Path Analysis on the Effect of Stress, Sleep Quality, and Hypertension on Type 2 Diabetes Mellitus Incidence in the 30–60 years Age Group in Medan City

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Abstract

Non-communicable diseases are still the leading cause of death worldwide, affecting not only the elderly but also the productive age group. Type 2 diabetes mellitus (DM) is one of the non-communicable diseases whose prevalence continues to rise, including in Indonesia. North Sumatra Province also experienced an increase in DM prevalence, with the highest number of cases in Medan City. The development of type 2 DM is a complex process and is associated with several risk factors, one of which is psychological stress. This study aims to analyze the effect of stress on the incidence of type 2 DM in the 30-60 years age group in Medan City directly and indirectly through sleep quality and hypertension. The research method used a case control design with a sample size of 68 cases and controls each. Data analysis was carried out univariately and multivariately using a path analysis model. The results showed that there is a direct effect between stress (b=0.892; 95% CI=0.149-1.636; p=0.019) on the incidence of type 2 DM in the 30 -60 years age group in Medan City. Stress increases the risk of type 2 DM indirectly through poor sleep quality (b=0.886; 95% CI=0.188-1.583; p=0.013) and hypertension (b=0.859; 95% CI=0.117-1.602; p= 0.023). In addition, sleep quality (b=0.820; 95% CI=0.076-1.565; p=0.031) and hypertension (b=1.046; 95% CI=0.249-1.841; p=0.010) also have a direct effect on type 2 DM. Avoiding and managing stress, getting enough and regular sleep, and controlling blood pressure can help prevent type 2 DM.

Keyword: Hypertension, Sleep Quality, Stress, Type 2 Diabetes Mellitus

INTRODUCTION

Non-communicable diseases (NCDs) are still the main cause of death worldwide, contributing to more than 41 million deaths (74% of all deaths globally) every year. Diabetes mellitus is one of the four leading NCDs which causes more than 80 percent of premature deaths (occurring before the age of 70 years) globally (WHO, 2023). Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to abnormalities in insulin secretion, insulin resistance or both. Diabetes is classified as type 1 DM, type 2 DM, gestational DM, and other types according to the underlying pathophysiology (ADA, 2022). More than 90 percent of diabetes cases worldwide are type 2 DM (IDF, 2021).

Prevalence of type 2 DM increases with age, especially in individuals aged >45 years (Perkeni, 2021). According to the International Diabetes Federation (IDF), in 2021, approximately 537 million adults aged 20-79 years (10.5% of the total population aged 20-79 years) worldwide suffer from diabetes and its prevalence is estimated to reach 643 million cases (11.3%) in 2030. The lowest prevalence of diabetes mellitus was found in the 20-24 year old age group and the highest in the 55-60 year old age group (IDF, 2021).

Indonesia is also one of the 10 countries with the highest number of DM sufferers aged 20-79 years in 2021 (19.5 million cases) (IDF, 2021). Basic Health Research data states that, the prevalence of diabetes based on doctor's diagnosis in residents aged 15 years and above in Indonesia increased to 2 percent in 2018 Kemenkes RI (2018) from 1.5 percent in 2013. In North Sumatra Province, the prevalence of DM cases also increased from 1.8 percent in in 2013 to 2.0 percent in 2018 (Kemenkes RI, 2013; Kemenkes RI (2018). During 2019, there were 249,519 DM sufferers recorded in North Sumatra, with the largest number in Medan City (95,240 people) (Dinas Kesehatan Provinsi Sumatera Utara, 2019).

The development of type 2 DM is a complex and multifactorial process. Rising DM prevalence is associated with many risk factors, especially due to changes in individual behavior and lifestyle, such as unhealthy diet, physical inactivity, smoking, and alcohol consumption, which cause metabolic changes that are also risk factors for other NCDs, including elevated blood pressure, hyperglycemia, hyperlipidemia, and obesity (Galicia-Garcia et al., 2020). Apart from the lifestyle factors, evidence suggests that psychological factors, such as stress, may also contribute to an increased risk of type 2 DM. The term stress describes the different physical and mental (emotional) reactions of individuals to various stressors (conditions that can trigger stress responses such as work stress, job and financial insecurities, family problems, etc.). Stress is a natural response that everyone must feel when faced with a difficult or threatening situation. Although stress is an adaptive response, prolonged exposure to stress can affect the physiological and psychological functions of the body, and lead to various health problems, including type 2 DM (Halbreich, 2021).

Several stress-induced mechanisms of type 2 DM have been described in previous studies. Research shows that chronic stress or uncontrolled psychological stress over a long period can cause changes in the neuroendocrine system that disrupt insulin regulation, leading to high blood glucose levels, especially those of productive age (Putri & Rustam, 2021). Prolonged exposure to stressors also triggers a stress response in the form of sympathetic nervous system activation, which raises blood pressure and thus indirectly increases the risk of type 2 DM through hypertension (Hackett & Steptoe, 2017). Previous study finds that individuals with uncontrolled blood pressure have an increased risk of developing diabetes (Przezak et al., 2022).

On the other hand, chronic stress can also indirectly manifest in changes in individual behaviors that put people at risk for developing type 2 DM, such as changes in appetite, increased smoking frequency, alcohol and drug use and sleep disturbances (Hackett & Steptoe, 2017). Changes in sleep quality have been reported to be associated with an increase in the risk

of type 2 diabetes. In a study of Korean outpatients by Lee et al., (2016), poor sleep quality was associated with up to twice the risk of diabetes compared to those with good sleep quality. Prolonged sleep deprivation can cause neuroendocrine changes that trigger insulin dysregulation and resistance, increasing the risk of type 2 DM by this mechanism (Larcher et al., 2015).

Metabolic dysregulation due to type 2 DM has the potential to cause complications and even death, which has an impact on reducing the quality of human resources of productive age and life expectancy, so efforts are needed to reduce the incidence of type 2 DM, especially through risk factors control. Based on this background, this research was conducted to determine the effect of stress directly and indirectly through sleep quality and hypertension on the incidence of type 2 DM in the 30-60 years age group in Medan City.

METHODS

This type of research is quantitative analytic observational with a case-control design. The study was conducted in 7 community health centers located in Medan Denai, Medan Tuntungan, and Medan Timur sub-district. The selection of the research site was done purposively based on the researcher's consideration because the three sub-districts ranked first with the highest number of type 2 DM cases in 2022 based on data from the Medan City Health Office. This research was carried out from February to September 2023.

The population in this study was all residents aged 30-60 years in Medan City. The number of samples was 136 people with 68 cases and 68 controls each, obtained using Lemeshow's sample size calculation formula for case-control studies. The sampling technique uses purposive sampling under determined inclusion and exclusion criteria.

Case inclusion criteria were patients with type 2 diabetes who were newly diagnosed by a doctor within the last 6 months and recorded in medical records. These inclusion criteria were used to minimize patient recall bias. The exclusion criteria for the cases were patients with type 1 DM, gestational DM, and other types of DM. Control inclusion criteria were patients who had never been diagnosed with type 2 DM and had normal blood sugar levels (<200 mg/dL) at the time of the examination, while the control exclusion criteria were individuals with mental/psychiatric disorders or hearing impairments, and cannot communicate well. Both case and control samples who are willing to participate in this study must sign an informed consent.

The variables in this research consisted of the independent variable (stress), the intervening variable (sleep quality and hypertension), and the dependent variable (the incidence

of type 2 DM). Stress was measured using the Depression, Anxiety, and Stress Scale (DASS) questionnaire which was translated into the Indonesian language and tested for validity and reliability by Damanik (2006) and categorized as "normal or not stressed" (score 0-14) and "stressed" (score ≥15). Sleep quality was measured using the PSQI (Pittsburgh Sleep Quality Index) questionnaire consists of 19 questions measuring seven components of sleep quality which was translated into the Indonesian language and tested for validity and reliability by Alim & Elvira (2015) and categorized as "good sleep quality" (score ≤5) and "poor sleep quality" (score >5). History of hypertension (systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg) is known through a doctor's diagnosis in the medical record and categorized as "no" or "yes".

Data processing uses STATA 17 software with univariate and multivariate analysis. Multivariate analysis using path analysis which conducted through stages that include model specification, model identification, model fit and parameter estimation, and model re-specification (if necessary). Model specification describes the relationship between the variables under study. The path analysis model that describes the relationship between variables in this research has been designed in such a way that it is based on theory and processed based on sample data that has been collected by the researcher. There are four measurable (observed) variables, which are stress, sleep quality, hypertension, and the incidence of type 2 DM. The exogenous variables (variables that are not influenced by other variables) in this study is stress, while the endogenous variables (variables that are influenced by other variables) are sleep quality, hypertension, and the incidence of type 2 DM.

Model identification is conducted to find out whether the path analysis model is identified or not and that hypotheses can be tested regarding the relationship between variables. Model identification can be known through the degree of freedom (df) value which is calculated using the following formula:

Df= *((number of observed variables × (number of observed variables + 1))÷2) − (endogenous variables + exogenous variables + number of parameters)*

Based on the calculation, the degree of freedom value is 2, which means that df ≥0, so that path analysis can be carried out. Furthermore, parameter estimation is conducted to determine the direct and indirect effects of exogenous variables (stress) on endogenous variables (sleep quality, hypertension, and the incidence of type 2 DM) as shown by the value

of the path coefficient (b) in the original measurement unit with a 95% confidence level (α=0.05).

RESULTS

Based on the data collection from 68 case subjects and 68 control subjects, the results are described in the following table:

Table 1. Frequency Distribution of Respondents Based on Characteristics

Characteristics	Cases		Controls	
	n = 68	%	n = 68	%
Age				
≤45 years	11	16.2	29	42.6
>45 years	57	83.8	39	57.4
Gender				
Female	50	73.5	48	70.6
Male	18	26.5	20	29.4
Education				
Elementary school	5	7.4	5	7.4
Junior high school	12	17.6	7	10.3
Senior high school	30	44.1	44	64.7
University	21	30.9	12	17.6
Occupation				
Housewife	29	42.6	35	51.5
Government employees	14	20.6	7	10.3
Private employees	5	7.4	2	2.9
Entrepreneur	14	20.6	15	22.1
Farmer	1	1.5	0	0
Laborer/driver/household assistant	3	4.4	5	7.3
Other	2	2.9	4	5.9
Income				
<3,600,000 IDR	49	72.1	52	76.5
≥3,600,000 IDR	19	27.9	16	23.5

According to Table 1 above, most of the respondents in the case group were aged over 45 years, namely 57 people (83.8%) and the remainder were aged 45 years and under, namely 11 people (16.2%). The control group was also dominated by respondents aged over 45 years, namely 39 people (57.4%) and the remainder were respondents aged 45 years and under, namely 29 people (42.6%). The majority of respondents in this study were female, namely 73.5 percent (50 people) in the case group and 70.6 percent (48 people) in the control group.

Most of the respondents had a senior high school education followed by university, namely 30 people (44.1%) and 21 people (30.9%) respectively in the case group and 44 people (64.7%) and 12 people (17.6%) respectively in the control group. Based on occupation in the case group and control group, there were more respondents who did not work or were housewives, namely 29 people (42.6%) and 35 people (51.5%) respectively. Most of the respondents who worked were entrepreneur, namely 14 people (20.6%) in the case group and

15 people (22.1%) in the control group. The majority of respondents in this study, namely 72.1 percent (49 people) and 76.5 percent (52 people), respectively in the case group and control group, had incomes below the Medan City minimum wage (<3,600,000.00 IDR) and the rest had income equal to or above the Medan City minimum wage (≥3,600,000.00 IDR), namely 27.9 percent (19 people) in the case group and 23.5 percent (16 people) in the control group.

Table 2. Frequency Distribution of Respondents Based on Variables

Variables	Cases		Controls	
	n = 68	%	n = 68	%
Stress				
Normal (not stressed)	22	32.4	41	60.3
Stressed	46	67.6	27	39.7
Sleep quality				
Good	29	42.6	46	67.6
Poor	39	57.4	22	32.4
History of Hypertension				
No	36	52.9	54	79.4
Yes	32	47.1	14	20.6

Based on Table 2, the results of this study show that the majority of respondents in the case group (67.6%) experienced stress, whereas the majority of respondents in the control group (60.3%) did not experience stress. Most respondents experienced mild stress, namely 32 people (47%) in the case group and 13 people (19.1%) in the control group and the rest experienced moderate stress and severe stress, namely 13 people (19.1%) and 1 person (1.5%) in the case group and 12 people (17.7%) and 2 people (2.9%) in the control group.

According to sleep quality, most of the respondents, namely 57.4 percent (39 people), in the case group, had poor sleep quality, while in the control group, the majority of respondents, namely 67.6 percent (46 people), had good sleep quality. Based on Table 2, it is known that the majority of respondents in both groups did not have a history of hypertension, namely 52.9 percent (36 people) in the case group and 79.4 percent (54 people) in the control group.

The structural model of path analysis with parameter estimates can be seen in Figure 1 below.

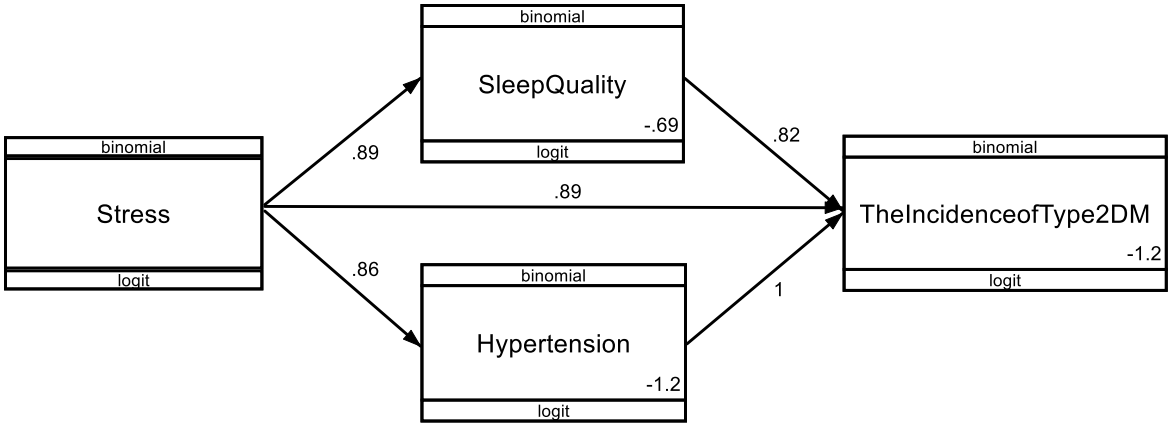

Figure 1. *Structural Model of Path Analysis with Parameter Estimation*

Table 3 below shows the results of multivariate analysis using path analysis with parameter estimation indicated by path coefficient values.

Table 3. Results of Path Analysis on the Effect of Stress, Sleep Quality, and Hypertension on Type 2 Diabetes Mellitus Incidence in the 30 -60 Years Age Group in Medan City

Variables			Path Coefficient (b)	95% CI		*p – value*
				Lower Limit	Upper Limit	
Indirect Effect						
Sleep quality	←	Stress	0.886	0.188	1.583	0.013
Hypertension	←	Stress	0.859	0.117	1.602	0.023
Direct Effect						
The incidence of type 2 DM	←	Stress	0.892	0.149	1.636	0.019
	←	Sleep quality	0.820	0.076	1.565	0.031
	←	Hypertension	1.046	0.249	1.841	0.010
N observation	=	136				
Log Likelihood	=	−257.33				

Based on the results of path analysis on the effect of stress, sleep quality, and hypertension on the incidence of type 2 DM in the 30–60 years age group in Medan City, it shows that there is a direct effect (p = 0.019) between stress on the incidence of type 2 DM in the 30–60 years age group in Medan City with a path coefficient (b) = 0.892. People who experience chronic stress have a log odds of developing type 2 DM that is 0.892 units higher than normal people (non-stressed).

Stress also increases the risk of developing type 2 DM indirectly through poor sleep quality (p=0.013) and hypertension (p = 0.023). Stressed individuals had log odds of

developing type 2 DM that is 0.886 units and 0.859 units higher than non-stressed or normal individuals due to poor sleep quality and suffering from hypertension, respectively.

The results of the path analysis also found that there is a direct effect between sleep quality (p = 0.031) and hypertension (p = 0.010) on the incidence of type 2 DM in the 30–60 years age group in Medan City which is statistically significant. Individuals with poor sleep quality have a log odds of developing type 2 DM that is 0.820 units higher than individuals with good sleep quality, and individuals with a history of hypertension have a log odds of developing type 2 DM that is 1.046 units higher compared to individuals without a history of hypertension.

DISCUSSION

Based on path analysis, the results of this study show that stress has a direct effect on the incidence of type 2 DM (b=0.892; 95% CI=0.149-1.636; p=0.019). This is relevant to the research conducted by Jayaprasad et al., (2018) in each sample of 100 diabetics and non-diabetics in India which showed that there was a statistically significant relationship between stress and the risk of developing type 2 DM (AOR=6.71; 95% CI=3.56–12.63; p<0.001). The study also found that there was a linear and positive relationship between the risk of type 2 DM and stress severity. When compared with normal conditions (not stressed), the risk of type 2 DM is 3, 8, and 21 times greater in individuals with mild, moderate, and severe stress.

Kabosu et al., (2019) also explained in their research conducted at Bhayangkara Hospital, Kupang, that the risk of type 2 DM in individuals who experienced stress was three times greater when compared to those with normal conditions (OR=3.033; 95% CI=1.176–7.820; p=0.036). Stressful conditions caused by physiological and psychological stressors can cause neuroendocrine changes that affect insulin regulation in the blood. The stress response that occurs in the form of activation of the hypothalamic-pituitary-adrenal axis in the nervous system and an increase in hormones (cortisol and catecholamines) which in the long term can trigger excessive accumulation of visceral fat and insulin resistance, causing hyperglycemia which is the beginning of the development of type 2 DM (Maria et al., 2022).

Stress-induced activation of the sympathetic nervous system causes changes in blood pressure, heart rate, and cardiac output while parasympathetic activation causes changes in heart rate variability. This mechanism is associated with high blood pressure, which is also a risk factor for type 2 DM (Hackett & Steptoe, 2017). This is relevant with the results of this study which show that there is an indirect effect of stress on the incidence of type 2 DM through hypertension (b=0.859; 95% CI=0.117-1.602; p=0.023).

The Australian Longitudinal Study on Women's Health reported a relationship between psychological stress and the incidence of type 2 DM through hypertension as a mediator variable. The results showed that women who experienced moderate–severe stress had an increased risk of experiencing hypertension by 1.67 times higher than those who did not experience stress (95% CI=1.46–1.90; p<0.001) and compared to those who did not experiencing hypertension, women with a history of hypertension have a 2.63 times higher risk (95% CI=2.28–3.04; p<0.001) of developing type 2 DM after three years of follow-up. Overall, women with mild stress (OR=1.56; 95% CI=1.14–2.14; p=0.005) and moderate–severe stress (OR=2.33; 95% CI=1.65 – 3.28; p<0.001) were reported to have an increased risk of developing type 2 DM after three years of follow-up compared to those who did not experience stress (Harris et al., 2017).

Hypertension also had a direct effect on the incidence of type 2 DM (b=1.046; 95% CI=0.249–1.841; p=0.010), as shown by the result of this study. This is relevant with research conducted by Rediningsih et al. (2022) in Kemambang Village, Banyubiru District, Semarang Regency which showed that there was a significant relationship (p=0.004) between hypertension and the incidence of type 2 DM. A case control study conducted on patients in the Palaran Samarinda Community Health Center in 2019 also found that individuals who had a history of hypertension were up to three times more likely to suffer from type 2 DM compared to individuals without a history of hypertension (p–value=0.008; OR=3.214; 95% CI=1.409–7.329) (Fradina & Nugroho, 2020). Kabosu et al., (2019) in their research also found that the risk of type 2 DM in individuals with a history of hypertension was 3.423 times greater than those without a history of hypertension (95% CI=1.315–8.909; p=0.019).

Insulin resistance, diabetes and hypertension have been widely mentioned in various literature as being related to each other. Research shows that primary hypertension patients, who do not receive treatment, develop increased fasting and postprandial insulin levels when compared with normotensive individuals, so it can be concluded that there is a direct correlation between plasma insulin levels and blood pressure (Samuel, 2020). A study conducted on 7,150 middle-aged samples in Korea found that pre-hypertension and hypertension had a significant effect (p=<0.001) in the development of diabetes, which means individuals with a history of pre-hypertension (HR=1.27; 95% CI=1 .09–1.48) and hypertension (HR=1.51; 95% CI=1.29–1.76) were at higher risk of developing type 2 DM later in life compared with individuals who had normal blood pressure even after adjusting for gender and BMI (Kim et al., 2015).

Excessive increased in activity of the renin-angiotensin-aldosterone system in hypertensive conditions in insulin-sensitive tissues causes a decrease in metabolic signaling to

insulin. The vascular remodeling and endothelial dysfunction that occurs also manifests in increased oxidative stress and reduced vasodilation which inhibits insulin and glucose from reaching peripheral tissues and weakens insulin-stimulated glucose uptake. Elevated blood pressure has also been found to increase inflammatory markers, which also impair insulin signaling and pancreatic beta cell function, and are thought to play a role in the development of diabetes through this mechanism (Przezak et al., 2022).

Controlled blood pressure has been proven to reduce morbidity and mortality due to cardiovascular disease, especially in hypertensive sufferers who also suffer from diabetes mellitus. Once hypertension is diagnosed, apart from treatment, non-pharmacological interventions such as lifestyle changes and maintaining an ideal body weight need to be carried out to maintain blood pressure and prevent the development of diabetes mellitus and other complications (Samuel, 2020).

On the other hand, emotional changes that occur in conditions of psychological stress are also associated with changes in individual behavior and unhealthy lifestyles such as poor diet, lack of desire for physical activity, increased consumption of alcoholic drinks and smoking. All of these things are risk factors that can cause type 2 DM. Apart from that, stress, anxiety and depression are also reported as psychological factors that affect sleep quality. As mentioned in various literature, poor sleep quality is one of the risk factors that plays a role in the development of type 2 DM. This is relevant with this research results which show that there is an indirect effect of stress on type 2 DM incidence in the 30-60 years age group in Medan City through poor sleep quality (b=0.886; 95% CI=0.188-1.583; p=0.013).

Emotional stress can make it difficult for a person to relax and rest. Prolonged stressful conditions can change a person's sleep patterns, such as having difficulty initiating sleep (prolonging sleep latency) and frequently waking up during the sleep cycle, causing sleep duration to decrease (Marks & Landaira, 2016). Research conducted by Zarch & Sorbi (2020) on an elderly sample group in Iran showed that stress and depression variables together contributed 45 percent to changes in sleep quality. The study also found that there was a positive correlation between stress and sleep quality (r=0.36; p<0.010), which means that the higher the stress level, the worse a person's sleep quality will be.

A study conducted based on Korea Community Health Survey data found that psychological stress was significantly associated with poor sleep quality. Individuals who experience stress are up to twice as likely to have poor sleep quality (OR=2.44; 95% CI=2.32–2.56; p<0.001 (men) and OR=2.81; 95 % CI=2.68–2.93; p<0.001 (female)) (S. Y. Lee et al., 2020). A national survey conducted in Sweden also showed that stress was the main cause of

sleep disorders in the population aged 18-84 years in that country, as much as 35.1 percent (Petersen et al., 2023). Stressful conditions that reduce sleep quality or duration, or both, can reduce insulin sensitivity and glucose tolerance, leading to development of type 2 DM. Maity et al., (2020) in their research explained that moderate levels of stress have an effect on poor sleep quality (OR=1.965; 95% CI=1.023–3.776; p=0.043) and that poor sleep quality was positively correlated with the incidence of type 2 DM (OR=1.055; 95% CI=1.001–1.113; p<0.001).

This study also found that sleep quality had a direct effect on the incidence of type 2 DM (b=0.820; 95% CI=0.076 – 1.565; p=0.031). Poor sleep quality including insufficient and prolonged sleep duration, as well as sleep disorders such as insomnia and obstructive sleep apnea (OSA), have been widely reported in various literature as risk factors that increase the incidence of type 2 DM. Hormonal changes, increased sympathetic activity and production of free fatty acids, as well as increased inflammatory cytokines that occur due to poor sleep quality and insufficient sleep duration, causing insulin resistance, impaired insulin sensitivity, beta cell dysfunction and impaired insulin secretion which leads to the development of type 2 DM (McNaughton et al., 2015).

This is relevant with research conducted by Sety & Muslim Shidiq (2019) at Kendari General Hospital which aimed to analyze risk factors for type 2 DM in samples living in rural and urban areas. The results showed that in both sample groups, poor sleep quality showed an increased risk of developing type 2 DM respectively by 4,148 (95% CI=1,368–12,580; p=0.020) and 4,060 (95% CI=1,261–13,072; p= 0.031) times greater than individuals who have good sleep quality. A study conducted based on data from the National Health and Nutrition Examination Survey (2005–2008) also found that a night's sleep duration of less than five hours was significantly associated with the incidence of prediabetes (OR=2.06; 95% CI=1.00–4 .22). The study also showed that difficulty maintaining sleep (OR=3.50; 95% CI=1.30–9.45) and waking up too early in the morning (OR=2.69; 95% CI=1.21 – 5.98) experienced up to five times a month significantly increases the risk of prediabetes (Engeda et al., 2013).

Prolonging sleep latency also had a significant effect on increasing the risk of type 2 DM (OR=1.085; 95% CI=1.008–1.168; p=0.010) (Maity et al., 2020). A prospective cohort study conducted on 241,949 adults in Australia found that a sleep duration of less than 6 hours significantly increased the risk of type 2 DM compared with a sleep duration of 7 hours per night even after excluding confounding factors (HR=1.29; 95% CI =1.08– 1.53; p=0.004). The results of a meta-analysis based on data from 10 prospective studies that were also carried out in the research also show that there is a significant effect between insufficient sleep duration

and the incidence of type 2 DM. Sleep duration that less than 6 hours (compared to sleep duration of 7 hours per night) can increase the risk of type 2 DM by up to 30 percent (Holliday et al., 2013).

Apart from insufficient sleep duration, sleep disorders and excessively long sleep duration have also been reported to be linked to diabetes. A prospective study conducted on military soldiers in the UK over six years found that difficulty sleeping (OR=1.21; 95% CI=1.03–1.42) and sleep apnea (OR=1.78; 95% CI= 1.39–2.28) has a significant effect on the incidence of diabetes (Boyko et al., 2013). Poor sleep quality, OSA, sleep duration ≤ 5 hours, 6 hours, and ≥ 9 hours per night were reported to have a significant relationship with an increased risk of diabetes with a relative risk of 1.40 (95% CI=1.21). –1.63), 2.02 (95% CI=1.57–2.61), 1.48 (95% CI=1.25–1.76), 1.18 (95% CI=1, 10–1.26), and 1.36 (95% CI=1.12–1.65) times greater than those who have good sleep quality (Anothaisintawee et al., 2016).

CONCLUSIONS

Based on the results of this study involving 68 case and 68 control subjects related to effect of stress, sleep quality, and hypertension on type 2 DM incidence in 30-60 years age group in Medan City, it can be concluded that there is a direct effect between stress, sleep quality, and hypertension on the incidence of type 2 DM. There is also an indirect effect between stress and the incidence of type 2 DM through sleep quality and hypertension, meaning that individuals who experience stress are likely to develop type 2 DM through poor sleep quality and suffer from hypertension.

Researcher's suggestion for community health centers and health workers to be able to provide education and information by adding material about the importance of adequate rest and managing stress to patients and the community, also the existing non-communicable disease prevention programs at community health centers can be improved and continue to be carried out regularly. Based on the findings in this study, it is expected that the community can take preventive measures independently, not only to avoid type 2 DM but also other non-communicable diseases through avoiding and managing stress, getting enough and regular sleep, implementing healthy lifestyle habits, and carrying out health checks regularly to health facilities including controlling blood pressure as well.

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