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Health Literacy is Strongest Determinant on Self-Monitoring Blood Glucose (SMBG) Type 2 DM Patients During COVID-19 Pandemic at Public Health Centre in Tabanan Regency

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Abstract---Diabetes mellitus is becoming the most common risks factor and comorbidities found in patients with COVID-19. Self-monitoring blood glucose (SMBG) could improve the prognosis of diabetic patients infected with the coronavirus. This study aims to analyze the most related determinant factor with SMBG type 2 DM patients during the covid-19 pandemic at the Tabanan's Public Health Centre. A cross-sectional approach was used in this study by involving 169 respondents using proportional stratified random sampling. Data gathering instruments included questionnaires. Binary logistic regression was performed to evaluate determinant factors and SMBG. the findings found that women 2,680 times more possible doing SMBG (AOR [95% CI] = 2,680 [1,222-5,879]), high income person 2,954 times more possible doing SMBG (AOR [95% CI] = 2,954 [1,363 – 6,403]), high anxiety rate 0.171 times lower for doing SMBG, high health literacy is 3,051 times higher possible perform SMBG (AOR [95% CI] = 3,051 [1,326 – 7,019]), high support from family 2,486 times higher possible to do SMBG. Health literacy is the strongest determinant factor on SMBG type 2 DM patients during the COVID-19 pandemic at the Tabanan Public Health Centre. Respondents with high health literacy increase the opportunity in SMBG by 3,051 times compared to the respondent with low health literacy. A person's health literacy can be improved by health education by considering the level of education, cultural background, gender, occupation, and age. During the COVID-19 pandemic, type 2 DM patients should remain routine to control blood sugar to prevent complications and a poor prognosis.

Keywords---COVID-19, diabetes mellitus, health literacy, logistic models, self-monitoring blood glucose

Introduction

Diabetes Mellitus patients in Indonesia are increasing every year. The World Health Organization estimates the amount of diabetes mellitus patients in Indonesia (particularly type 2) will increase significantly up to 16.7 million in 2045. In 2017 Indonesia recorded get 6th position in the world with 10.3 million patients with type 2 Diabetes. DM

registered as one of 10 causes top death in adults, and it is estimated that has cause four million death globally in 2017. During the COVID-19 pandemic, the death risk due to COVID-19 reached 50% higher in DM patients compared to those who don't (Remuzzi & Remuzzi, 2020). With a high prevalence of diabetes, it is important to understand special aspects of COVID-19 infections in a patient with DM. It becomes more important because the world sets restrictions on the mobility of the patient to overcome the pandemic (Gupta et al., 2020).

Social restrictions through Enforcement of Restrictions Community Activities (PPKM) on the island Java and Bali started early January 2021 to be applied in Indonesia's policy to stop and prevent the spread of COVID-19 infection, by considering the amount of COVID-19 cases confirmed has a massive increase in number and by August 17, 2021, recorded there was addition case confirmed positive as many as 20,741 cases where 37.5% is with DM. The case confirmed positive for COVID-19 in Bali on August 18 2021 was 98,637 with 10,720 being the active case. Temporary for Tabanan district is in 3rd position in several cases within 9 districts in Bali which was confirmed there are 9,835 cases confirmed positive with 1,263 cases active.

Prevention of COVID-19 transmission in DM patients can be done by maintaining good glycemic control. DM Patients need to control the glycemic because glycemic control could help reduce the risk of infection and also the level of severity. Daily monitoring of the rate of glucose blood (blood sugar monitoring independent) is very required (Gupta et al., 2020). SMBG is one of the valuable tools in self-management diabetes and has proven to improve glycemic control (Mbaezue et al., 2010). An evaluation of self-practice maintenance in patients in China with type 2 DM on treatment with oral anti-diabetics (OAD) and in several cases of OAD plus insulin showed that only 13% of patients that practicing SMBG (Zhou et al., 2013). The research conducted by Raoufi et al. (2018), shows 48.6% (1,060 inhabitants) have SMBG in the low category level.

Do tasks that are very technical like SMBG can be influenced by poor health literacy health (Mbaezue et al., 2010). poor health literacy is an independent predictor of poor glycemic control and is associated with a trend toward lower for reaching control towards high glycemic (Saeed et al., 2018). Success DM patients in controlling blood sugar are also affected by family support. Between people who live with disease chronic like DM, family support becomes important to help face the disease (Kamaryati & Malathum, 2020). Research conducted by Melinda et al. (2019), shows an existing connection between family support with stable blood sugar levels in people with diabetes mellitus.

The period of pandemic and social isolation tends to increase the anxiety that can also cause poor compliance in diabetic patients in treatment and can worsen the risk factor (Qiu et al., 2020). This is caused by anxiety feeling from DM patients to go to hospital or health service (Banerjee et al., 2020). SMBG as part of self-management diabetes is very important in controlling blood sugar during the COVID-19 pandemic. The aim of this study is for knowing the most related determinant factor with SMBG consisting of characteristics respondents, anxiety, health literacy, and family support.

Materials and Methods

Research location and design

This study was conducted in the work area of Tabanan's City Public Health Centre, Bali Province. This study used a descriptive correlation analytic method with a cross-sectional approach.

Population and sample

The population in this study is whole Type 2 DM patients in the Tabanan City's Public Health Center which were taken in the last 6-month period (July – December 2020). With an amount population of 505 people. For taking the sample this study using a proportional stratified random sampling technique. To determine amount sample this study using WHO application size, as many as 169 respondents who meet criteria inclusion which are patients who are medical diagnosed with type 2 diabetes, type 2 diabetes patients treated at Tabanan City's Public Health Center, DM patients aged >15 years, type 2 DM patients who are willing to become respondents and signed the informed consent issued by the Committee Ethics ITEKES BALI.

Statistical analysis

All statistical calculations in a study this use computer with SPSS version 21.0 program. Bivariate statistical analysis was performed using the Chi-Square test. Test performed multivariate binary logistic regression with entering a predictor that meets condition with p-value < 0.25 (Bursac et al., 2008).

Research Results*General characteristics of the respondent*

General overview respondent cover characteristics respondents (age, type gender, education level, income, length of suffering, and therapy regimen), anxiety, health literacy, family support shown in table 1.

Table 1
Distribution frequency of characteristics respondents, anxiety, health literacy, and family support type 2 DM patients at Tabanan City's public health center (n=169)

Characteristics	n	%
Age		
Non-elderly	104	61.5
elderly	65	38.5
Gender		
Men	82	48.5
woman	87	51.5
Education level		
Low	84	49.7
High	85	50.3
Income		
<UMR	76	45.0
≥UMR	93	55.0
Length of Suffering		
< 5 years	137	81.1
≥5 years	32	18.9
Therapy regimen		
Oral	149	88.2
Oral and insulin	20	11.8
Anxiety		
Light	92	54.4
Heavy	77	45.6
Health literacy		
Inadaquate	66	39.1
Adequate	103	60.9
Family Support		
Poor	81	47.9
High	88	52.1
SMBG		
Bad	70	41.4
Good	79	58.6

Table 1 shows that the majority of respondents are in the non-elderly category (61.5%) with more than half of them being female (51.5%). The education level of the respondents is 50.3% belonging to higher education level and the income is above the minimum wage as much as 55%. The majority of respondents who went to the Tabanan City's Public Health Center had suffered from type 2 diabetes for less than 5 years (81.1%) most of whom used oral drug therapy regimens (88.2%), respondents had a mild anxiety level of 54.4%, the majority had adequate Health Literacy

at 60.9%. More than half (52.1%) of respondents received high family support and 58.6 % of respondents have good Self-monitoring of blood glucose (Banerjee et al., 2020; Singh et al., 2020).

Bivariate analysis

Bivariate analysis is shown in table 2.

Table 2
Relationship analysis characteristics respondent (age, gender, education level, income, length of suffering, therapeutic regimen), anxiety, health literacy, and family support with self-monitoring blood glucose (SMBG)

Variable	SMG				Total		p Nilai value	OR with 95% CI
	Bad		Well		f	%		
	f	%	f	%				
Age							0.505	0.808 (0.431-1.513)
No elderly	41	58.6	63	63.6	104	61.5		
Elderly	29	41.4	36	36.4	65	38.5		
Gender							0.012	2,213 (1,185-4,131)
Men	42	60	40	40.4	82	48.5		
Woman	28	40	59	59.6	87	51.5		
Education level							0.000	3,077 (1,625-5,826)
Low	46	65.7	38	38.4	84	49.7		
High	24	34.3	61	61.6	85	50.3		
Income							0.003	2,585 (1,378-4,850)
<UMR	41	58.6	35	35.4	76	45.0		
≥UMR	29	41.4	64	64.4	93	55.0		
Length of suffering							0.274	0.651 (0.300-1.409)
<5 years	54	77.1	83	83.8	137	81.1		
≥5 years	16	22.9	16	16.2	32	18.9		
Therapy regimen							0.011	4,630 (1,301-16,472)
Oral	67	95.7	82	82.8	149	88.2		
Oral and insulin	3	4.3	17	17.2	20	11.8		
Anxiety							0.000	0.265 (0.139-0.506)
Light	25	35.7	67	67.7	92	54.4		
Heavy	45	64.3	32	32.3	77	45.6		
Health Literacy							0.001	3,011 (1,584-5,723)
Inadequate	32	54.3	28	28.3	66	39.1		
Adequate	32	45.7	71	71.7	103	60.9		
Family Support							0.001	2,836 (1,506-5,341)
Poor	44	62.9	37	37.4	81	47.9		
High	26	37.1	62	62.6	88	52.1		

Table 2 show that factor type gender ($p=0.012$), an education level ($p=0.000$), income ($p=0.003$), therapy regimen ($p=0.011$), anxiety ($p=0.000$), health literacy ($p=0.001$), and family support ($p=0.001$) is a factor that has a significant correlation with SMBG type 2 DM patients during the COVID-19 pandemic at the Tabanan City's Public Health Center ($\alpha<0.05$). Two factors do not have a significant correlation s which are age ($p=0,505$) and duration of suffering from type 2 DM ($p=0,274$).

Multivariate analysis

Multivariate analysis using binary logistic regression test is shown in table 3.

Table 3

Analysis of the relationship between respondents characteristics variables (type gender, education level, income, therapy regimen), anxiety, health literacy, family support with self-monitoring blood glucose (SMBG)

Variable	B	SE	Wald	df	p Nilai value	Adjusted Odds Ratio	95% CI for Odds Ratio	
							Lower	Upper
Gender	.986	.401	6.054	1	.014	2,680	1.222	5.879
Education level	.746	.434	2.950	1	.086	2.109	.900	4,941
Income	1.083	.395	7.533	1	.006	2,954	1.363	6.403
Therapy regimen	.651	.747	.760	1	.383	1,917	.444	8,281
Anxiety	-1.769	.413	18,367	1	.000	171	.076	.383
Health literacy	1.116	.425	6.887	1	.009	3.051	1.326	7.019
Family Support	.911	.399	5.209	1	.022	2.486	1.137	5.436

Table 3 shows that the education level factor ($p=0.086$) and therapeutic regimen ($p=0.383$) were non-determinants factors that significantly related to SMBG. Gender factor ($p=0.014$), income ($p=0.086$), anxiety ($p=0.000$), health literacy ($p=0.009$) and family support ($p=0.022$) are determinant factors that has significant and strong correlation with SMBG.

Discussion

Gender with SMBG

This research results find that gender has a strong and significant relationship where woman respondent tends for do a good SMBG in amount to 2,680 times than men. These Research results are in line with research conducted by [Rasdianah et al. \(2016\)](#), which compares the level of obedience type 2 DM patients in terms of obedience in treatment obtained results that women have a higher level of obedience than men. On this research obtained results majority respondent is women (51.5%) in line with study [Meidikayanti & Wahyuni \(2017\)](#), who stated majority respondent is female (84%). The high amount of woman respondents in this study linked with the theory that states that women tend more susceptible to get DM because by a physical woman is likely to increase her body mass index, pre-menstruation syndrome and menopause can cause fat accumulation in the body caused by hormonal processes ([Trisnawati & Setyorogo, 2013](#)). Gender makes a significant contribution to the self-management of DM patients. Diabetes self-management can be carried out by anyone who suffers from diabetes, both men and women, but women seem to care more about their health so that they strive optimally to carry out self-management of the disease they are experiencing ([Ningrum & Siliapantur, 2019](#)).

Education with SMBG

This research results find that in the bivariate test, level education has a significant relationship with SMBG type 2 DM patients. Because the value of sig $p < 0.25$ then level education variable fulfill the condition to continue in the multivariate binary logistic regression test for proving that education level is one of the most related factors with SMBG type 2 DM patients. However, from a multivariate test performed we conclude that the education level variable has no significant correlation. This result shows that by statistics level education relates with SMBG however there is no prove level education can become a variable predictor that gives direct influence on SMBG. The results of this study are in line with the research of [Rasdianah et al. \(2016\)](#), which states that the level of education is not related to treatment adherence of DM patients. Likewise, research conducted by [Ningrum & Siliapantur \(2019\)](#), stated that there was no significant relationship between education level and self-management of type 2 DM patients at the UPTD Pasirkaliki Public Health Centre Bandung City.

In this study, the respondent's education level was higher education (50.3%). Higher education usually has more knowledge about health so that this knowledge can increase the ability to understand their health conditions ([Trisnawati & Setyorogo, 2013](#)). In theory, someone with a higher level of education will have the opportunity to behave well and more easily understand and comply with treatment behavior compared to people with low education. Likewise, [Heryati & Setiawan \(2014\)](#), research reveals that someone with higher education will have

broader knowledge than someone with a lower level of education because education is the main base for getting treatment success.

Income with SMBG

The results of this study found that income has a strong and significant relationship with SMBG where respondents with total family income above the minimum wage have an opportunity for good category SMBG by 2,954 times than respondents with total family income below the minimum wage. The results of this study are in line with research conducted by [Mansouri et al. \(2015\)](#), where higher total family income is a significant predictor of SMBG practice. Majority respondent with total family income above the minimum wage has more protective character to DM disease. High income could fulfill nutrition for family members specifically Type 2 DM patients are suitable needs as well as could routinely do checking or blood sugar control ([Musdalifah & Nugroho, 2020](#)).

However, different results were expressed by [Arindari & Suswitha \(2021\)](#), who stated that there was no relationship between income and Diabetes Self-Management. Low income can affect the process of accessing health education information facilities and it is difficult to provide costs to obtain health access through social media and mass media. In addition, someone who has a low socioeconomic status tends to have less and poor awareness of treatment to control blood sugar levels which can have an impact on increasing the risk of disease complications ([Sari, 2017](#)).

Therapy regimen with SMG

The results of this study found that in the bivariate test the therapeutic regimen had a significant relationship with SMBG ($p = 0.011$). However, from the multivariate test, the therapeutic regimen did not have a significant relationship ($p = 0.383$). This shows that statistically the therapeutic regimen has a relationship with SMBG but it is not proven that the therapeutic regimen is a predictor variable that has a direct effect on SMBG. This shows that in perform SMBG, type 2 DM patients do not influence by treatment regimens in controlling blood sugar ([Guerci et al., 2003](#); [Walford et al., 1978](#)).

Different results were found by [Al-Keilani et al. \(2017\)](#), who revealed that the DM treatment regimen has a significant influence on obedience to the patient against SMBG. Likewise, [Mansouri et al. \(2015\)](#), revealed a treatment regimen that included insulin was a significant predictor of SMBG practice. However, in this study majority of respondents consume oral medication (88.2%), some use combination oral medication (11.8%) and insulin, and no patients were found who only use insulin therapy. Where the respondents who majority use the therapeutic regimen of oral medication have a good SMBG category because easier and practical to be done. Besides, according to [Mansouri et al. \(2015\)](#), the study found almost a quarter of patients believe that diabetes can be cured with drink medicine. moreover, [Puspitasari et al. \(2012\)](#), explain that the usual therapeutic regimen which is more complex and polypharmacy as well as give effect side drug that occurs During treatment tends to make lower obedience in Type 2 DM patients.

Anxiety with SMBG

The results of this study found that anxiety and SMBG had a significant relationship with negative values. This means the higher anxiety will reduce the SMBG of type 2 DM patients. This Finding study in line with study [Mawan & Muflihatin \(2021\)](#), where the lower anxiety face by people with type 2 diabetes mellitus then people will have better self-management. [Yilmaz et al. \(2019\)](#), disclose a direct result with this results in a study where the existence of anxiety symptoms experienced by patients with diabetes can cause drop obedience treatment and response in treatment so that cause more complications and dropping quality survival in DM patients. Anxiety is a form of feeling worried, restless, and other unpleasant feelings. Anxiety often arises in individuals when they are dealing with unpleasant situations ([Suryaatmaja & Wulandari, 2020](#)). During the COVID-19 pandemic and social isolation tends to increase anxiety which can also cause poor adherence in DM patients to treatment and can exacerbate risk factors ([Qiu et al., 2020](#)). This is caused by the fear of DM patients going to the hospital or health services ([Banerjee et al., 2020](#)).

However, in this study, the majority of respondents had mild anxiety with SMBG in the good category. DM patients who experience mild anxiety are caused by having been exposed to knowledge about DM in addition to that usually because they have a family history of diabetes mellitus and have been diagnosed with diabetes mellitus for a long time ([Mawan & Muflihatin, 2021](#)). In addition, [PERKENI \(2020\)](#), has stated that during the COVID-19

pandemic, DM patients can take medicine at the public health center for the next two or three months to ensure the availability of medicine at home, so DM patients do not have to worry about running out of medicine.

Health literacy with SMBG

The results of this study found that health literacy has a strong and significant relationship with SMBG where respondents who have adequate health literacy have the opportunity to do SMBG in the good category of 3,051 times than respondents with inadequate health literacy. According to [Wilde & Garvin \(2007\)](#), in their concept of self-monitoring, it is emphasized that the main factor for the success of SMBG is awareness of the process of cognitive abilities possessed by individuals about SMBG, and health literacy is a contributing factor in increasing individual awareness ([Montagnana et al., 2009](#); [Schillinger et al., 2004](#)).

This study is in line with the research conducted by [Souza et al. \(2014\)](#), and [Saeed et al. \(2018\)](#), who stated a significant relationship between health literacy and glycemic control, typed 2 DM patients with inadequate health literacy tend to have poor glycemic control. In theory, low health literacy will result in low self-management as well as respondents who have high health literacy will produce high self-management. Better self-management is an expected consequence of self-monitoring ([Sabil, 2018](#)). Understand health literacy for everyone is very important because it is related to the ability to get information for improving and maintaining health especially during the COVID-19 pandemic. Health literacy is very useful for somebody to navigate sources of information health and service existing health as well as empower people to make a decision informed and practicing health behavior protective during the coronavirus and COVID-19 pandemic ([Paakkari & Okan, 2020](#)).

The implementation of SMBG in this study showed the majority in the good category. This is inseparable from the health literacy of the majority of respondents in the adequate category. Adequate health literacy for the respondents is associated with the respondent's education, most of which is higher education. The higher a person's education, it is assumed that the higher his knowledge, skills, and abilities ([Riniasih & Hapsari, 2020](#)). In line with the theory which states that health literacy is an individual's cognitive and social ability to obtain, process, and use health information in making health decisions that will affect their health status in various fields life along lifetime ([Sabil, 2018](#)).

One's understanding cannot be separated from the knowledge that person has. Poor disease knowledge due to limited health literacy is common in patients with chronic diseases such as type 2 DM and has an impact on poorer health outcomes ([Saeed et al., 2018](#)). One's understanding cannot be separated from the knowledge one has. Poor disease knowledge due to limited health literacy is common in patients with chronic diseases such as type 2 DM and has an impact on poorer health outcomes ([Saeed et al., 2018](#)).

Family support with SMBG

The results of this study found that family support has a strong and significant relationship with SMBG where respondents who have high family support have the opportunity to do SMBG in a good category by 2,486 times than respondents with low family support. This result is supported by research by [Melinda et al. \(2019\)](#), which stated there is a significant relationship Between family support with the regularity of blood sugar control in diabetic patients. Family support is one indicator that can give a positive impact on treatment in DM patients ([Melinda et al., 2019](#)).

In this study, the majority of high family support showed SMBG in the good category. According to the researcher, this is due to the various types of support provided by the family in the form of informational support, instruments, awards, and emotional support ([Friedman, 2013](#)). The family support provided can affect physical and psychological comfort in increasing self-confidence, feeling valuable, and loved so that it increases respondents' motivation in doing SMBG. By the theory presented that family support has a positive influence on the compliance of DM sufferers in carrying out self-management which includes independent blood sugar monitoring and treatment ([Yamin & Sari, 2018](#)).

Family support can help people who have chronic diseases such as type 2 DM to adapt to stress and new lifestyles due to conditions experienced due to the treatment regimen they are undergoing and reduce the barriers of type 2 DM patients in performing self-care behaviors, especially in monitoring blood sugar. [Syahid \(2021\)](#), revealed that DM patient compliance increased due to the low level of conflict in the family, the closeness between family members, and good communication between family members.

Health literacy is the most powerful determinant of SMBG

Multivariate analysis was carried out in this study using the binary logistic regression enter method. Where the independent variables meet the requirements of the multivariate test with a p-value <0.25. The independent variables in question are 7 variables, namely the characteristics of the respondents (gender, education level, income, therapy regimen), anxiety variable, health literacy variable, and family support variable (Huang et al., 2020; Cosson et al., 2006; Mustika et al., 2017). The 7 variables carried out by the multivariate test found that the health literacy variable was the determinant factor most related to SMBG type 2 DM patients where the OR value was the highest than the other variables, namely 3.051. This study proves that health literacy has a major influence on the implementation of SMBG for type 2 DM patients during the COVID-19 pandemic at the Tabanan City Health Center.

The rapid development of the COVID-19 disease into a pandemic has asked people to obtain and apply health information, and adjust behavior quickly (Zarocostas, 2020). According to the theory of Sørensen et al. (2012), that someone who has good health literacy will allow them to act independently in overcoming their personal, structural, social, and economic barriers. A systematic review was conducted by Nazmi et al. (2015), to see the relationship between health literacy and health outcomes, it was found that education is the most significant factor influencing health literacy. Likewise, this study shows something in line where most of the respondents are at the level of higher education. According to Paakkari & Okan (2020), in their research entitled COVID-19, health literacy is an underestimated problem, they emphasize that education and communication are investments in health literacy. In addition, education is also said to have a significant relationship with medication adherence in DM patients. Research conducted by Saeed et al. (2018), stated that patients with adequate health literacy reported no complications and had a higher socioeconomic level. It seems that the patient's socioeconomic status may be one of the independent variables that can affect health literacy. Health literacy is directly affected through education and indirectly through the access to health services (Romano et al., 1998; Ozdemir et al., 2003).

Limitations study

This study has a cross-sectional characteristic that is only researched in one limited time, only to prove conditions that occur at the time of the research and changes that may have and will happen could not observe. Self Report about SMBG may not reflect the actual performance because the researcher does not evaluate by direct or take notes on blood sugar measurement while implementing SMBG.

Conclusion

Health literacy is the strongest factor determinant related to SMBG type 2 DM patients during the COVID-19 pandemic at the Tabanan City's Public Health Center.

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