Association between Gender and Occupation with Hypercholesterolemia Risk among Hypertension Population: A Cross-sectional Study

Muhammad Luthfi Adnan [1*], Yanasta Yudo Pratama [2, *]

[1]Nusa Medika Clinic, Bekasi, West Java, Indonesia

[2]Yogyakarta State University, Sleman, Special Region of Yogyakarta, Indonesia

Corresponding Author :

Muhammad Luthfi Adnan

Nusa Medika Clinic, Bekasi, West Java, Indonesia

Email: luthfiadnan35@yahoo.co.id

ABSTRACT

Metabolic syndrome is one of the major global health problems. Hypertension and hypercholesterolemia are indicators in the diagnosis of metabolic syndrome. However, the analysis of the relationship between risk factors for hypercholesterolemia in the hypertensive population needs further study. This study aims to analyze the risk factors for hypercholesterolemia in hypertensive patients. This cross-sectional study was conducted at Depok 2 Community Healthcare Center with a focus on adult hypertensive patients. The results of blood pressure measurements, total cholesterol examinations, and participant characteristics were then analyzed using the Chi-Square test. 117 hypertensive patients were analyzed in this study with the majority being women (60.7%), elderly (70.1%), and household-based occupancy (70.1%). The majority of participants were diagnosed with grade I hypertension (53.8%) and hypercholesterolemia (59%). Women have higher risk of developing hypercholesterolemia than men (OR 3.38 (95% CI 1.555 – 7.361); p = 0.002), and non-household based occupancy were protective factor from hypercholesterolemia (OR 0.327 (95% CI 0.144 – 0.742); p = 0.008). Gender and occupation are risk factors for hypercholesterolemia in the hypertensive population. Education at the household level is needed for early detection of the risk of metabolic syndrome in the general population.

Keywords: Cardiovascular Risk, Hypercholesterolemia, Hypertension, Metabolic Syndrome, Public Health

Introduction

Currently, there is an increasing incidence of metabolic syndrome (MetS) that has been reported in various countries around the world. In the United States, the prevalence of Mets increased from 32.5% in 2011-2012 to 36.9% in 2016, while in China the incidence of Mets reached 31%.[1,2] In Indonesia, the prevalence of MetS varies in each study between 27.8 - 33.1% based on study location.[3] The diagnosis of MetS is based on five criteria: increased waist circumference, triglycerides, blood pressure, fasting blood glucose, and decreased high-density lipoprotein.[4] MetS plays an important role in increasing the risk of cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM).[4] The increase in MetS is associated with a high incidence of hypertension and hypercholesterolemia, which is influenced by an unhealthy lifestyle and diet.[5]

Hypertension is one of the risk factors for the development of cardiovascular disease. The prevalence of hypertension is estimated to reach more than 30% of the adult population worldwide, with the majority occurring in low- and middle-income countries (LMICs).[6] In Indonesia, the prevalence of hypertension based on the Indonesia Family Life Survey (IFLS-5) is higher than the global prevalence of 33.4%.[7] Several factors such as physical inactivity, high sodium intake, smoking, unhealthy diet, and alcohol consumption contribute to the increase in hypertension coupled with the problem of low levels of assistance.[6,8] Gender differences have been known as non-modifiable risk factors for cardiovascular disease, while in women the increases risk is correlated with age and is related to menopause.[9] In Indonesia, the prevalence of women with hypertension is higher than men (34% vs 31%) [7]. Also, gender differences have different levels of blood pressure control due to difficulties in accessing health care for women and contribute to the increasing development of cardiovascular disease.[10]

Early detection and prevention are main strategies in reducing risk of cardiovascular disease (CVD).[11] CVD develops progressively as the population ages, with a higher risk of complications and lower survival rates in older populations.[12] However, the level of awareness of CVD risk factors is still low in the general population, especially in vulnerable populations who cannot be screened for health because they rarely have access to health care.[13,14] In Indonesia, one of the functions of the community healthcare center as a primary healthcare provider to make public health access easier and prevent the development of non-communicable diseases through early detection.[15] However, not many similar studies are set in primary healthcare, considering that this setting can be the first line of detection of

cardiovascular disease. This study aimed to determine the effect of gender differences on the incidence of hypertension and hypercholesterolemia in public primary health care settings.

Materials and Methods

1. Study design

This cross-sectional study was conducted in the Depok 2 Community Healthcare Center, Sleman, Special Region of Yogyakarta.

2. Ethical statement

This research has received ethical approval from the Ethichal Committee of Faculty of Medicine, Universitas Islam Indonesia No. 28/Ka.Kom.Et/70/KE/Xll/2020.

3. Participants

Participants for this study were adult (age > 18 years) hypertension patient who routinely controlled in primary healthcare facility. The exclusion criteria were patients with hypertensive urgency (SBP higher than 180 mmHg and DBP higher than 120 mmHg) and patient with end organ damage (cerebrovascular disease, chronic kidney disease, and cardiovascular disease) were excluded because need more comprehensive treatment in higher level healthcare facilities.

4. Procedures

Blood pressure was checked with a digital sphygmomanometer. The diagnosis of hypertension is made based on the criteria according to the Joint National Committee (JNC) 7 including normal (systolic blood pressure (SBP) < 120 mmHg or diastolic blood pressure (DBP) 80 mmHg), prehypertension (SBP 120-139 mmHg and/or DBP 80-89 mmHg), hypertension grade I (SBP 140-159 mmHg and/or DBP 90-99 mmHg), and hypertension grade II (SBP 160-179 mmHg and/or 100-110 mmHg) [16]. Cholesterol examination is carried out by taking total cholesterol sample with simple test strips, with classification based on The Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III, or ATP III) namely “normal” total cholesterol (<200 mg/dL), “borderline” (200-240 mg/dL), and “high” (≥240 mg/dL) [17]. In this study, normal and borderline total cholesterol were categorized as “normal”.

5. Statistical Analysis

Population characteristic, blood pressure, and cholesterol level were recorded in table and analyzed using the SPSS version 21 software. Descriptive data were presented with number and percentage, and correlation between hypertensive population characteristic, blood pressure, and cholesterol level were analyzed using the Chi-Square test. The p-value < 0,05 were considered as significant.

Results

A total of 121 participants were recruited in this study. 4 participants had (SBP higher than 180 mmHg and DBP higher than 120 mmHg) and were excluded from data analysis. The average age of the study participants was 62.39 ± 10.15 years with an average SBP and DBP of 148.52 ± 13.80 mmHg and 84.88 ± 10.20 mmHg. The average total cholesterol of the participants was 212.66 ± 44.41 mg/dL. The majority of participants in this study were women (71 people (60.7%), elderly with work at home (household and retired) (82 people (70.1%) in both variables). Based on the diagnosis, the majority of participants in this study had stage I hypertension (63 people (53.8%)) and had hypercholesterolemia (69 people (59%)). The characteristics of the participants are shown in Table 1.

Table 1. Participants characteristic for this study.

Variable	**N (%)**
Gender	
Men	46 (39,3)
Women	71 (60,7)
Age group	
< 60 y.o	35 (29,9)
≥ 60 y.o	82 (70,1)
Occupation-based	
Household	82 (70,1)
Non-household	35 (29,9)
Hypertension grade	
Pre-hypertension	31 (26,5)
Grade I Hypertentsion	63 (53,8)
Grade II Hypertentsion	23 (19,7)

Total cholesterol level	
Normal	48 (41)
Hypercholesterol	69 (59)

Statistical analysis showed that women had a risk of hypercholesterolemia up to three times higher than men (OR 3.38 (95% CI 1.555 – 7.361); p = 0.002). Non-household occupancy basis had a lower risk of hypercholesterolemia than household-based participants (OR 0.327 (95% CI 0.144 – 0.742); p = 0.008). There was no significant relationship between gender and hypertension (p = 0.458). The results of the analysis are shown in Table 2.

Table 2. Association of participant characteristics with hypercholesterolemia risk.

Variable	**Cholesterol level**		**P**	**OR (95% CI)**
	Normal	**Hypercholesterol**		
Gender				
Men	27	19	0,002	3,383 (1,555 – 7,361)
Women	21	50		
Age group				
< 60 y.o	10	25	0,100	0,463 (0,198 – 1,086)
≥ 60 y.o	38	44		
Occupation-based				
Household	27	55	0,008	0,327 (0,144 – 0,742)
Non-household	21	14		
Hypertension degree				
Pre-hypertension	9	22	0,138	0,493 (0,204 – 1,194)
Hypertension	39	47		

Discussion

The results of this study indicate that women with hypertension are more susceptible to hypercholesterolemia than men while increasing the risk of developing cardiovascular and cerebrovascular diseases. Similar results from Brechtel et al (2020) and Iyen et al (2020) also showed that gender is a risk factor for ischemic stroke, especially with increasing age, especially in patients with familial hypercholesterolemia (FH) who are at risk of increasing CVD morbidity at age over 30 years.[18,19] Furthermore, other studies also support the risk of women developing MetS being higher than men, especially in groups that already have previous comorbidities (obesity, hypertension, and diabetes).[20,21] These findings are important for evaluating more aggressive cholesterol treatment in women, especially those who have previously developed comorbidities such as hypertension or diabetes.

The combination of hypertension and hypercholesterolemia have been studied for their correlation to cardiovascular disease and other complications. Both components are contributors to MetS incidence, which is more common in women than in men.[22] Hypercholesterolemia is a higher risk in women because of lower low-density lipoprotein cholesterol target achievement compared to men.[23,24] This condition is related to women's difficulty in accessing cholesterol-lowering medication, although women are also more likely to be obese and have lower physical activity compared to men.[23–25] One meta-analysis showed a linear association between increased CVD mortality and hypercholesterolemia (HR 1.27 (95% CI, 1.19–1.36) based on total cholesterol measurement and HR 1.21 (95% CI, 1.09–1.35) for low-density lipoprotein cholesterol measurement (LDL-C).[26] However, there are differences in study results between gender differences and the development of CVD risk. Study by Kazlauskienė et al (2015) in Lithuania showed differences in the risk of myocardial infarction and stroke in the male population with MetS, including abdominal obesity and higher hypertriglycerides with low high-density lipoprotein cholesterol.[27] While other studies show higher blood pressure and fasting blood sugar in the female population with Mets developing a higher risk of CVD.[28]

The susceptibility of the female population to hypercholesterolemia and other components of the metabolic syndrome can occur from the postmenopausal period.[29] In premenopausal conditions, higher estrogen levels in women are a protective factor from the risk of cardiovascular disease by contributing to the production of nitric oxide (NO) and avoiding blood vessel stiffness due to the pathophysiological process of hypertension.[30] The protective effect of estrogen has also been observed in cardiac function, where estrogen induces

antioxidant activity and activates phosphorylation of aldehyde dehydrogenase 2 (ALDH2), which protects the effects of damage due to ischemic conditions.[31] Also, estrogen protects mitochondria from cardiac structural damage due to infarction, thereby reducing the risk of tachycardia or cardiac fibrillation and reducing the infarct size [31]. Another review explained that women have greater salt sensitivity, regardless of ethnicity or age, due to higher expression of mineralocorticoid receptors in the vascular endothelium, which can increase endothelial dysfunction due to decreased NO production, resulting in increased blood pressure.[32]

In this study, we found that the majority of participants were elderly people aged > 60 years. Several studies have shown useful indicators as predictors of MetS such as visceral adiposity index, lipid accumulation product, and triglyceride/high density lipoprotein (TG/HDL) ratio.[33,34] One study in China showed that the TG/HDL ratio was one of the best predictors of insulin resistance in a non-obese population besides BMI, TC, and TG.[35] Older patients are at risk of functional impairment and are at risk of developing higher comorbidities resulting in recurrent myocardial infarction due to increased cardiovascular risk along with the degenerative process resulting in increased cell oxidation and inflammation.[12,36] In this study, although we did not find an association between age and hypercholesterolemia among hypertensive patients, the prevalence was higher in the elderly population because this cholesterol examination was based on total cholesterol levels which are known to be associated with cognitive function in several studies.[37,38]

Another finding in this study is the higher risk of hypercholesterolemia in household-based occupational activities (housewives, retirees) compared to non-household occupations. In some studies, retirees and women who initially worked to become unemployed can develop a greater risk of metabolic syndrome in addition to the risk due to aging.[39,40] Household activity levels have been associated with physical activity insufficiency in housewives which can be at risk of obesity.[41] While retirees develop increased leisure-time physical activity, especially in populations with a tendency to sedentary lifestyles.[42] Socioeconomic factors such as environment, income, and wealth are also predictors of hypertension risk, especially in retirees.[43] Also, findings by Saat et al (2021) on a population of low-income housewives can develop the risk of obesity, where physical activity interventions show challenges in cholesterol-lowering programs.[41,44] These findings emphasize the need for health promotion at the household level to increase family physical activity, especially in groups with low physical activity to reduce the risk of metabolic syndrome.

Our study also has some limitations. Because our study setting was in a primary healthcare center, we did not perform other important examinations such as anthropometric (weight, height, arm circumference, waist circumference) and laboratory (HDL, LDL, TG) due to time and equipment limitations considering that the study was conducted during service hours that required rapid examination to avoid the risk of disrupting treatment time. We also did not analyze variables related to lifestyle such as diet patterns, so an explanation of the influence of gender requires further study. The sample in this study was small, limiting the generalizability of the conclusions drawn. Further studies in multiple settings both at the primary healthcare level with larger samples are needed to analyze MetS risk factors in the general population.

Conclusions

Among the hypertensive population, women have a higher risk of hypercholesterolemia than men. Non-household occupation is a protective factor from hypercholesterolemia. This finding is related to the level of physical activity and biological factors such as age and menopause. This finding emphasizes the important role of routine examination by healthcare workers in the general population at the primary healthcare center level by targeting some specific groups for early diagnosis and intervention to prevent the development of MetS and its complications in the future.

References

1. Yao F, Bo Y, Zhao L, Li Y, Ju L, Fang H, et al. Prevalence and influencing factors of metabolic syndrome among adults in China from 2015 to 2017. Nutrients. 2021;13(12):1–10.
2. Hirode G, Wong RJ. Trends in the Prevalence of Metabolic Syndrome in the United States, 2011-2016. JAMA. 2020 June 23;323(24):2526.
3. Tahapary DL, Harbuwono DS, Yunir E, Soewondo P. Diagnosing metabolic syndrome in a multi-ethnic country: is an ethnic-specific cut-off point of waist circumference needed? Nutr Diabetes. 2020;10(1):8–11.
4. Suastika K. The challenges of metabolic disorders in Indonesia: Focus on metabolic syndrome, prediabetes, and diabetes. Med J Indones. 2020;29(4):350–3.
5. Nilsson PM, Tuomilehto J, Rydén L. The metabolic syndrome – What is it and how should it be managed? Eur J Prev Cardiol. 2019;26(2_suppl):33–46.

6. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020 Apr 5;16(4):223–37.
7. Peltzer K, Pengpid S. The Prevalence and Social Determinants of Hypertension among Adults in Indonesia: A Cross-Sectional Population-Based National Survey. Int J Hypertens. 2018;2018.
8. Zeng Z, Chen J, Xiao C, Chen W. A global view on prevalence of hypertension and human develop index. Ann Glob Health. 2020;86(1):1–6.
9. Rajendran A, Minhas AS, Kazzi B, Varma B, Choi E, Thakkar A, et al. Sex-specific differences in cardiovascular risk factors and implications for cardiovascular disease prevention in women. Atherosclerosis. 2023 Nov;384:117269.
10. Connelly PJ, Currie G, Delles C. Sex Differences in the Prevalence, Outcomes and Management of Hypertension. Curr Hypertens Rep. 2022;24(6):185–92.
11. Wenger NK, Lloyd-Jones DM, Elkind MSV, Fonarow GC, Warner JJ, Alger HM, et al. Call to Action for Cardiovascular Disease in Women: Epidemiology, Awareness, Access, and Delivery of Equitable Health Care: A Presidential Advisory from the American Heart Association. Circulation. 2022;145(23):E1059–71.
12. Rodgers JL, Jones J, Bolleddu SI, Vanthenapalli S, Rodgers LE, Shah K, et al. Cardiovascular Risks Associated with Gender and Aging. J Cardiovasc Dev Dis. 2019;6(2):19.
13. Aerts N, Anthierens S, Van Bogaert P, Peremans L, Bastiaens H. Prevention of Cardiovascular Diseases in Community Settings and Primary Health Care: A Pre-Implementation Contextual Analysis Using the Consolidated Framework for Implementation Research. Int J Environ Res Public Health. 2022 July 11;19(14):8467.
14. Alshakarah A, Muriyah D, Alsaghir F, Alanzi R, Almalki S, Alsadan S, et al. Awareness and Knowledge of Cardiovascular Diseases and Its Risk Factors Among Women of Reproductive Age: A Scoping Review. Cureus. 2023 Dec 2;
15. Sujarwoto, Maharani A. Participation in community-based healthcare interventions and non-communicable diseases early detection of general population in Indonesia. SSM - Popul Health. 2022 Sept;19:101236.
16. Chobanian A V, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Jama. 2003;5:344–54.

17. National Cholesterol Education Program (US). Expert Panel on Detection and T of HBC in Adults. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). The Program. 2002.
18. Brechtel L, Poupore N, Stoikov T, Roley LT, Emerson JF, Nathaniel T. Comorbidities associated with different levels of total cholesterol in male and female acute ischemic stroke patients. Med U S. 2020;99(52).
19. Iyen B, Qureshi N, Weng S, Roderick P, Kai J, Capps N, et al. Sex differences in cardiovascular morbidity associated with familial hypercholesterolaemia: A retrospective cohort study of the UK Simon Broome register linked to national hospital records. Atherosclerosis. 2020 Dec;315:131–7.
20. Strack C, Behrens G, Sag S, Mohr M, Zeller J, Lahmann C, et al. Gender differences in cardiometabolic health and disease in a cross-sectional observational obesity study. Biol Sex Differ. 2022;13(1):1–11.
21. Choi YJ, Kim GS, Chu SH, Lee KH, Park CG, Sohn M. Metabolic syndrome clustering patterns and the association with cardiovascular disease among post-menopausal Korean women. Sci Rep. 2024;14(1):22702.
22. Ahmed AE, Alsamghan A, Momenah MA, Alqhtani HA, Aldawood NA, Alshehri MA, et al. Metabolic Syndrome and Cardiometabolic Risk Factors in the Mixed Hypercholesterolemic Populations with Respect to Gender, Age, and Obesity in Asir, Saudi Arabia. Int J Environ Res Public Health. 2022;19(22).
23. Vynckier P, Ferrannini G, Ryden L, Jankowski P, De Backer T, Gevaert S, et al. Gender gap in risk factor control of coronary patients far from closing: Results from the European Society of Cardiology EUROASPIRE V registry. Eur J Prev Cardiol. 2022;29(2):344–51.
24. Xia S, Du X, Guo L, Du J, Arnott C, Lam CSP, et al. Sex Differences in Primary and Secondary Prevention of Cardiovascular Disease in China. Circulation. 2020;141(7):530–9.
25. Barone Gibbs B, Hivert MF, Jerome GJ, Kraus WE, Rosenkranz SK, Schorr EN, et al. Physical Activity as a Critical Component of First-Line Treatment for Elevated Blood Pressure or Cholesterol: Who, What, and How?: A Scientific Statement From the American Heart Association. Hypertension. 2021;78(2):E26–37.

26. Jung E, Kong SY, Ro YS, Ryu HH, Shin S Do. Serum Cholesterol Levels and Risk of Cardiovascular Death: A Systematic Review and a Dose-Response Meta-Analysis of Prospective Cohort Studies. Int J Environ Res Public Health. 2022 July 6;19(14):8272.
27. Kazlauskiene L, Butnoriene J, Norkus A. Metabolic syndrome related to cardiovascular events in a 10-year prospective study. Diabetol Metab Syndr. 2015;7(1):1–7.
28. Ramezankhani A, Azizi F, Hadaegh F. Gender differences in changes in metabolic syndrome status and its components and risk of cardiovascular disease: a longitudinal cohort study. Cardiovasc Diabetol. 2022;21(1):1–13.
29. Meloni A, Cadeddu C, Cugusi L, Donataccio MP, Deidda M, Sciomer S, et al. Gender Differences and Cardiometabolic Risk: The Importance of the Risk Factors. Int J Mol Sci. 2023;24(2).
30. Ryczkowska K, Adach W, Janikowski K, Banach M, Bielecka-Dabrowa A. Menopause and women's cardiovascular health: is it really an obvious relationship? Arch Med Sci. 2023;19(2):458–66.
31. Iorga A, Cunningham CM, Moazeni S, Ruffenach G, Umar S, Eghbali M. The protective role of estrogen and estrogen receptors in cardiovascular disease and the controversial use of estrogen therapy. Biol Sex Differ. 2017;8(1):33.
32. Barris CT, Faulkner JL, Belin de Chantemèle EJ. Salt Sensitivity of Blood Pressure in Women. Hypertension. 2023 Feb;80(2):268–78.
33. Li Y, Gui J, Liu H, Guo LL, Li J, Lei Y, et al. Predicting metabolic syndrome by obesity- and lipid-related indices in mid-aged and elderly Chinese: a population-based cross-sectional study. Front Endocrinol. 2023;14(July):65–74.
34. Nie G, Hou S, Zhang M, Peng W. High TG/HDL ratio suggests a higher risk of metabolic syndrome among an elderly Chinese population: A cross-sectional study. BMJ Open. 2021;11(3):1–6.
35. Yang Y, Wang B, Yuan H, Li X. Triglycerides to High-Density Lipoprotein Cholesterol Ratio Is the Best Surrogate Marker for Insulin Resistance in Nonobese Middle-Aged and Elderly Population: A Cross-Sectional Study. Int J Endocrinol. 2021;2021.
36. Dodson JA, Hajduk AM, Murphy TE, Geda M, Krumholz HM, Tsang S, et al. Thirty-day readmission risk model for older adults hospitalized with acute myocardial infarction: The silver-Ami study. Circ Cardiovasc Qual Outcomes. 2019;12(5):1–12.

37. Pang K, Liu C, Tong J, Ouyang W, Hu S, Tang Y. Higher Total Cholesterol Concentration May Be Associated with Better Cognitive Performance among Elderly Females. Nutrients. 2022;14(19):1–17.
38. Chang H Te, Chan PC, Chiu PY. Non-linear relationship between serum cholesterol levels and cognitive change among older people in the preclinical and prodromal stages of dementia: a retrospective longitudinal study in Taiwan. BMC Geriatr. 2024;24(1):1–10.
39. Mirmiran P, Asghari G, Farhadnejad H, Alamdari S, Dizavi A, Azizi F. The Relationship Between Occupation Transition Status and Metabolic Syndrome in Adult Women: Tehran Lipid and Glucose Study. Metab Syndr Relat Disord. 2016 June;14(5):265–71.
40. Runge K, van Zon SKR, Bültmann U, Henkens K. Transitioning out of work and metabolic syndrome incidence: a longitudinal study among 13 303 older workers from the Lifelines Cohort Study and Biobank. J Epidemiol Community Health. 2022 Sept;76(9):779–85.
41. Mohd Saat NZ, Hanawi SA, Farah NMF, Mohd Amin H, Hanafiah H, Shamsulkamar NS. Relationship between physical activity and cardiovascular risk factors: A cross-sectional study among low-income housewives in Kuala Lumpur. Int J Environ Res Public Health. 2021;18(11).
42. Ter Hoeve N, Ekblom M, Galanti MR, Forsell Y, Nooijen CFJ. Unfavourable sedentary and physical activity behaviour before and after retirement: A population-based cohort study. BMJ Open. 2020;10(7):1–7.
43. Neufcourt L, Zins M, Berkman LF, Grimaud O. Socioeconomic disparities and risk of hypertension among older Americans: the Health and Retirement Study. J Hypertens. 2021 Dec;39(12):2497–505.
44. Omar A, Husain MN, Jamil AT, Nor NSM, Ambak R, Fazliana M, et al. Effect of physical activity on fasting blood glucose and lipid profile among low income housewives in the MyBFF@home study. BMC Womens Health. 2018;18(Suppl 1).