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Clinical Profile of Hypertension in Diabetes Mellitus Patients at Surya Melati Muhammadiyah Hospital, Kediri, in 2021

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ABSTRACT

Introduction: The cardiologic and vascular consequences of both diabetes mellitus (DM) and hypertension often occur side by side in a high incidence worldwide. They are primarily caused by the significant overlap of microvascular and macrovascular aberrations, as well as several other factors, making them closely related to one another. A better understanding between these two is needed. This study examined the clinical profile of hypertension in DM patients at Surya Melati Muhammadiyah Hospital, Kediri, in 2021.

Methods: This study employed an observational, descriptive design. The population of the study was patients with DM and hypertension treated at Surya Melati Muhammadiyah Hospital, Kediri, in 2021. This study used a total sampling method. Diabetes mellitus, hypertension, age, and gender were the observed variables. All the necessary data were obtained from the patients' medical records. All statistical data analyses were conducted using Microsoft Excel.

Results: A total of 520 DM patients were included, comprising 185 males and 335 females. Most of them were between 51 and 60 years old, with a total of 233 patients. A total of 277 DM patients with hypertension were included, comprising 89 males and 188 females. Most of them were between 51 and 60 years old, with a total of 121 patients.

Conclusion: The number of DM patients with hypertension exceeded that of DM patients without hypertension. There were more female patients than males. Most of them were elderly.

Highlights:
1. This study presented the clinical profile of hypertension in patients with DM, providing regional data not previously reported in the literature. It emphasized the value of implementing targeted interventions.
2. Discussion of pathophysiological mechanisms explained the link between DM and hypertension.

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Introduction

Systolic blood pressure of 130 mm Hg or higher and/or diastolic blood pressure of greater than 80 mm Hg are considered hypertension. Hypertension is an important risk factor that can increase the mortality and morbidity of many cardiovascular system diseases, such as coronary heart disease, myocardial infarction, heart failure, atrial fibrillation, stroke, kidney failure and peripheral arterial disease.[1, 2]

Approximately 31.1% of adults worldwide suffer from hypertension and this number is almost the same in all socioeconomic level, around 28.5% adults of high-income countries and 31.5% adults of low-income countries. This situation increases to around 60% in the population of people aged over 60 years old.[3,4] By 2025, it is expected that there will be 1.5 billion persons worldwide who have hypertension, up from the projected 972 million in 2000, 65% of whom reside in developing nations.[5] According to recent research, the main reason why hypertension treatment fails is because patients and doctors don't work together to modify lifestyle choices and adhere to medication regimens. This predicament arises because individuals are not adequately informed about therapeutic approaches and the repercussions of not treating their illness or treating it improperly. Furthermore, several studies demonstrate that the vast majority of patients (70–90%) lack adequate awareness about the hazards associated with arterial hypertension and the available therapeutic alternatives.[6]

Diabetes mellitus (DM) is a non-communicable metabolic disease that is synonymous with high blood sugar and the body's inability to control it properly.[7,8] Diabetes mellitus can be influenced by factors such as age, obesity, family history, pre-diabetes, race or ethnicity, metabolic characteristics, behavior, and life style.[9,10] Diabetes mellitus can cause complications such as disorders of the cardiovascular and nervous systems and other targeted organs damage.[7,8] The mortality rate increases 2-3 times in diseases that can be exacerbated by diabetes. Those disease include infections, cancer, cardiovascular disease, stroke, chronic kidney disease and chronic liver disease.[11] Diabetes, especially type 2 diabetes mellitus (T2DM), is acknowledged as an important public health issue because of its critical impact on quality of life and medical costs. The medical cost for DM treatment is at least 3.2 times higher than the average of national healthcare spending for each individual in a nation, and the cost is able to reach approximately 9.4 times higher when the patients have complications caused by it.[12]

Around 415 million adults in 2015, in range of 20-79 years old, had diabetes mellitus.[13] It is estimated that as many as 10 percent of adults worldwide are diabetic patients and 90 percent of them are patients with type 2 diabetes mellitus.[7] From 2000 to 2013, there were 211 million more cases worldwide. From 2013 to 2035, it is estimated that there will be an additional 210 million cases of DM. Almost 11 million adults in Indonesia have been diagnosed as T2DM patient, making it as a country with the seventh highest number of diabetes patients in worldwide.[14,15]

Diabetes and hypertension are interrelated due to characteristic similarities, such as endothelial dysfunction, vascular inflammation, arterial remodeling and atherosclerosis, or similarities in risk factors such as dyslipidemia and obesity. In addition, there is an overlap between hypertension and diabetes in cardiovascular complications. Mismatched of renin-angiotensin-aldosterone system (RAAS) activation and sympathetic nervous systems (SNS), disfunction of mitochondria and aberrant accumulation of reactive oxygen species are some of the molecular factors that contribute to hypertension in diabetic patients. Insulin resistance in diabetic patients has an important part in generating hypertension. Since hypertension is noted by concomitant vascular dysfunction and injury that is happening in the body, it can be concluded as a risk factor for vascular problems that is related to diabetes.[16,17]

Hypertension is more common in diabetic patient than in patient without diabetes. Approximately 50-80% of type 2 diabetes mellitus patients suffer from hypertension, whereas such situation occur in around 30% of type 1 diabetes mellitus. In a study, it was stated that people with type 2 diabetes mellitus aged 45-64 years old were 2.5 times more likely to develop blood pressure higher than normal (hypertension), which was originally a normal blood pressure.[16,17]

This Study examine the clinical profile of hypertension in diabetes mellitus patients because it is valuable for several reasons, as it contributes to our understanding of the intersection between these two common health conditions. It has broad implications for clinical practice, public health, and patient outcomes. It can lead to improved management strategies, better risk prediction, and enhanced overall care for individuals with these coexisting conditions.

Methods

This study design used a observational descriptive study design to describe the hypertension profile in diabetes mellitus patients at Muhammadiyah Surya Melati Hospital, Kediri in 2021. Samples of this study was determined by using the total sampling method. The population in this study were diabetes mellitus patients that were admitted at Muhammadiyah Surya Melati Hospital, Kediri in 2021. The research variable was diabetes mellitus, hypertension, age, and sex. Data was entirely taken from the patient's medical record. All statistical data analyses were conducted using Microsoft Excel.

Results

In this study, a total of 520 Diabetes Mellitus patients were obtained. It was found that the youngest diabetes mellitus patients were in the range of 21-30 years old while the oldest patients were in the range of 81-90 years old. The mean age of all patients was 57.9 years old. There were 9 patients (1.7%) were 21-30 years old, 10 patients (1.9%) were 31-40 years old, 80 patients (15.4%) were 41-50 years old, 233 patients (44 .8%) were 51-60 years old, 79 patients (15.2%) were 61-70 years old, 42 patients

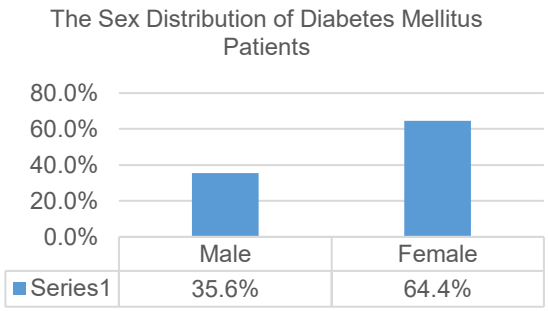
(8.1%) were 71-80 years old, and 7 patients (1.3%) were 81-90 years old. Most of the patients (44.8%) were 51-60 years old, the least were 81-90 years old, which was only 1.3% of the total patients. The age characteristic of diabetic patient is summarized in Table 1.

Table 1. The age frequency of diabetes mellitus patients

Age (Years Old)	Percentage
0-10	0.0%
11-20	0.0%
21-30	1.7%
31-40	1.9%
41-50	15.4%
51-60	44.8%
61-70	15.2%
71-80	8.1%
81-90	1.3%

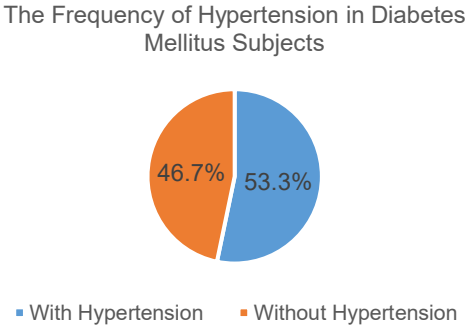
Source: Research data, processed

Based on sex, the diabetic patients was constituted of 185 male patients (35.6%) and 335 female patients (64.4%). The sex characteristic of diabetic patient is summarized in Figure 1.



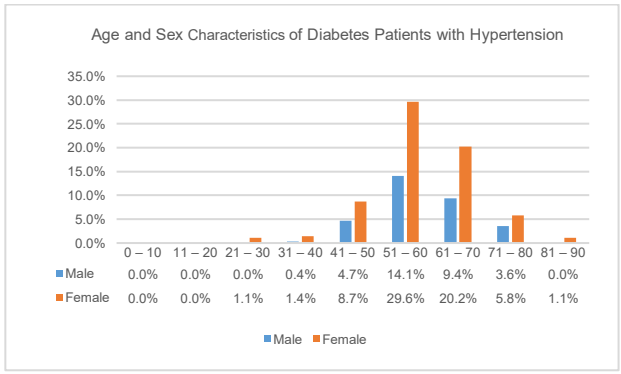
Source: Research data, processed
Figure 1. The sex distribution of diabetes mellitus patients

Of the 520 patients with diabetes mellitus, there were 277 patients (53.3%) with hypertension and 243 patients (46.7%) without hypertension. The hypertension frequency of diabetic patient is summarized in Figure 2.



Source: Research data, processed
Figure 2. Frequency of hypertension in diabetes mellitus patients

The age and sex characteristic of diabetic patients with hypertension are summarized in Figure 3. The youngest patient was 21-30 years old, while the oldest was 81-90 years old. The average age is 58.8 years old. Based on sex, there were 89 male patients (32.1%) and 188 female patients (67.9%). In all age ranges, there were more female than male. They were mostly 51-60 years old as many as 121 patients (39 male, 82 female), while at least were 21-30 years old and 81-90 years old as many as 3 Patients (0 male, 3 female). 31-40 years old were 5 patients (1 male, 4 female). 41-50 years old were 37 patients (13 male, 24 female). 61-70 years old were 82 patients (26 male, 56 female). 71-80 years old were 26 patients (10 male, 16 female).



Source: Research data, processed
Figure 3. Age and sex characteristics of diabetes patients with hypertension

Discussion

In this study, it was found that the frequency of diabetes mellitus patients increased with age, reaching its peak at the age of 51-60 years. then decreased when entering the elderly, from 61-70 years old to 81-90 years old. Age is a risk factor for Diabetes Mellitus besides obesity, lack of physical activity, and family history. Approximately, there are 415 million people (20 to 79 years old) that had diabetes mellitus in 2015. The incidence increased as the people get older. The majority of people with T2DM are over 45 years of age. About 25% of people over the age of 65 suffered from diabetes. If only considering the age, people aged less than 25 years have a low risk, whereas those aged more than 45 years are already at risk of suffering from diabetes mellitus.[7]

From generation to generation, the incidence of diabetes in children and adolescents is getting higher. Metabolic disorders during pregnancy are becoming more common among female as a result of increasing population obesity rates. Someone who had exposures to maternal diabetes during fetal stage (intrauterine) were more likely to be overweight as a children, followed by reduced glucose tolerance as a young adults. As a result, there is a relationship between a history of such exposure and diabetes mellitus that occurs in someone aged 10 to 22 years (OR 5.7, 95% CI 2.4-13.4). Therefore, if there is no early intervention, the diabetes cycle can be carried over to the next generation when they reach childbearing age.

Type 2 diabetes in children, whether child (6 to 12 years old) or adolescents (13 to 18 years old), is still relatively rare, although its incidence is increase significantly as a result of increasing obesity and unhealthy eating habits and lack of exercise.[10] The incidence rate decreases when the elderly are aged compared to the ages of 51-60 years because it is at this age that many people start to die.

This study found that in patients of diabetes mellitus, there are more female patients than male patients. According to IDF 2018, type 2 diabetes was estimated to affect 221 million male and 204 million female globally in 2017. According to historical patterns, the age-standardized prevalence of diabetes (% [95% credible interval]) grew from 4.3% (2.4 , 7.0) in male and 5.0% (2.9, 7.9) in female worldwide between 1980 and 2014. The prevalence may higher in male than female in some regions.[18]

There was no sex difference in the age-standardized type 2 diabetes patients in the US population (male, 12.3% [95% CI 11.3%, 13.4%]; female, 10.8% [95% CI 9.8 %, 11.9%]), whereas there was sex difference in some Chinese populations (p = 0.0001) with the prevalence was 16.1% in male and 14.9% in female. Additionally, there might be sex differences in type 2 diabetes prevalence that change accordingly throughout a person's lifetime as the rates are much higher in childhood for female than for male, then they are very similar later in life for both sexes.[18]

The frequency of diabetes mellitus patients with hypertension increased with age until the age of 51-60 years and decreased from 61-70 years of age. Female have more frequency than male both generally and at all ages. Sex and race can influence the relationship between insulin resistance and diabetes-related hypertension. Up to age 64, males are more likely than females to develop hypertension in non-diabetics, but after that point, the sex gap narrows and the prevalence of females catches up to that of males. It is interesting to note that male with comparably impaired glucose homeostasis have a lower incidence of hypertension than female with impaired glucose tolerance and diabetes.[17]

This study found that there were more diabetes mellitus patients with hypertension than those without it. Diabetes mellitus is associated with the damage of macrovascular (large arteries) and microvascular (small arteries and capillaries). In a study at a primary health center in the Kingdom of Saudi Arabia, microvascular complications had a higher prevalence than macrovascular complications in T2DM patients.[19]

There are several mechanisms that might be the cause. Chronic hyperglycemic state can both increase the formation of advanced glycation end products (AGEs) and activate its receptors, receptors for advanced glycation end products (RAGE), thus inducing abnormal change in AGE-RAGE axis. Besides that, insulin resistance can increase oxidative stress and induce inflammation. All of these conditions are able to give role in the development of vascular damage, thus induce hypertension. In addition, recent studies have shown that a small molecule in cell, microRNAs (miRNAs), may also contribute some roles to diabetic vasculopathy.[16,20] The common risk factor that contributes in the development of hypertension from diabetes state can be seen in Figure 4.

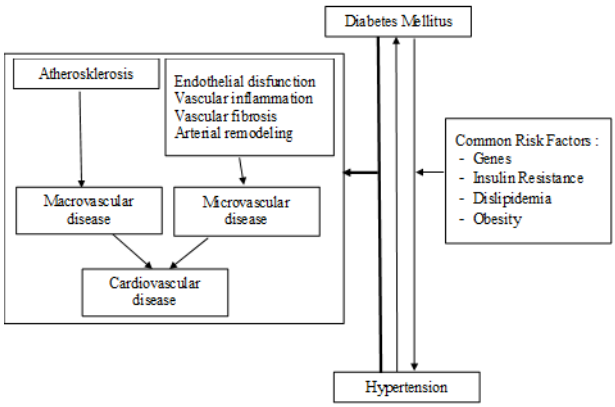


Figure 4. Common risk factor that contributes in the development of hypertension from diabetes state[16]

Hypertension is characterized by vascular dysfunction and injury that is similar to vascular damage happens as a result of diabetes mellitus. Thus, it is a significant risk factor for diabetes-related vascular problems. The strong association between diabetes and cardiovascular disease (CVD) is likely due to common mechanisms including abnormal stimulation of the RAAS pathway and the automatic sympathetic nervous system, oxidative stress, inflammation, and activation of the immune system (Figure 5).[16,17,21]

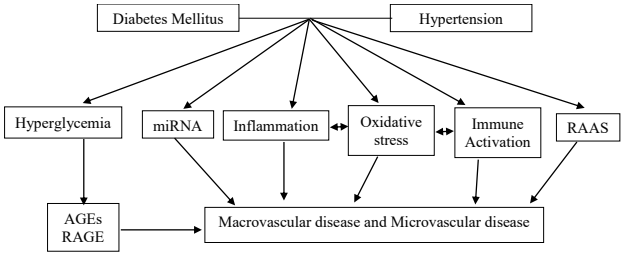


Figure 5. Hypothesized mechanisms via which vascular disease is brought on by diabetes and hypertension[16]

While diabetes and insulin resistance can lead to hardening of the arteries and consequent hypertension and CVD, hypertension itself causes blood vessel remodelling and can cause diabetes. Hyperinsulinemia accompanying insulin resistance may, according to recent findings, operate as a separate risk factor for the hardening of the arteries. Another study investigated the relationship between the arterial stiffness index and measures of serum insulin and glucose tolerance in a biracial sample of 4701 patients (male and female patients between the ages of 45 and 64 years). It was found that patients with abnormal glucose tolerance limits have stiffer arteries compared to those with normal glucose tolerance. It is proposed that a synergistic interaction between high glucose and insulin may have a positive effect on arterial stiffness and be

important in the early pathogenesis of hypertension and CVD in people with type 2 diabetes.[17]

Dysregulation of the intestinal microbiota and renal sodium-glucose cotransporter 2 (SGLT2), as well as abnormal extracellular vesicle discharge (EVs), and inappropriate activation of RAAS and SNS, have been proposed as mechanisms that underlies the development of both insulin resistance and type 2 diabetes-induced hypertension 2 (Figure 7).[17,22]

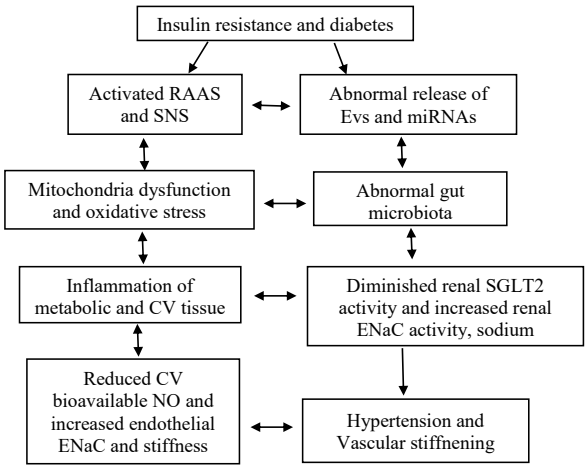


Figure 7. Diabetes, hypertension, and insulin resistance in relation to metabolic syndrome. CV stands for cardiovascular; EnNaC for endothelial sodium channel; and NO for nitric oxide[17]

Changes in lipid profiles and lipoproteins are the main causes of atherosclerosis in T2DM. Atherosclerosis is known to be a risk factor for people with high levels of lipoprotein (a)/Lp (a). According to several research, T2DM macrovascular problems linked to high levels of Lp (a). According to other investigations, the levels of Lp (a) in T2DM patients did not fluctuate and did not link to either arterial stiffness or diabetes state.[23]

Patients with type 2 diabetes frequently have raised LDL levels followed by rising oxidized LDL levels, which lead to kidney fibrosis, oxidative stress, and inflammation. This is a result of leptin levels rising, mechanical stress, and fat buildup in renal sinuses, which have toxic consequences, cause glomerulus hypertrophy, cause podocyte death, and constrict blood arteries in the kidneys.[24]

TNF-alpha is a proatherosclerotic cytokine produced by a number of atherosclerotic cell types, including macrophages, endothelial cells, and smooth muscle cells. The risk of atherosclerotic problems brought on by diabetes-induced inflammation can be assessed using TNF-alpha. Moreover, increasing peripheral tissue insulin resistance is influenced by inflammatory mediators.[25]

Strengths and Limitations

This study offers important details about the age, sex, and Composition of Diabetes Mellitus with and without Hypertension in Research Subjects in a particular region of Indonesia. A reasonably large sample size and greater representativeness of the sample were made possible by the use of medical records as a data source and entire sampling, respectively. The results may not apply to other places or people because the study was only carried out at one public health facility in Indonesia.

Conclusion

Diabetes Mellitus subjects with hypertension are mostly elderly. Diabetes Mellitus subjects with hypertension more than those without hypertension. There were more female subjects than male subjects both as a whole, diabetes mellitus subjects and diabetes mellitus subjects with hypertension.

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Conflict of Interest

The authors declared there is no conflict of interest.

Funding

This study did not receive any funding.

Ethical Clearance

The research was performed in a descriptive study. All research subjects were taken from Diabetes Mellitus patients that were admitted at Muhammadiyah Surya Melati Hospital, Kediri in 2021. The data required for this research is entirely taken from medical record of each patient. Receiving approval from Muhammadiyah Surya Melati Hospital. Ref. No. 0047/KET/III.6.AU/F/I/2023 on 16-01- 2023.

Authors' Contributions

Designed the study, drafted and revised the manuscript: AZNAA. Collected data and performed background literature review: AZNAA. Performed the analysis: AZNAA. Supervised results and discussion: FAP. Drafting the manuscript and revising: FAP.

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