

Association between Hypertension with the Incidence of Type 2 Diabetes Mellitus in South Kalimantan

(Data Analysis of Indonesia Family Life Survey 5 Year 2014)

Husda Oktaviannoor¹, Ahmad Hidayat², St. Hateriah¹

¹Lecture and Assistant Professor, Health Promotion Department, Health Faculty, Sari Mulia University, Indonesia,

²Lecture and Assistant Professor, Information System Department, Science and Technology Faculty, Sari Mulia University, Indonesia

Abstract

Background: South Kalimantan is the 3rd highest prevalence in Kalimantan, which is 1.8% and there is an increase in prevalence compared to the results of the 2013 Riskesdas study of 1, 4% (an increase of 0.4%). The purpose of this study was to know the association between hypertension and the incidence of diabetes mellitus. This study used a cross sectional design. The sample was 1,423. The analysis carried out was univariate, bivariate and multivariate.

Finding: Multivariate analysis showed hypertension is risk factor to experience diabetes mellitus (p-value 0.011). Hypertension has a 1.46 times greater risk of developing diabetes mellitus.

Conclusion: It is hoped that this research will serve as input for determining policy directions to educate the public so that they can prevent and control blood pressure levels so as not to cause hypertension which can lead to diabetes mellitus.

Keywords: Hypertension; IFLS-5; South Kalimantan; Type 2 Diabetes Mellitus.

Introduction

In the past two decades there has been a significant shift from communicable disease problems to noncommunicable disease threats not only around the world but also in Indonesia. NCDs tend to keep growing and have been a threat from an early age. The main non-communicable diseases include diabetes mellitus, high blood pressure, cancer, and chronic obstructive pulmonary disease (COPD)¹.

Diabetes Mellitus (DM) is a disease in which the patient cannot control the level of glucose in his blood. The pancreas gland in a healthy body functions to easily release the hormone insulin which is in charge of transporting sugar through the blood to muscles and other tissues for energy supplies. While DM is a metabolic disorder in the distribution of sugar in the body².

Based on data from the World Health Organization (WHO), the number of people with diabetes has increased from 108 million in 1980 to 422 million in 2014 globally. The prevalence of diabetes in adults over 18 years of age increased from 4.7% in 1980 to 8.5% in 2014³.

Corresponding author:

Husda Oktaviannoor

Lecture and Assistant Professor, Health Promotion Department, Health Faculty, Sari Mulia University, Indonesia.

E-mail: husda.oktaviannoor@gmail.com

The results of Riskesdas 2018, the prevalence of being diagnosed by doctors aged 15 years is 2% and in the Kalimantan area, South Kalimantan is the 3rd highest prevalence after North Kalimantan and East Kalimantan which is 1.8% and there is an increase in prevalence compared to the results of the 2013 Riskesdas study of 1.4% (0.4% increase)⁴.

In addition to insulin resistance, which acts as a pathogenesis factor for DM, there are many other factors that play a role in interfering with insulin hormone metabolism in the blood, thereby increasing the risk of DM⁵. One of the factors that play a role is hypertension. Hypertension is a factor that causes diabetes mellitus. Hypertension and DM are health problems that are closely related and both need to be handled carefully. Death caused by diabetes and cardiovascular disease, one of the factors that play a role in increasing both diseases is hypertension⁶.

Based on the above background, the researcher will conduct an analysis to determine the effect of hypertension on the incidence of diabetes mellitus in South Kalimantan.

Materials and Methods

This research is an analytical quantitative observation with a cross sectional design. Cross sectional studies study the relationship between risk factors and outcomes in the form of a particular disease or health status, all of which refer to the same time point. This study can assess the prevalence of a disease^{7,8}.

Researchers took data from secondary data sources, namely IFLS-5 2014. IFLS is an ongoing longitudinal survey in Indonesia. This survey has been reviewed and approved by Institutional Review Boards in the United States and in Indonesia at Gadjah Mada University for IFLS3, IFLS4 and IFLS5⁹. This research was conducted in June-August 2021.

The researcher determines the research sample by counting from the population aged 15 years in South Kalimantan Province who are the respondents of the Indonesia Family Life Survey-5. The inclusion criteria in this study were respondents from South Kalimantan or long-standing domicile in South Kalimantan. The exclusion criteria were incomplete data. The minimum sample size in this study uses the sample size formula as follows⁷:

$$n = \frac{(z_{1-\frac{\alpha}{2}}\sqrt{2P(1-P)} + z_{1-\beta}\sqrt{p_1(1-p_1) + p_2(1-p_2)})^2}{(p_1 - p_2)^2}$$

n = minimum number of samples

$z_{1-\frac{\alpha}{2}}$ = z value based on the degree of confidence 95%=1,96

$z_{1-\beta}$ = z value based on test power 80%= 0,84

p_1 = proportion of type 2 diabetes mellitus in people who have hypertension

p_2 = proportion of type 2 diabetes mellitus in people who do not have hypertension

$$P = \frac{p_1 + p_2}{2}$$

Calculation using proportion based on hypertension factor. This sample research is 1,423.

Researchers conducted data analysis through three stages, namely: univariate analysis, simple relationship analysis (bivariate), and multivariate analysis with the help of data analysis program applications. The results of data analysis are presented in the form of tables.

Results

In this study, most of the respondents had diabetes mellitus by 19.75%, hypertension by 28.39%, age 35 years by 51.37%, lack of physical activity by 33.66%, smoking status by 27.97% , not working by 18.90%, women by 46.24%, less consumption of vegetables and fruit by 64.79%, and abnormal nutrition by 44.83% (Table 1).

Table 1. Proportion of Independent and Confounding Dependent Variables

Variable	Total	
	N=1,423	(%)
Diabetes Mellitus Type 2 (Dependent)		
Diabetes Mellitus	281	19.75
No Diabetes Mellitus	1,142	80.25
Hypertension (Independent)		
Yes	404	28.39
No	1,019	71.61
Covariate		
Age		
≥35 years	731	51.37
< 35years	692	48.63
Lack of Physical Activity		
Yes	479	33.66
No	944	66.34
Smoker Status		
Yes	398	27.97
No	1,025	72.03
Job Status		
Does not work	269	18.90
Work	1,154	81.10
Gender		
Women	658	46.24
Men	765	53.76
Less Consumption of Vegetables and Fruits		
Yes	922	64.79
No	501	35.21
Nutritional Status		
Abnormal	638	44.83
Normal	785	55.17

In this study, there was a relationship between hypertension, age, and employment status with diabetes mellitus. However, there was no relationship between gender, smoking status, lack of physical activity, less consumption of vegetables and fruit, and nutritional status with diabetes mellitus (Table 2).

Table 2. Association of Hypertension and Confounding Variables with Diabetes Mellitus

Variabel	DM				POR	95% CI	p-value
	Yes		No				
	n	%	n	%			
Hypertension (Independent)							
Yes	108	38.43	296	25.92	1.78	1.341-2.367	<0.0001
No	173	61.57	846	74.08	ref		
Covariate Variable							
Age							
≥35 years	181	64.41	550	48.16	1.95	1.475-2.581	<0.0001
< 35years	100	35.59	592	51.84	ref		
Lack of Physical Activity							
Yes	160	56.94	605	52.98	1.17	0.895-1.542	0.233
No	121	43.06	537	47.02	ref		
Smoker Status							
Yes	65	23.13	204	17.86	1.38	0.992-1.914	0.043
No	216	76.87	938	82.14	ref		
Job Status							
Does not work	68	24.20	330	28.90	0.79	0.572-1.070	0.116

Cont... Table 2. Association of Hypertension and Confounding Variables with Diabetes Mellitus

Variabel	DM				POR	95% CI	p-value
	Yes		No				
	n	%	n	%			
Work	213	75.80	812	71.10	ref		
Gender							
Women	107	38.08	372	32.57	1.27	0.960-1.682	0.080
Men	174	61.92	770	67.43	ref		
Less Consumption of Vegetables and Fruits							
Yes	189	67.26	733	64.19	1.15	0.862-1.530	0.334
No	92	32.74	409	35.81	ref		
Nutritional Status							
Abnormal	131	20.53	507	79.47	1.10	0.834-1.433	0.502
Normal	150	19.11	635	80.89	ref		

In the final model of multivariate analysis using logistic regression test, it can be seen that hypertension is a risk factor for the incidence of diabetes mellitus. The results of the analysis show that people with hypertension have a 1.46 times greater risk of developing diabetes mellitus (Table 3).

Table 3. Final Model Multivariate Analysis

Variable	POR	95% CI	P-Value
Hypertension	1.46	1.092-1.961	0.011
Age	1.72	1.292-2.297	<0.0001

Note: Adjusted by age

Discussion

The objective of this study is to know association of hypertension with the incidence of type 2 diabetes mellitus through a cross-sectional design. The use of design in this study has weaknesses due to temporal ambiguity such that the incidence of diabetes mellitus and its predictive variables may precede each other, giving rise to unclear aspects of the concept of causality. Furthermore, the causal model that this research design uses could not provide the most accurate picture to predict diabetes mellitus because it uses a cross-sectional design, so in this study it is possible that someone with diabetes mellitus may be at risk before the factor. However, this design is suitable for defining risk factors as a basis and reference for future research, as it is more efficient and effective than other designs.

In this study, it was found that there was a significant relationship between hypertension and the incidence of diabetes mellitus. In this study, it can be seen that there is a tendency that those aged 35 years who have hypertension have more diabetes than those aged <35 years.

The prevalence of DM with hypertension in Indonesia tended to increase with age. Most NCDs are more likely to have a positive linear association with aging due to metabolic pathways or biological changes during aging that can be positively or negatively influenced by lifestyle risk factors such as diet, smoking, physical activity and alcohol consumption¹⁰.

Hypertension is a factor that causes diabetes mellitus. Hypertension and DM are health problems that are closely related and both need to be handled carefully. Death caused by diabetes and cardiovascular disease, one of the factors that play a role in increasing both diseases is hypertension⁶. Based on JNC*VIII, blood pressure is expected to be controlled based on

the following populations, namely 60 years < 140/90 mmHg, > 60 years < 150/mmHg, chronic kidney disease and diabetes < 140/90 mmHg¹¹.

Hypertension has been shown to cause microvascular dysfunction, which can lead to the pathophysiology of the development of diabetes. Endothelial dysfunction associated with insulin resistance is also closely associated with hypertension, and endothelial dysfunction biomarkers were found to be an independent predictor of type 2 diabetes^{12,13}. Insulin resistance is a residual for hypertension, type 2 diabetes and cardiovascular disease. Thus there could be another potential relationship between hypertension and type 2 diabetes¹³.

According to Marewa (2015) high blood pressure (hypertension) is one of the factors that can cause beta cell damage due to insulin resistance¹⁴. Chou's research (2015) states that people with hypertension have a 1.60 times greater risk of developing DM¹⁵. Research by Zou Disha et al (2017) states that people with hypertension will have a 1.61 greater risk of developing DM¹⁶. Insulin resistance can be detected for several years in advance onset of T2D. It is associated with obesity, especially central obesity, but may be present in lean individuals with hypertension¹⁷.

Hypertension occurs in two thirds of DM patients, and its development coincides with the occurrence of hyperglycemia. The mechanism underlying the relationship these include insulin resistance in nitric-oxide pathways; stimulatory effect of hyperinsulinemia on sympathetic drive, smooth muscle growth, sodium-fluid retention; and the excitatory effect of hyperglycemia on the renin-angiotensin-aldosterone system¹⁸. Diabetes mellitus and hypertension are among the most common diseases and cardiovascular risk factors, respectively, worldwide, and their frequency increases with age. Elevated blood pressure (BP) values are a common finding in patients with type 2 diabetes mellitus (T2D)

and thought to reflect, at least in part, the impact of underlying insulin resistance on blood vessels and kidneys. In contrast, accumulated evidence suggests that carbohydrate metabolism disorders are more common in hypertensive individuals, thus suggesting that the pathogenic relationship between diabetes mellitus and hypertension is actually two-way¹⁹.

Hypertension usually occurs when blood pressure exceeds 140 mmHg (systolic) and 8590 mmHg (diastolic). The effect of high blood pressure on the incidence of DM is caused by the thickening of the arteries, which causes the diameter of the blood vessels. This interrupts the process of transporting glucose out of the blood. The higher prevalence of high blood pressure in diabetics requires special treatment for diabetics who also have high blood pressure. Management is controlling blood pressure to keep it within normal limits (below 120/80 mmHg) through a healthy lifestyle²⁰.

There are several factors that contribute to a greater coexistence of DM and arterial hypertension. The incidence of obesity in children and adolescents in industrialized countries has exploded in recent decades, with a threatening parallel increase in the incidence of arterial hypertension and DM^{21,22}.

High blood pressure is a powerful independent risk factor for cardiovascular disease and chronic kidney disease (CKD), and when hypertension is associated with DM, the risk increases even further^{23,24}. Although there is controversy about the optimal goal to reduce blood pressure^{24,25,26}, it remains clear that constant control of blood pressure in patients with DM is important to prevent and delay micro and macrovascular complications^{27,28}.

This study was conducted cross-sectional so it cannot ensure a definite causal relationship between the independent and dependent variables. However, in this study, the hypertension variable can be assumed

to occur earlier than the incidence of diabetes mellitus. Diabetes mellitus can occur due to the influence of hypertension or not a person's hypertension plus the age variable which further encourages the influence of hypertension to occur in diabetes mellitus.

Conclusion

Most of the respondents had diabetes mellitus and had hypertension. Age over 35 years is more likely to have hypertension than age less than 35 years. Hypertension is a risk factor for diabetes mellitus. Hypertension has a 1.46 times greater risk of developing diabetes. It is hoped that this research will serve as input for determining policy directions to educate the public so that they can prevent and control blood pressure levels so as not to cause hypertension which can lead to diabetes mellitus.

Ethical Clearance: Taken from institutional Ethics Committee of Universitas Sari Mulia

Source of Funding: Funding is given by RISTEK-BRIN RI

Conflict of Interest: Nil

References

1. Irianto K. *Epidemiologi Penyakit Menular dan Tidak Menular; Panduan Klinis*. Alfabeta. 2014
2. Ministry of Health RI. PMK RI No 39 Tahun 2016 *Pedoman Penyelenggara Indonesia Sehat*. 2016
3. WHO. Diabetes [Internet]. 2016 [cited 2021 June 20]. Available from: <http://www.who.int/en/news-room/fact-sheets/detail/diabetes>
4. Ministry of Health RI. *Riset Kesehatan Dasar*. 2018.
5. Ministry of Health RI. *Waspada diabetes: Eat well live well*. 2014
6. Naingolan, O., Kristanto, A. Y., & Edison, H. *Determinan Diabetes Melitus Analisis Baseline*

- Data Studi Kohort Penyakit Tidak Menular Bogor 2011. Buletin Penelitian Kesehatan.* 2013; 16(2), 331–339
7. Lemeshow, S., Hosmer Jr, D. W., Klar, J., & Lwanga, S. K. Adequacy of Sample Size in Health Studies. John Wiley & Sons, Inc. 1990
 8. Rothman, K. Epidemiology an introduction (2nd ed.). Oxford University Press. 2012
 9. RAND Corporation. Indonesia Family Life Survey (IFLS) [Internet]. 2014 [cited 2021 June 30]. Available from: <https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html>
 10. Kusumawardani N, Suhardi, Pradono J, Delima, Aryastami NK, Krishnan A. Behavior risk factor and lipid profiles of diabetes mellitus with hypertension among adult population in Indonesia. *Health Science Journal of Indonesia.* 2016; 7(2): 97-106
 11. Bell, K., Twiggs, J., & Olin, B. R. Hypertension: The Silent Killer: Updated JNC-8 Guideline Recommendation. 2015; 1–8. doi.org/0178-0000-15-104-H01-P
 12. Meigs JB. Metabolic Syndrome In search of clinical role. *Diabetes Care.* 2004; 27(11):2761-2763.
 13. Kim, E. S., et al. Impact of metabolic status on the incidence of psoriasis: A Korean nationwide cohort study. *Scientific Reports.* 2017; 7(1), 1–7. doi.org/10.1038/s41598-017-01983-y
 14. Marewa, L. Pengaruh gaya hidup dan sosial budaya prediabetes menjadi diabetes melitus tipe 2 pada masyarakat gasuku (Bugis, Makassar, Toraja) di Provinsi Sulawesi Selatan (Sebuah pendekatan antropologi-epidemiologi). Dissertation. University of Indonesia. 2015
 15. Cho, N. H., et al. High blood pressure and its association with incident diabetes over 10 years in the Korean Genome and Epidemiology Study (KoGES). *Diabetes Care.* 2015; 38(7), 1333–1338. doi.org/10.2337/dc14-1931
 16. Zou, D., Ye, Y., Zou, N., & Yu, J. Analysis of risk factors and their interactions in type 2 diabetes mellitus: A cross-sectional survey in Guilin, China. *Journal of Diabetes Investigation.* 2017; 8(2), 188–194. doi.org/10.1111/jdi.12549
 17. Petrie JR, et al. Diabetes, hypertension, and cardiovascular disease clinical insight and vascular mechanisms. *Canadian Journal of Cardiology.* 2018; 34, 575-584
 18. Sirait AM. et al. Incident and Risk Factor of Diabetes Mellitus in Adults at Bogor. Prospective Cohort Study Risk Factors Non Communicable Diseases. *Buletin Penelitian Sistem Kesehatan.* 2015; 18(2): 151-160
 19. Tsimihodimos V. et al. Hypertension and diabetes mellitus: Coprediction and Time Trajectories. Original Article. *American Heart Association Journal.* 2018; 71. doi: 10.1161/hypertensionaha.117.10546
 20. Simbolon D, Siregar A, Talib RA. Physiological Factors and Physical Activity Contribute to the Incidence of Type 2 Diabetes Mellitus in Indonesia. *National Public Health Journal.* 2020; 15(3): 120-127 doi.org/10.21109/kesmas.v15i3.3354
 21. Sowers JR, Whaley-Connell A, Hayden M. The role of overweight and obesity in the cardiorenal syndrome. *Cardiorenal Med.* 2011; 1:5–12.
 22. Ogden CL, Carroll MD, Kit BK, et al. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA.* 2012; 307:483–490.
 23. Stamler J, Vaccaro O, Neaton JD, et al. Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial. *Diabetes Care.* 1993; 16:434–444.

24. Garcia-Touza M, Sowers JR. Evidence-based hypertension treatment in patients with diabetes. *J Clin Hypertens Greenwich*. 2012; 14:97–102.
25. Sowers JR. Diabetes mellitus and vascular disease. *Hypertension*. 2013; 61(5):943–7.
26. Cushman WC, Evans GW, Byington RP, et al. ACCORD Study Group. Effects of intensive bloodpressure control in type 2 diabetes mellitus. *N Engl J Med*. 2010; 362:1575–1585.
27. American Diabetes Association. Standards of medical care in diabetes --2011. *Diabetes Care*. 2011; 34:S11–S61.
28. UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ*. 1998; 317:703–713.