abnormally high blood sugar levels, even in people without diagnosed diabetes. However, when there is a major physical threat such as diabetes, stress hinders the body from delivering insulin, and that allows glucose to accumulate in the blood (Khalfallah, Abdelmageed, Elgendy, & Hafez, 2020). Subsequently, elevated glucose levels can cause long-term complications such as diabetes.

In this study, the level of anxiety was also considered. It is shown that there are wider and overlapping confidence intervals due to a smaller sample size or a higher variability. Therefore, even though it is identified the difference in hyperglycemia between both groups, we could not conclude the risk estimation of hyperglycemia between anxiety levels.

Although this study was unable to prove the effects of pandemic anxiety on hyperglycemia, it is undeniable that the COVID-19 pandemic has had a significant impact on society. Many people are dealing with problems that can be stressful, overwhelming, and cause strong emotions in both adults and children (Lin, Hu, Alias, & Wong, 2020). Because of the risk of being infected by Coronavirus, communities began to express a wide range of concerns about the coronavirus outbreak. Some people are particularly vulnerable to the pandemic's psychological impact. During this outbreak, people with certain diseases, such as cardiac disease, hypertension, or diabetes, are more vulnerable to severe stress and anxiety (Fang, Karakiulakis, & Roth, 2020). This is related to the fact that diabetes is a risk factor and contributes to the seriousness and mortality of patients with COVID-19 (Abdi, Jalilian, Ahmadi, & Vlaisavljevic, 2020). Diabetes mellitus co-morbidity causes 2.17 times higher risk of death in COVID-19 patients contrasted in patients without diabetes mellitus (Apicella et al., 2020). Moreover, Coronavirus social restriction has advanced psychological distress with tension and despondency among the overall public in general and especially those tormented with constant infections like individuals with diabetes (Verma & Mishra, 2020).

Researchers calculated the duration of diagnosed diabetes to estimate the diabetes duration associated with hyperglycemia. More than half of respondents (51.05 %) claimed to have had diabetes for 8 years or more, with hyperglycemia affecting 63.38 % of them. However, the effect of anxiety after being confounded by diabetes duration is still unknown. The CI also describes the degree of uncertainty in our estimated difference (PR=1.63; 95% CI: 0.99-2.64).

Another study found that the duration of diabetes had a significant impact on poor glycemic control, which was identified as uncontrolled random blood glucose levels or hyperglycemia. This previous study agrees that factors correlated with poor glycemic control include a longer duration of diabetes as the function of the pancreas further degrades due to the failure of the β-cells (Alramadan et al., 2018). In addition, people with a longer span of diabetes are potentially at a higher danger of creating diabetes-related complexities, which can substantially affect glycemic control.

Admittedly, the way people cope with a crisis can be influenced by their level of education (Lunau, Siegrist, Dragano, & Wahrendorf, 2015). It may be acknowledged by some diabetes patients that contracting COVID-19 would be dangerous for their well-being however gaps in their education and acknowledgment may hinder their ability to protect themselves. However, this paper does not consider how likely education levels might be to anxiety due to COVID-19.

Lifestyle factors such as age, sex, smoking behavior, obesity, physical activity, and diet could play a role in elevating blood glucose levels. Previous epidemiological studies reported the risk of developing hyperglycemia to be more prevalent among men (OR=1.09; 95% CI: 0.51−2.33), and ex-smokers (OR=1.35; 95% CI: 0.65−2.81) (Quang Binh et al., 2012). Chia et al. reported aging is a well-known risk factor for elevated blood glucose (Chia, Egan, & Ferrucci, 2018). Some people gradually lose their ability to regulate glucose levels as they get older. Diet and physical

inactivity are also major contributors to the rapidly rising incidence of hyperglycemia and diabetes in developing countries (Sami, Ansari, Butt, Rashid, & Hamid, 2015).

In addition, recent studies suggested a link between diabetes and alexithymia. Those suffering from alexithymia can experience issues with recognizing and managing signals and sensations concerned with identifying emotions. A previous study claimed two out of every five patients with diabetes had alexithymia (Hintistan, Cilingir, & Birinci, 2013). This fact potentially confounds the results of patients' anxiety levels since, in this study, there are no questions pertaining to alexithymia.

Additional research is required to improve the measurement of COVID-19 anxiety by adding questions to the survey. The majority of the items in the current questionnaire focused on asking the participant if they were stressed. To achieve more informative results, the next poll could ask patients to prioritize a list of health-related dangers during the pandemic, to indicate what participants perceive as more serious. Furthermore, they could be asked to rate the severity of their anxiety.

The results of this study show that almost half of participants experience hyperglycemia, suggesting glycemic control monitoring is needed in patients. In the current pandemic situation, it would be preferable for patients to have help managing their anxiety and depression with psychological assistance. Anxiety, like other mental health issues, requires early detection by screening with various questionnaires. This strategy can be carried out from the nearest health service in the community, namely the community health center. Although many health services will be limited with resources during a pandemic due to prioritizing COVID-19 patients, it would be beneficial to reassess input by considering effects of stress, particularly on the population with comorbidities and the elderly.

CONCLUSION

The research indicates a correlation between COVID-19 anxiety and hyperglycemia in type 2 diabetes patients after controlling for previous anxiety diagnosis and diabetes duration; however, the magnitude of the effect cannot be estimated due to overlapping CIs in all categories. This study does not account for biases related to alexithymia and medication adherence, including the type of drug used, such as insulin. To obtain more in-

depth information, the limitations of questions used to assess smoking behavior must also be considered, including the presence of former smokers among participants. To measure COVID-19 anxiety, future research should use a larger sample size and more detailed questionnaire.

CONFLICT OF INTEREST

The authors declare that this study has no competing interest, and we confirm the accuracy of the results.

AUTHOR CONTRIBUTIONS

KH drafted the initial manuscript, conceived and designed the study, and completed the statistical analysis. HH designed the analysis and provided critical feedback on the intellectual content from the Epidemiology perspective. CK contributed analysis tools, was responsible for compiling Psychology literature review, and editing the manuscript. All authors have contributed intellectually to this manuscript and have read the final manuscript.

ACKNOWLEDGMENTS

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