Ordinal Regression Model to Predict Hypertension

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Abstract

Introduction: Hypertension in the world and Indonesia has been increasing every year. Hypertension can be prevented by controlling risky behaviors such as smoking, unhealthy diet, obesity, lack of physical activity, and excessive alcohol consumption. **Aim**: This study aims to predict hypertension using an ordinal regression model. **Materials and Method**: This research is an observational analytic study using a cross-sectional approach. The research was conducted in Jati Agung Subdistrict, South Lampung in 2021. The measuring instrument used a questionnaire and measured blood pressure. The study population was all people over 50 years of age, with a total sample of 92 people. The independent variables include age, gender, education, job status, consumption of fatty foods, physical activity, alcohol consumption, and smoking behavior. The dependent variable in this study was hypertension. The analysis used was univariate and multivariate using ordinal regression models. **Results**: The analysis found that most of the respondents were aged 61-70 years, women, elementary education level, did not work, rarely ate fatty foods, had enough physical activity, did not drink alcohol, did not smoke, and was categorized as level-1 hypertension. Multivariate analysis used regression. ordinal, it was found that the variables associated with hypertension were gender (p = 0.034) and consumption of fatty foods (p = 0.000). **Conclusion**: The variables associated with hypertension are gender and consumption of fatty foods.

Keywords: ordinal regression, gender, consumption of fatty foods, hypertension

Introduction

Currently, the world is facing a Covid-19 outbreak.[1] On the other hand, there are several diseases whose numbers are increasing every year.[2] One of the diseases is hypertension. The Institute for Health Metrics and Evaluation (IHME) in 2017, stated that of the 53.3 million deaths in the world, 33.1% of the causes of death were cardiovascular disease, 16.7% cancer, 6% diabetes, and endocrine disorders, and respiratory infections 4.8%. Data on the causes of death in Indonesia in 2016 showed a total of 1.5 million deaths with the most common causes of death were cardiovascular disease 36.9%, cancer 9.7%, diabetes and endocrine disease 9.3% and tuberculosis 5.9%. IHME also stated that from a total of 1.7 million deaths in Indonesia, the risk factors that caused death were hypertension of 23.7%, hyperglycemia of 18.4%, smoking 12.7%, and obesity of 7.7%.

Every year nearly 9.5 million cases of hypertension are recorded.[3] The World Health Organization (WHO) in 2015 stated that as many as 1.13 billion people in the world have hypertension. The number of hypertension sufferers is estimated at 1.5 billion people in 2025 and an estimated 10.44 million people die from hypertension each year. The prevalence of hypertension in Indonesia has increased from 2013 to 2018. Based on the 2013 Basic Health Research survey, shows hypertension with a prevalence of 25.8%.[4] Meanwhile, 2018 showed an increase of 34.1%.[5] The estimated number of hypertension cases in Indonesia is 63,309,620

people, while the death rate in Indonesia due to hypertension is 427,218 deaths. This number will have an impact on various sectors and are potentially dangerous for humans.[6]

Signs and symptoms of hypertension often go undetected.[7] As many as 90% of hypertension has no known cause (primary hypertension) and 10% is congenital from the disease suffered. Hypertension has the potential to damage organs in the body, such as blood vessels, heart, and kidneys. Organs that have blood vessels will be affected by hypertension. Hypertension can be prevented by controlling risky behaviors such as smoking, an unhealthy diet, less consumption of vegetables and fruits, consumption of sugar, excess salt and fat, obesity, lack of physical activity, excessive alcohol consumption, and stress.[8] This study aims to predict hypertension using an ordinal regression model.

Materials and Method

This research is observational analytic using a cross-sectional approach. The research was conducted in Jati Agung Subdistrict, South Lampung in 2021. The measuring instrument used a questionnaire and measured blood pressure. The study population was all people over 50 years of age, with a total sample of 92 people. The independent variables include age, gender, education, job status, consumption of fatty foods, physical activity, alcohol consumption, and smoking behavior. The dependent variable in this study was hypertension. According to JNC VIII, hypertension is divided into three categories, namely, prehypertension if the systolic blood pressure is 120-139 mmHg, and diastolic 80-89 mmHg, level-1 hypertension if the systolic blood pressure is 140-159 mmHg and diastolic 90-99 mmHg, and level-2 hypertension if systolic blood pressure >160 mmHg and diastolic >100 mmHg. The analysis used was univariate using percentages and multivariate using ordinal regression models to identify factors associated with the incidence of hypertension.

Results and Discussion

Table 1. Sociodemographic Characteristics and Blood Pressure Measurement

Sociodemography Characteristics		Frequency	Percentage (%)
Age (years)	50-60	22	23,9
	61-70	53	57,6
	>70	17	18,5
Gender	Man	41	44,6
	Woman	51	55,4
Education level	Elementary school	55	59,8
	Junior high school	13	14,1
	Senior high school	21	22,8
	Bachelor	3	3,3
Job status	No	61	66,3
	Yes	31	33,7
Consumption of fatty foods	Rare	60	65,2
	Often	32	34,8
Physical activity	Enough	53	57,6
	Less	39	42,4

Alcohol consumption	No	58	63,0
	Yes	34	37,0
Smoking behavior	No	57	62,0
	Yes	35	38,0
Hypertension	Pre-Hypertension	14	15,2
	Level-1	47	51,1
	Level-2	31	33,7
Total		92	100,0

This study found that most of the respondents were aged 61-70 years. The health level of a person tends to decline so that he is susceptible to disease, one of which is hypertension. At this age, it is very important to maintain a healthy lifestyle and avoid the risk of disease. Health problems at this age are very diverse, such as weight gain and other health problems. Someone at this time is advised to carry out health screening to detect diseases.[9]

Most of the respondents are women. Previous studies have found that sex differences have implications for the prevalence and factors that influence hypertension. Meanwhile, hypertension control between men and women did not differ in antihypertensive treatment. The study also found that most of the respondents with hypertension were women.[10]

The characteristics of respondents based on education are mostly elementary schools. The level of education is one of the factors affecting knowledge. A good level of knowledge will lead to good behavior. Higher education will increase understanding and good behavior. Meanwhile, low education will result in poor understanding and bad behavior.[11]

Majority category of respondents are not working. Work is an activity to find a source of income. A person who works will get an income that can be used for health maintenance. Most of the respondents in the study were not working which has implications for the lack of health care.[12]

Most of the respondents have the habit of rarely eating fatty foods. Excessive consumption of saturated fat will increase low-density lipid (LDL).[13] High LDL levels will increase blood pressure and can have an impact on coronary heart disease. This risk can be reduced by substituting fat sources from whole grains, olive oil, and avocados.[14]

Physical activities carried out by the respondents were in the moderate category. The physical activities carried out by the respondents were jogging and light exercise. Respondents mostly did not consume alcohol and did not smoke. They have the awareness to avoid alcohol consumption and smoking. Most of the respondents were in the category of level-1 hypertension. According to JNC VIII, level-1 hypertension if the systolic blood pressure is 140-159 mmHg and diastolic 90-99 mmHg.[15]

Table 2. Estimation of Hypertension Based on Ordinal Regression Analysis

Variables	Pre Hypertension n (%)	Level-1 n (%)	Level-2 N (%)	p-value
Age (years)				0,611
50-60	10 (45,5%)	11 (50,0%)	1 (4,5%)	
61-70	4 (7,5%)	28 (52,8%)	21 (39,6%)	
>70	0 (0,0%)	8 (47,1%)	9 (52,9%)	
Gender				0,034
Man	4 (9,8%)	20 (48,8%)	17 (41,5%)	
Woman	10 (19,6%)	27 (52,9%)	14 (27,5%)	
Education level				0,992
Elementary school	1 (1,8%)	27 (49,1%)	27 (49,1%)	
Junior high school	0 (0,0%)	9 (69,2%)	4 (30,8%)	
Senior high school	10 (47,6%)	11 (52,4%)	0 (0,0%)	
Bachelor	3 (100,0%)	0 (0,0%)	0 (0,0%)	
Job status				0,876
No	5 (8,2%)	33 (54,1%)	23 (37,7%)	
Yes	9 (29,0%)	14 (45,2%)	8 (25,8%)	
Consumption of fatty foods				0,000
Rare	11 (18,3%)	36 (60,0%)	13 (21,7%)	
Often	3 (9,4%)	11 (34,4%)	18 (56,2%)	
Physical activity				0,749
Enough	9 (17,0%)	32 (60,4%)	12 (22,6%)	
Less	5 (12,8%)	15 (38,5%)	19 (48,7%)	
Alcohol consumption				0,389
No	10 (17,2%)	35 (60,3%)	13 (22,4%)	
Yes	4 (11,8%)	12 (35,3%)	18 (52,9%)	
Smoking behavior				0,522
No	8 (14,0%)	36 (63,2%)	13 (22,8%)	
Yes	6 (17,1%)	11 (31,4%)	18 (51,4%)	

The results showed that most respondents in the pre-hypertension category were aged 50-60 years, level-1 hypertension was 61-70 years old, and level-2 hypertension was aged >70 years. Although there is no relationship between age and hypertension, blood pressure substantially increases with age. The results of this study are supported by previous studies which found no relationship between age and hypertension.[16]

Hypertension in the pre-hypertension category and level-1 hypertension were dominated by women. Meanwhile, level-2 hypertension is dominated by men. This is following previous studies which found that hypertension in women was more at the age of 50 years, while hypertension in men was more at the age >60 years. The level of education shows that the higher level of education, the lower the risk of hypertension. This is related to the knowledge possessed by the respondent. High education correlates with good knowledge.

Respondents who work are more likely to experience pre-hypertension and level-1 hypertension. Meanwhile, respondents who do not work more experience level-2 hypertension. This is following previous research which found that someone who is sufficiently financed will

take advantage of health services, one of which is to control blood pressure.[17] Respondents who have sufficient physical activity are more in the pre-hypertension category, while respondents who lack physical activity are more in the category of level-2 hypertension. This is because regular and measured physical activity is one of the preventions of hypertension. So that the results of this study showed that better physical activity makes lower the risk of hypertension complications.

Respondents who did not consume alcohol were more in pre-hypertension, while those who consumed alcohol were more in level-2 hypertension. This is due to the presence of chemicals from alcoholic drinks that trigger an increase in blood pressure. Although there is no association between alcohol consumption and hypertension, the research is consistent with the theory that alcohol increases blood pressure. Respondents who smoke tend to fall into the category of level-2 hypertension. This is due to the effects of chemicals in cigarettes which can trigger an increase in blood pressure. Past research has found that smoking increases the risk of hypertension.[18]

The analysis found that there is a relationship between gender and hypertension. The risk of hypertension in men and women is both high. Men experience hypertension more often than women at the age of fewer than 55 years. Meanwhile, women who are more than 55 years old are more susceptible to developing hypertension. Women have more of the hormone progesterone, which is thought to play a role in causing high blood pressure. Apart from hormonal problems, stress can also make women more prone to developing hypertension than men.[19] Stress is one of the factors that have been known to influence hypertension. Studies have found that women's brain cells are more sensitive to a stress hormone called corticotropin-releasing factor so that women are twice as likely to experience stress as men, which results in the risk of hypertension.[20]

The results showed a relationship between consumption of fatty foods with hypertension. One of the factors causing hypertension is food intake. This is because food has a significant role in increasing blood pressure, such as excessive consumption of sodium, carbohydrates, protein, and fat.[21] High consumption of fat can cause blood pressure to rise.[22] Excessive fat consumption will increase cholesterol levels in the blood, especially LDL, which will accumulate in the body. Fat deposits caused by cholesterol stick to blood vessels. This situation causes blockage of blood vessels. Blood flow throughout the body will be disrupted and can lead to increased blood volume and blood pressure. The recommended fat consumption for hypertensive patients is 27% of the total energy and <6% is the type of saturated fat. Several studies have shown a link between fat consumption and increased blood pressure.[23]

Conclusion

The analysis found that most respondents were aged 61-70 years, women, elementary education level, did not work, rarely ate fatty foods, had enough physical activity, did not drink alcohol, did not smoke, and were categorized as level-1 hypertension. Multivariate analysis used ordinal regression. It was found that the variables associated with hypertension were gender (p = 0.034) and consumption of fatty foods (p = 0.000). Suggestions for health services are to establish hypertension control and prevention programs through health promotion activities.

Conflict Of Interest
None

Source Of Funding
Self

Ethical Clearance
This research has received ethical approval from the Faculty of Medicine, Universitas Lampung, Indonesia with Number 3886/UN26.18/PP.05.02.00/2019.

References

1. Kang SH, Kim SH, Cho JH, Yoon CH, Hwang SS, Lee HY, et al. Prevalence, Awareness, Treatment, and Control of Hypertension in Korea. Sci Rep. 2019;9(1):3–10.
2. Lacruz ME, Kluttig A, Hartwig S, Löer M, Tiller D, Greiser KH, et al. Prevalence and Incidence of Hypertension in the General Adult Population. Med (United States). 2015;94(22):e952.
3. Plumettaz C, Viswanathan B, Bovet P. Hypertension prevalence based on blood pressure measurements on two vs. One visits: A community-based screening programme and a narrative review. Int J Environ Res Public Health. 2020;17(24):1–14.
4. Kemenkes RI. Riset Kesehatan Dasar. Jakarta: Kementerian Kesehatan Republik Indonesia; 2013.
5. Kemenkes RI. Riset Kesehatan Dasar. Jakarta: Kementerian Kesehatan Republik Indonesia; 2018.
6. Levanovich PE, Diaczok A, Rossi NF. Clinical and Molecular Perspectives of Monogenic Hypertension. Curr Hypertens Rev. 2019;16(2):91–107.
7. Carey RM. 2008 and 2018 American Heart Association Scientific. 2020;73(2):424–31.
8. Shen Y, Chang C, Zhang J, Jiang Y, Ni B, Wang Y. Prevalence and risk factors associated with hypertension and prehypertension in a working population at high altitude in China: A cross-sectional study. Environ Health Prev Med. 2017;22(1).
9. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, et al. Hypertension in India: A systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens. 2014;32(6):1170–7.
10. Taylor LE, Ramirez LA, Musall JB, Sullivan JC. Tipping the scales: Are females more at risk for obesity- and high-fat diet-induced hypertension and vascular dysfunction? Br J Pharmacol. 2019;176(21):4226–42.
11. Montalvo PL, Flores PB, Mantolan AE, Bordoy JP, Leiva A. The MEDICHY study. 2020;17(March):1–7.
12. Yong X, Gao X, Zhang Z, Ge H, Sun X, Ma X, et al. Associations of occupational stress with job burn-out, depression and hypertension in coal miners of Xinjiang, China: a cross-sectional study. BMJ Open. 2020;10(7):e036087.
13. Hsu CN, Hou CY, Chan JYH, Lee C Te, Tain YL. Hypertension programmed by perinatal high-fat diet: Effect of maternal gut microbiota-targeted therapy. Nutrients. 2019;11(12).
14. Díaz AA, Tringler MF. Prevalence of hypertension in rural populations from Ibero-America and the Caribbean. Rural Remote Health. 2014;14(1).
15. German CA. Implications of the 2017 American College of Cardiology/American Heart

Association Hypertension Guidelines in a Modern Primary Prevention Multiethnic Prospective Cohort (MESA). Am J Cardiol. 2019;123(7):1076–82.

16. Paulose-Ram R, Gu Q, Kit B. Characteristics of U.S. Adults With Hypertension Who Are Unaware of Their Hypertension, 2011-2014. NCHS Data Brief. 2017;(278):1–8.

17. Armario P, Calhoun DA, Oliveras A, Blanch P, Vinyoles E, Banegas JR, et al. Prevalence and clinical characteristics of refractory hypertension. J Am Heart Assoc. 2017;6(12):1–7.

18. Naseem R, Adam AM, Khan F, Dossal A, Khan I, Khan A, et al. Prevalence and characteristics of resistant hypertensive patients in an Asian population. Indian Heart J [Internet]. 2017;69(4):442–6. Available from: http://dx.doi.org/10.1016/j.ihj.2017.01.012

19. Okoth K, Chandan JS, Marshall T, Thangaratinam S, Thomas GN, Nirantharakumar K, et al. Association between the reproductive health of young women and cardiovascular disease in later life: Umbrella review. BMJ. 2020;371.

20. Lu X. The association between perceived stress and hypertension among Asian Americans: does social support and social network make a difference? J Community Heal. 2019;44(3):451–62.

21. Drouin-Chartier JP, Brassard D, Tessier-Grenier M, Côté JA, Labonté MÉ, Desroches S, et al. Systematic review of the association between dairy product consumption and risk of cardiovascular-related clinical outcomes. Adv Nutr. 2016;7(6):1026–40.

22. Chaar LJ, Coelho A, Silva NM, Festuccia WL, Antunes VR. High-fat diet-induced hypertension and autonomic imbalance are associated with an upregulation of CART in the dorsomedial hypothalamus of mice. Physiol Rep. 2016;4(11):1–15.

23. Alvirde-García U. Dyslipidemia and hypertension. Gac Med Mex. 2016;152:56–62.

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To,
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Dear author/s

I have pleasure to inform you that your following Original Article has been accepted for publication in Indian Journal of Forensic Medicine & Toxicology

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With regards

Yours sincerely

Dr R K Sharma
Editor