Determinants of Metabolic Syndrome (Hypertension and Diabetes Mellitus Type 2)

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ABSTRACT

Metabolic Syndrome (SM) is a complex metabolic disorder caused by obesity, insulin resistance, diabetes mellitus, and hypertension. The prevalence of metabolic syndrome continues to increase from year to year in Ternate Maluku Regency. This can be seen from the prevalence of cases, namely 27.9% (2017), 30.6% (2018), and 45.5% (2019), 50.5 (2020). This is due to lifestyle factors, inadequate physical activity, family history and age factors. The research design used was observational with a cross sectional study design. The research design used was observational with a cross sectional study design. The number of samples consisted of 128 respondents with type 2 diabetes mellitus and 64 respondents with hypertension. The sample collection technique was a non-probability sampling technique with purposive sampling. The sample used in this study were outpatients at the Siko Health Center in Ternate City who met the following criteria: outpatients with hypertension and type 2 diabetes mellitus, had metabolic syndrome, and underwent examination blood sugar and fat profile laboratory. Data analysis using the Chi-square test and multiple logistic regression. The results obtained were that there was a significant relationship between metabolic syndrome with the length of time suffering from p-value 0.000 <α (0.05), family history of disease p-value 0.019 <α (0.05), physical activity p-value 0.000 <α (0.05), dietary pattern p-value 0.001 <α (0.05) and age p-value 0.000 <α (0.05). There was no significant relationship between metabolic syndrome and smoking status p-value 0.309> α (0.05). Family history of chronic disease, long suffering from type 2 diabetes mellitus and hypertension, lack of physical activity, poor diet are determinants of metabolic syndrome.

Keywords: *metabolic syndrome, diabetes mellitus, hypertension, physical activity, diet history*

1. INTRODUCTION

Metabolic Syndrome (SM) is a complex metabolic disorder caused by obesity, insulin resistance, diabetes mellitus, and hypertension. Diabetes Mellitus Diabetes Mellitus is a degenerative disease which is generally associated with genetic and environmental factors. The prevalence of diabetes mellitus among the world's populations continues to increase yearly [1],[2]. Hypertension is defined as persistent blood pressure where the systolic pressure is above 140 mmHg and diastolic over 90 mmHg [3],[4],[5]. One of the major risk factors of hypertension is stroke, heart failure, chronic kidney disease, visual impairment, and hypertension is often called the silent killer. Hypertension is a condition when a person experiences a rise in blood pressure either slowly [6-11].

The burden of non-communicable diseases (NCDs) has caused substantial impact to health systems and economies worldwide. NCDs cause greater increase to morbidities and mortalities, reduced quality of life and escalated healthcare expenditures to governments, particularly in low- and middle-income countries (LMICs)[12],[13] Coupled with these unprecedented consequences of NCDs, global public health systems are being challenged with the rise of metabolic syndrome (MetS) incidence [14].

The global epidemic proportions of MetS was estimated to be around 20–25%. When compared across regions, it was estimated that 12–37% of the Asian population were afflicted with MetS, while around 12–26% of the European population suffered the condition [15]. The Joint Interim Statement (JIS) "Harmonized"

criteria definition that was later adopted was found to be more suitable to determine the proportions of MetS in Asian populations [16]. While literature to determine MetS in populations was burgeoning rapidly, the exploration of such investigations to occupational groups were limited [17]. Research in Indonesia regarding the prevalence of metabolic syndrome varies widely, it was found that out of 100 people, 29% met the WHO criteria and 31% met the ATP III criteria suffering from metabolic syndrome [18].

The prevalence increases with age, and it was found that the most common component of the metabolic syndrome is central obesity. Cases of Metabolic Syndrome (Hypertension and Diabetes Mellitus Type 2) North Maluku haze, Indonesia continues to increase, namely 31.2% (2017), 37.9% (2018), and 42.3% (2019), 48.7 (2021) [19]. The cases are almost the same in Ternate City and even higher and continue to increase, namely 27.9% (2017), 30.6% (2018), and 45.5% (2019), 50.5 (2020) [20]. Literature has identified a multitude of factors to be associated with MetS. Demographic characteristics such as being a woman or older age was shown to escalate the risk of having MetS, whereas lifestyle behaviors like physical activity, alcohol consumption, smoking, overweight or obesity were commonly linked to MetS across different geographies and populations.

Hypertension and Type 2 Diabetes Mellitus are considered the dominant factors for the metabolic syndrome. In addition to these two determinants, unhealthy lifestyles such as smoking, unhealthy eating patterns, and lack of physical activity also have the potential to cause metabolic syndrome.

The shift in lifestyle behavior from cities to villages is marked by an increase in cases of degenerative diseases so that prevention efforts continue to be improved. They no longer want to process traditional food into daily food because it is considered that the processing process takes a long time while they are already busy with their activities. Based on this background, researchers are interested in analyzing the causes of the increasing cases of metabolic syndrome.

2. METHOD

The research design used was observational with a cross sectional study design. The number of samples consisted of 128 respondents with type 2 diabetes mellitus and 64 respondents with hypertension. The sample collection technique was a non-probability sampling technique with purposive sampling. The sample used in this study were outpatients at the Siko Health Center in Ternate City who met the following criteria: outpatients with hypertension and type 2 diabetes mellitus, had metabolic syndrome, and underwent examination blood sugar and fat profile laboratory. Data

analysis using the Chi-square test and multiple logistic regression.

All research materials, including research protocols, were approved by the ethics committee of the Research Institute, Universitas Muslim Indonesia. Description of ethical approval "Ethical Approval" 579/A/ KEPK-UMI/I/2021. All participants gave their consent before their data was collected.

3. RESULTS

This research was carried out at the Siko Health Center, Ternate City, North Maluku in January-April 2021. The results of the study can be seen in Table 1.

Table 1. Determinants of metabolic syndrome

Variable	Metabolic syndrome				p-value
	Positive		Negative		
	n	%	n	%	
Long Suffering					.000
>6 Years	55	67,1	27	32,9	
1-5 Years	9	19,6	37	80,4	
Family History					0.000
Yes	58	54,7	48	45,3	
Not	6	27,3	16		
Physical Activity					.000
Light	25	67,6	12	32,4	
Medium	28	58,3	20	41,7	
Weight	11	25,6	32	74,4	
Dietary habit					.000
Bad	44	63,8	25	36,2	
Good	20	33,9	39	66,1	
Smoking Status					.309
Not Smoker	53	48,2	57	51,8	
Smoker	11	61,1	7	38,9	
Age					.000
30-45	1	4,2	23	95,8	
46-60	34	54,8	28	45,2	
>60	29	69	13	31	

Table 1 shows that there is a significant relationship between length of suffering from chronic disease, family history, physical activity, diet and age (ρ value 0.000) with metabolic syndrome (hypertension and type 2 diabetes), while smoking variable (p value 0.309) does not have significant association with Metabolic Syndrome (Hypertension and type 2 DM). Multiple logistic regression analysis (multiple logistic regretion) predictive model includes the selection of modeling candidates to determine the variables that make a major contribution to the incidence of metabolic syndrome (hypertension and type 2 diabetes).

Table 2. Multiple Logistic Regression Modelling

	B	Wald	Sig.	Exp(B)	95% CI	
					Lower	Upper
Long Suffering	-1.764	10.263	.001	.166	.055	.498
Family History of Chronic Disease	1.007	2.621	.105	2.736	.809	9.255
Physical Activity	.000	.000	.999	1.000	.492	2.033
Dietary habit	-1.657	12.451	.000	.191	.076	.479
Age	-.917	4.111	.043	.400		
Costant	8.155	11.636	.001	3.482E3		

Table 2 shows that the long-suffering variable value 0.001, family history of chronic disease value 0.105, physical activity value 0.999 and diet value 0.000, age value 0.43 The results of the analysis show that there are 3 variables (long suffering, diet and age) with a value the significance is smaller than <0.25 so that the variables of length of suffering, diet and age have a partial influence on the metabolic syndrome. Meanwhile, there are two variables (family history of chronic disease and physical activity) with a significant value > 0.25 so that H0 is accepted, thus the variables of family history of chronic disease and physical activity have no significant effect on metabolic syndrome.

4. DISCUSSION

The results of the analysis of the relationship between long suffering from type 2 DM, long suffering from hypertension, family history of chronic disease, physical activity, diet, smoking, and age. The criteria for metabolic syndrome in the study used the NCEP ATP III category where there must be at least 3 out of 5 criteria met to be able to determine someone positive for metabolic syndrome. The results showed that 67,1% of respondents suffered from metabolic syndrome.

Hypertension and type 2 DM with the age of 40-60 years had the highest percentage of metabolic syndrome. It shows that the age of 40-60 years is significantly associated with metabolic syndrome risk factors.

The study the most metabolic syndrome occurred at the age of 60-69 years, where most of the respondents at that age were no longer working or retired. This is in line with previous research which states that the prevalence of metabolic syndrome tends to increase with age. Then metabolic syndrome is more common in women. This study shows that female respondents are more at risk of suffering from metabolic syndrome than men.[21]

The results showed a high percentage of metabolic syndrome in married respondents. Stated that marital status, at the time of retirement, overweight and obesity were significantly related to metabolic syndrome risk factors with an value of 0.002. The type of work may be related to the metabolic syndrome. A person's job can affect their level of physical activity, the incidence of metabolic syndrome in this study is more common in housewives (IRT).

Long-term changes in kidney function can result in further damage to existing nephrons. Sclerotic lesions that form more and more so that it can lead to obliteration of the glomerulus resulting in a further decline in renal function, and creates a vicious cycle that develops slowly that ends in terminal kidney disease. If the patient has metabolic syndrome and cannot be treated appropriately, it will lead to terminal CKD within 5-10 years.

It is best illustrated by the fact that hypertension is a major component of the metabolic syndrome (MS), a cluster of CV risk factors which include abdominal obesity, glucose intolerance or diabetes type 2, and dyslipidemia characterised by increased triglycerides and reduced HDL-cholesterol. The duration of hypertension is a risk factor for metabolic syndrome disease, long-term uncontrolled hypertension can build complexity. In this study it was also found that the duration of hypertension increased the risk of developing metabolic syndrome.[22],[23]

The metabolic syndrome (hypertension and type 2 diabetes) with a family history of chronic disease so it can be said that there is a significant relationship between the metabolic syndrome (hypertension and type 2 diabetes mellitus) and a family history of chronic disease. Which states that family history is one of the parameters incorporated in several genetic substances including perisoxome proliferators, CD3C adiponectin, B-adrenergic receptors, insulin substrate receptors, B-dihydroxylated dehydrogenases, and adipocytokines.

That those with a family history of DM had a significant relationship with MetS and DM, and those with a family history of HTN had a positive relationship with HTN. Subjects with a family history of DM in the PBF quartile were associated with higher cardiometabolic events, the combination of family history containing a family history of DM had a significant relationship with the risk of cardiometabolic disorders such as MetS, DM and cardiovascular disease. [24]

Murningtyas F. S, Larasati. M.D at al (2020), shows that there is a significant relationship with an OR value of 3.778, meaning that samples with a genetic history have a risk of 3.778 times the incidence of metabolic syndrome compared to samples without a genetic history. Most of the samples in this study had people or families

who had diabetes mellitus, hypertension, and obesity. A history of diabetes mellitus in one or both parents not only has an impact on glucose disturbances but also has an impact on cardiometabolics such as central obesity, low HDL levels, and high blood pressure which are components of the metabolic syndrome. A history of hypertension in parents or siblings also has an impact on obesity, hypertension and decreased HDL levels which are components of the metabolic syndrome.[25]

It can be said that there is a significant relationship between metabolic syndrome (type 2 diabetes hypertension) and physical activity. Physical activity variables were categorized into 3, namely, light, moderate and heavy physical activity. Most of the respondents had relatively light physical activity. This is possible because there are more respondents who are elderly so that they are not too able to do strenuous sports/physical activities and spend more time resting or staying at home.

Lityandini R, Pertiwi F, at al (2020), states that there is a significant relationship between physical activity variables and metabolic syndrome. A sedentary lifestyle contributes to the obesity epidemic, physical exercise has many benefits for one's body. In people who do regular exercise insulin sensitivity will increase and the ability to regulate increases. But stopping physical activity can reduce insulin sensitivity, the muscles of a person who are trained have a better blood supply because blood glucose is obtained effectively. The liver becomes more efficient in producing glycogen and glucose in the blood. This study shows that the risk of metabolic syndrome increases with age and food intake, especially excessive carbohydrate intake is associated with the risk of metabolic syndrome, low physical activity is associated with the risk of metabolic syndrome.[26]

Iit is known that the proportion of people who eat less fruit and vegetables aged 10 years or older is 93.6 percent. Some food intakes that are determinants of metabolic syndrome are saturated fatty acids, unsaturated fatty acids, fiber and carbohydrates, eating patterns with unbalanced and excessive menus such as foods high in protein, high in fat and high in carbohydrates, especially pure carbohydrates accompanied by low fiber intake. affects lipoprotein levels, triglycerides, cholesterol levels in the blood which results in increased cases of metabolic syndrome.

Reduction of caloric intake and weight loss can significantly improve aspects of the metabolic syndrome. These improvements can be made by reducing saturated fat intake to reduce insulin resistance, reducing salt intake to lower blood pressure and reducing carbohydrate intake with a high glycemic index to lower blood glucose and triglyceride levels.

Wang, J., Wang, A., Chen, M, 2019 states that respondents who are less in terms of servings of vegetables and fruits mostly experience metabolic syndrome. Likewise for respondents who do not eat vegetables and fruits every day, most of them have metabolic syndrome. This is related to the nutrients and non-nutritional substances contained in vegetables and fruits. The content of natural phytochemical compounds in vegetables and fruit, for example, acts as an anticancer, antimicrobial, antioxidant, anti-inflammatory, and antithrombotic substance.[27]

The results of the analysis of the relationship between metabolic syndrome (hypertension and type 2 diabetes) with smoking status showed hasil value 0.309 > (0.05) so it can be said that there is no significant relationship. Based on the distribution of data by gender, most respondents are female, where none of the respondents smokes. States that there is no relationship between smoking and the incidence of metabolic syndrome, the content in cigarettes can cause a reduction in sensitivity and increase insulin resistance.

The risk of metabolic syndrome increases with age. Changes in body composition in old age have decreased muscle mass causing a decrease in the basal metabolic rate, namely a decrease in energy burning power up to 10% every 10 years so that fewer calories are burned and cause an increase in body fat, a decrease in activity so that the risk of disease increases. All of these conditions are factors that trigger the occurrence of metabolic syndrome.

Biadgo ballete et al (2018), stated that the results of multivariable logistic regression analysis showed that age 47-57 years aged 58 years and having FBS > 130mg/dl was found to have a significant relationship value 0.039 with MetS. That it can be said that there is no significant relationship with the metabolic syndrome. This is because the number of respondents aged <60 years (35.9%) suffer from metabolic syndrome, supported by a poor diet (37.5%) and a family history of chronic diseases so that in adulthood the respondents have experienced metabolic syndrome.[28]

The results of the multivariate test showed that the variables of length of stay, diet and age had a partial influence on the metabolic syndrome, while the variables of family history of chronic disease and physical activity had no significant effect on the metabolic syndrome. Family history of chronic disease is also very risky OR 2,736 and physical activity is also very risky OR 1 times for metabolic syndrome.

In addition, with increasing severity of hypertension, the prevalence of type 2 DM also increases. Diabetes and blood pressure are closely related diseases. There is a high incidence rate of these two diseases in the same patient. When this happens they are called "Comorbidities" there is a gradual increase in type 2 diabetics from normal BP (37.2%) to pre-HT (42.7%) in each category, Frompre-HT jumps to (61.4%) in HT

stage 1 and slightly increased to (63.5) in HT stage 2 these data confirm the fact that DM and HT are comorbidities.

More than 60% of subjects with a family history of MetS, had an abnormal lipid profile (high total cholesterol, high LDL levels, low HDL levels, high triglyceride levels), and subjects with a family history of MetS indicated higher insulin resistance. Central to this is related to family history of cardiovascular disease, diabetes and hypertension in all study participants in Ghana. MetS is also a contributor in individuals with a family history of premature cardiovascular disease). Individuals who have a family history of diabetes mellitus have significantly greater waist circumference, waist circumference ratio, body mass index, fasting blood glucose levels compared to individuals who do not have a family history of Diabetes Mellitus.

Liu Chen-Chieh et al (2018) stated that obesity is usually documented as being associated with a poorer health-related quality of life (HRQOL) relationship, not only in the physical but also in the mental domain, in this study showing that a higher number of MetS components accompanied by lower physical health scores were found in women but not in men. Physical activity may not be the most influential factor in Mets, or Mets may be influenced by many factors including diet, age, and genetics.[29]

The absence of a relationship between the level of physical activity can be caused because most of the subjects are in a low level of physical activity, only a few subjects have a high level of physical activity, whereas according to Ekelund high physical activity plays an important role in the risk factors for SM. One study reported that adolescents' energy expenditure was lower when they watched television than when they rested.

States that physical activity tends to decrease in old age as a result of increasing obesity rates. As you get older, blood pressure tends to increase and increases again with overweight or obesity. Obesity, especially central obesity, is an independent predictor of an increased risk of DM, hypertension, ischemic heart disease, and dyslipidemia. From the results of this analysis, it is known that central obesity has a 2.5-fold risk for the occurrence of DM.

5. CONCLUSION

Family history of chronic disease, long suffering from type 2 diabetes mellitus and hypertension, lack of physical activity, poor diet are determinants of metabolic syndrome. It is necessary to eat and do aerobic physical activity both in terms of frequency and duration with a duration of 40-60 minutes / item in preventing Metabolic Syndrome.

AUTHORS' CONTRIBUTIONS

All authors contributed in designing, collecting, analyzing, and writing the manuscript.

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