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THE EFFECT OF SLEEP QUALITY ON POST PRANDIAL GLUCOSE IN DIABETIC PRE-ELDERLY AND ELDERLY: A CROSS-SECTIONAL STUDY IN SURABAYA, INDONESIA

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Abstract - Diabetes Mellitus (DM) often caused by lifestyle changes, food consumption habits that are high in calories, lack of activity, smoking, obesity, and the presence of sleep disorders. Elderly have a higher risk of developing DM than adults, one of which is due to sleep disorders that are often experienced due to physiological changes in the central nervous system affecting sleep regulation, general sense damage with the aging process which can reduce sensitivity to time maintaining the circadian rhythms. This study aimed to analyze the effect of sleep quality on post prandial glucose (PPG) in diabetic pre-elderly and elderly. This cross-sectional study involved 17 pre-elderly and 28 elderly in four community health clinics in the area of Mulyorejo District, Surabaya. The sampling technique was one stage cluster random sampling in which four areas were chosen among 12 communities under the supervision of Mulyorejo Public Health Center. Sample size was 45. PSQI questionnaire and DTX instrument were used in data collection. Linear regression test was used in data analysis ($\alpha < .05$). Results showed that most respondents were female (86.67%), aged 60-74 years (57.78%), basic education level (33.3%), unemployed (93.3%), diagnosed with DM for >1-5 years (42.2%), had poor sleep quality (71.11%), and had hyperglycemia (71.11%). Sleep quality has no significant effect on PPG in diabetic pre-elderly and elderly ($p = .937$). Other potential factors need to be further analyzed in order to determine stronger predictor of PPG in diabetic pre-elderly and elderly, such as co-morbidity, stress, diet, drug consumption, lifestyle, and environment.

Index Terms - Diabetes Mellitus, elderly, post prandial glucose, pre-elderly, sleep quality.

I. INTRODUCTION

DM often caused by lifestyle changes, food consumption habits that are high in calories, lack of activity, smoking, obesity, and the presence of sleep disorders [8]. According to Spiegel et al (1999), sleep disturbances are associated with the risk of DM, where individuals who sleep less than four hours a night have a risk of impaired glucose tolerance compared to groups who have enough sleep [8]. A study in Malmo, Sweden, found that sleep disorders in healthy people can cause impaired glucose metabolism and imbalance of sympathovagals that have an impact on the incidence of DM in middle adulthood (40-48 years old) [14]. Sleep, rest, and rhythm of Circadian play a role in regulating insulin production and sensitivity, glucose utilization and tolerance at night [3]. Diabetic elderly with a tendency to have sleep disorders potentially experience impaired glycemic control that have an impact on hyperglycemic resistance. The effect of sleep quality on PPG in diabetic elderly remains unclear. The prevalence of DM in the elderly continues to increase. Data from basic health research conducted nationally every year in Indonesia showed that previously in 2007 the prevalence of DM in residents over 65 years old was 4.6%. Five years afterwards, data from the national socio-economic survey in Indonesia showed that in 2012 the prevalence of sleep disturbances in the elderly was 41.05%. In East Java Province, 52.12% elderly reported having problems of sleeping at night [18]. In

addition, there were 30% of the 70 years olds who wake up at night during their sleep. In the preliminary survey towards seven elderly with DM showed that they had sleep disorder every night because they had the urgency to urinate, and had difficulty of sleeping due to discomfort in sleeping position secondary to wound of diabetic gangrene. DM in the elderly often not realized because the signs and symptoms are disguised by natural physical/ physiological changes that occur in the elderly. The result is they are undiagnosed, and potentially have fatal consequences of DM complications. Signs and symptoms of DM, such as frequent thirst and urination, high appetite and food consumption but weight loss, are common symptoms found in diabetic elderly. The urgency to urinate, especially at night, is excessive. This will cause disruption of the sleep pattern resulted in low sleep quality. Sleep quality seems to change in most elderly. Rapid Eye Movement (REM) sleep episodes tend to shorten. There is a progressive decrease in REM sleep episodes stages 3 and 4, some elderly have almost no stage 4 or deep sleep [17]. Sleep disorder can also cause an increase in blood sugar levels, such as PPG, as a result of increased metabolic activity of protein into blood sugar at night when someone awake [3]. This study aimed to analyze the effect of sleep quality on PPG in diabetic pre-elderly and elderly.

II. METHOD

This descriptive analytic study utilized cross sectional

design. The population was all diabetic pre-elderly and elderly in the working area of Mulyorejo Public Health Center (PHC) by number of ± 250 by June, 2018. There were 17 pre-elderly and 28 elderly in four community health clinics in the area of Mulyorejo District, Surabaya, participated in this study. The sampling technique was one stage cluster random sampling in which four areas were chosen among 12 communities under the supervision of Mulyorejo PHC. Sample size was 45. The instrument used were the Pittsburgh Sleep Quality Index (PSQI) questionnaire for measuring sleep quality, and DTX instrument for measuring PPG via peripheral blood. Prior to data collection, all respondents have given their consent to participate in this study. Anonymity and confidentiality were assured. At data collection process, firstly the researcher gave two slices of white bread to be consumed simultaneously to all respondents, then within two hours of waiting for the PPG test the researcher provided health education about DM and its management along with question and answer session, and then finally spread the PSQI questionnaire. After two hours passed, the researchers conducted PPG test to all respondents by using DTX instrument. The results of PPG test was documented in an observation sheet, while the data of sleep quality was recapitulated after the scoring process. The collected data were then analyzed by descriptive statistic and linear regression test ($\alpha < .05$) to determine the effect of sleep quality on PPG in diabetic pre-elderly and elderly.

III. RESULT

Table 1 showed that majority of respondents were elderly women, aged 60-74 years old, graduated from elementary school, and being unemployed. Table 2 showed that most of them had DM for >1-5 years. They all do not smoke, but mostly drink coffee, and always take a nap. They are not used to consume sleeping pills. Habits before going to bed at night are mostly watching TV. Sleep duration was mostly eight hours, in which time to sleep at night was mostly 9 PM, and time to wake up every day was mostly 5 AM in the morning. This is considered as sufficient sleep duration for elderly according to normal sleep needs. Most respondents are accustomed to sleep with bright lighting (actually not recommended), and normal room temperature. In addition, other supporting parameter measured in this study was blood pressure by purpose of early detection of DM complications. It turned out that the majority had stage II of hypertension (HT), so that they needed to be referred to Mulyorejo PHC to receive anti-hypertensive drugs. Results showed that the majority had poor sleep quality and experienced hyperglycemia (@71.11%). This fact is contradictory to the data of sleep duration,

because most of them mostly reported eight hours of night sleep. Problems encountered during sleep at night are in the aspects of subjective sleep quality, sleep latency, daily sleep efficiency, sleep disorders, use of sleeping pills, and daytime activity dysfunction based on PSQI. All data of sleep quality and PPG were normally distributed ($p = .122$ and $p = .382$ respectively). The results of linearity test showed that the data of sleep quality was linear with the data of PPG ($p = .272$). The results of the linear regression test showed that sleep quality has no effect on PPG in diabetic pre-elderly and elderly ($p = .937$). Other factors possibly play a more important role than sleep quality in determining/predicting PPG in diabetic pre-elderly and elderly.

IV. DISCUSSION

Type 2 DM is an independent risk factor for respiratory problems during sleep. Daytime drowsiness is also more common in people with type 2 DM with hyperglycemia resulted in sleep quality reduction. By having type 2 DM, the basal value of blood sugar levels and sex factors could independently predict the scale of daytime sleepiness. Elderly with type 2 DM also show frequent sleep disorders. Having HT as co-morbidity of DM could also cause a decrease in sleep quality. The majority of respondents in this study were found to have HT stage 2 (51.11%). A study towards 37 respondents with DM in Medan Teladan PHC, North Sumatra, showed that the factors of sleep disorders in HT patients were dizziness (81%), nocturia (64%), and discomfort related to physical condition (57%) [13]. HT patients generally experience various symptoms, such as headache, dizziness, breathing difficulty, nocturia, dyspnea, palpitations, depression, and fatigue [4,10,14]. In general, HT patients have sleep disorder due to some clinical conditions / symptoms resulted in poor sleep quality. Related to chronic diseases, elderly often consume various drugs for a long time, consistent with the disease duration. The majority of respondents reported having DM since >1-5 years ago (42.22%), and consuming several types of long-term drugs. Apart from that, related to acute illness / infection, it was potential for the elderly to buy freely sold drugs in the market, or by prescription from a doctor, where some prescribe drugs or over-the-counter drugs have side effects of drowsiness, insomnia and weakness, which can also reduce sleep quality [18]. Hypnotic or sleeping pills can interfere with Non-REM sleep stages 3 and 4, and could suppress REM sleep, whereas β -blockers could cause insomnia and nightmares [21]. In this study, 88.89% of respondents did not consumed sleeping pills and β -blockers. A person's lifestyle, such as eating and drinking habits, could also affect their quality of sleep. Large, heavy,

and spicy dinners cause food to be hard to digest, so that it can disrupt night sleep. The use of ingredients containing caffeine, nicotine, and alcohol could stimulate the central nervous system (CNS), so that it has an impact on changes in sleep patterns [10]. Apart from the pattern of activity and working hard, dissolve social activities also have the potential to cause sleep problems. Fatigue could also affect sleep patterns, in which the higher the level of fatigue, the better the sleep quality, which causes a shorter period of REM sleep [5]. There were 73.33% of respondents reported did not drinking coffee, 100% has no smoking habit, 48.89% always taking naps, 93.33% unemployed, and

86.67% women, so that it could be assumed that their daily activities were most likely housework or caring for grandchildren. Individuals who have low sleep quality, frequent night out, and experience depression have higher levels of HbA1C and alanine aminotransferase, and experience albuminuria. Individuals with high physical activity have low uric acid levels and a slight increase in alanine aminotransferase and aspartate aminotransferase [15]. A person's lifestyle can affect various values of physical parameters in the body, especially for people with type 2 DM.

Table 1: Demographic Characteristic (n=45)

No.	Characteristic	Frequency	Percentage	
1	Gender	Female	39	86.67
		Male	6	13.33
2	Usia	45-59	17	37.78
		years old (middle age)	26	57.78
		60-74	2	4.44
		years old (elderly)		
	years old (old)			
3	Educational background	None	10	22.22
		(formal)	15	33.33
		Elementary school	12	26.67
		Secondary school	8	17.78
		High school		
4	Occupation	Unemployed	42	93.33
		Entrepreneur	2	4.44
		Employed	1	2.22
		Employee of private sector		

Table 2: Primary Data (n=45)

No.	Characteristic	Frequency	Percentage	
1	Period of being diagnosed with DM	≤ 1 years	11	24.44
		> 1-5 years	19	42.22
		6-10 years	7	15.56
		≥ 11 years	8	17.78
2	Smoking habit	Yes	0	0
		No	45	100
3	Drinking coffee habit	Yes	12	26.67
		No	33	73.33
4	Consuming sleeping pills habit	Yes	5	11.11

		No	40	88.89
5	Napping habit			
		Always	22	48.89
		Never	11	24.44
		1-2 times a	11	24.44
	week		1	2.22
	week	3-5 times a		
6	Habit before night sleep			
		Watching	36	80.00
	TV		6	13.33
		Talking	2	4.44
		Reading	2	4.44
		Eating/dri	3	6.67
	nking		3	6.67
		Praying		
	particular	Nothing		
7	Time to sleep at night (PM)			
		8	7	15.56
		9	16	35.56
		10	13	28.89
		11	9	20.00
8	Time to wake up every morning (AM)			
		≤ 3	9	20.00
		≤ 4	9	20.00
		5	25	55.56
		6	2	4.44
9	Light utilization during night sleep			
		Bright	32	71.11
		Dim	6	13.33
		Dark	7	15.56
10	Room temperature during night sleep			
		Warm	5	11.11
		Normal	34	75.56
		Cool	6	13.33

11	Blood pressure*			
	1 (less than 120/80 mmHg)	Normal	3	6.67
		Elevated	6	13.33
	(systolic between 120-129 mmHg and diastolic less than 80 mmHg)	Stage 1 of	8	17.78
	HT (systolic between 130-139 mmHg or diastolic between 80-89 mmHg)	Stage 2 of	23	51.11
	HT (systolic at least 140 mmHg or diastolic at least 90 mmHg)	HT crisis	4	8.89
	(systolic over 180 mmHg and/or diastolic over 120 mmHg)			

*Based on the New ACC/AHA Blood Pressure Guidelines [23]

Table 3: Measured Variables (n=45)

No.	Characteristic	Frequency	Percentage
1	Sleep quality		
	Good	13	28.89
	Bad/poor	32	71.11
2	PPG		
	Normal / euglycemia	13	28.89
	Abnormal / hyperglycemia	32	71.11

Emotional stress could also affect sleep quality. It makes a person tense and often causes frustration when he can't sleep. Stress also causes a person to try too hard to sleep, often wake up during the sleep cycle, or get too much sleep. Continued stress can cause poor sleep habits. In addition, anxiety and depression often interfere with one's sleep. Anxiety conditions can increase blood nor-epinephrine levels through stimulation of the sympathetic nervous system. This condition causes the Non-REM sleep cycle stage 4 and REM sleep reduction, frequent awake during sleep [7,10]. Stress level was not identified in this study. Environmental factors could also affect the quality of sleep by supporting or inhibiting sleep; temperature, ventilation, lighting, and noise conditions could greatly affect one's sleep [9]. There were 71.11% of respondents reported accustomed to bright lights during night sleep, and 75.56% of respondents were prefer room temperature. During sleep, actually the eyes also need to be rested, so using bright lighting when sleeping is not recommended. Sleep quality includes various aspects, such as subjective sleep quality, sleep quantity, sleep latency, daily sleep efficiency, sleep disorders, use of sleeping pills, and daytime activity dysfunction. There are many factors that can affect a person's sleep quality beyond chronic illness like DM, but the presence of DM could

exacerbate the decline in sleep quality, especially in the elderly who are already physiologically vulnerable to sleep disorders. Efforts to improve sleep quality in elderly with DM need to be done, such as by modifying lifestyle (diet and activity/exercise) and the environment (lighting, room temperature, noise, and bed comfort). The results showed that the majority of respondents experienced hyperglycemia (71.11%), the condition of euglycemia was only found in 28.89% of respondents. PPG describes the speed of post-meal glucose absorption determining the function of insulin regulation and macronutrient metabolism in the body. Sleep quality has no significant effect on sleep quality in diabetic elderly ($p = .937$). Sleep quality cannot be a good predictor of PPG in this context. Consistent variations in 24-hour cycle of glucose regulation are normal in disease-free/normal individuals. This diurnal variation changes in conditions with impaired glucose tolerance (aging, obesity, and DM). A study in normal individuals who received glucose infusion therapy showed that a major changes in glucose tolerance occurred during sleep, and sleep quality marked the influence of glucose utilization. The diurnal variation of glucose tolerance is a result of changes in sleep and wakefulness, as well the intrinsic effects of the Circadian rhythm. The effects of sleep modulation and Circadian rhythms on glucose

regulation have clinical implications for the diagnosis and treatment of abnormal carbohydrate metabolism [20]. Still in normal individuals, a study in China towards mid-adults aged 40-60 years with an average night time sleep of 7.9 hours per-day, in which more male respondents who took naps than women, showed that odd ratio (OR) of HbA1C > 6% was 1.8 and 1.26 for people who used to take a nap \leq 1 hour and > 1 hour respectively. The OR value of insulin resistance was significantly lower in respondents who slept at night with a deviation from normal, which is 8 hours (can be >8 or <6 hours). It can be concluded that mid-adult individuals without DM who normally take naps have higher HbA1C levels and insulin resistance, while individuals who sleep shorter nights also experience an increase in HbA1C values. The recommended night's sleep duration is between 6-8 hours per day [1]. Factors affecting blood sugar levels consist of internal and external factors. Internal factors consist of the insulin, glucose and cortisol, as a receptor system in the muscles and liver cells; while external factors consist of food consumed and physical activity [1]. Exercise can reduce insulin resistance so that insulin could be functioned normally for cells in the body and burn fat to prevent the occurrence of obesity [6]. Foods that contain high carbohydrate and fiber could affect the pancreatic β -cells in producing insulin, and consuming excess fat could also affect insulin sensitivity. Consuming alcohol could increase blood sugar levels because it contains high sugar levels. Individuals who have good dietary knowledge could control their blood sugar levels well [17]. Many obese people with DM are found to be not adherent to the regiment, resulting in hyperglycemia and additional medical therapy to treat DM. Co-morbid diseases can trigger anxiety, resulted in disruption of the hormone system in the body, so that it can increase blood sugar levels [22]. Anxiety is a response to chronic illnesses that are perceived as a pressure, discomfort, and disappointment. These psychological disorders make patients become indifferent to the rules of treatment that must be carried out, such as diet, medical therapy, and exercise, so that the blood sugar levels are not controlled properly. It appears to be there are many potential factors that have the potency to affect blood sugar levels, especially PPG, beyond the aspect of sleep quality alone in diabetic elderly. However, sleep quality still needs special attention because it has the potency to affect various physical and psychological parameters in the body.

CONCLUSION

diet, drug consumption, lifestyle, and environment.

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