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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 mmHg or higher and/or diastolic blood pressure of greater than 80 mmHg is considered hypertension. Hypertension is a significant risk factor that can increase the mortality and morbidity of many cardiovascular diseases (CVD), 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 at all socioeconomic levels, around 28.5% of adults in high-income countries and 31.5% of adults in low-income countries.[1,3] This situation increases to around 60% in the population of people aged 60 years old and older.[1,3] 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.[4] According to a study, the main reason why hypertension treatment fails is that patients and doctors do not work together to modify lifestyle choices and adhere to medication regimens.[5] This predicament arises because individuals are not adequately informed about therapeutic approaches and the repercussions of not treating their illness or treating it improperly. A previous study demonstrated that the vast majority of patients (70-90%) lack adequate awareness about the hazards associated with arterial hypertension and the available therapeutic alternatives.[5]

Diabetes mellitus (DM) is a non-communicable metabolic disease that is synonymous with high blood sugar and the inability of the body to control it properly.[6,7] It can be influenced by factors such as age, obesity, family history, pre-diabetes, race or ethnicity, metabolic characteristics, behavior, and lifestyle.[8,9] It can cause complications, such as disorders of the cardiovascular and nervous systems, as well as damage to other targeted organs.[6,7] The mortality rate increases 2-3 times in diseases that can be exacerbated by diabetes.[10] Those diseases include infections, cancer, CVD, stroke, chronic kidney disease, and chronic liver disease.[10] Diabetes, especially type 2 diabetes mellitus (T2DM), is acknowledged as an essential 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 national healthcare spending per individual, and the cost can reach approximately 9.4 times higher when patients develop complications.[11]

In 2015, around 415 million adults aged 20-79 years old had DM.[12] It is estimated that as many as 10% of adults worldwide are diabetic patients, and 90% of them are patients with T2DM.[6] From 2000 to 2013, there were 211 million more cases worldwide.[13] From 2013 to 2035, it is estimated that there will be an additional 210 million cases of DM.[13] Almost 11 million adults in Indonesia have been diagnosed as T2DM patients, making it a country with the seventh highest number of diabetes patients worldwide.[13,14]

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. Mismatches in the renin-angiotensin-aldosterone system (RAAS) activation and the sympathetic nervous system (SNS), dysfunction of mitochondria, and aberrant accumulation of reactive oxygen species (ROS) are some of the molecular factors that contribute to hypertension in diabetic patients. Insulin resistance in diabetic patients plays an essential 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 are related to diabetes.[15,16]

Hypertension is more common in diabetic patients than in patients without diabetes. Approximately 50-80% of T2DM patients suffer from hypertension, whereas such a situation occurs in around 30% of type 1 diabetes mellitus (T1DM). In previous studies, it was stated that people with T2DM aged 45-64 years old were 2.5 times more likely to develop blood pressure higher than normal (hypertension), which was initially a normal blood pressure.[15,16]

This study examined the clinical profile of hypertension in DM patients because it is valuable for several reasons, as it contributes to the 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 employed an observational descriptive design to describe the hypertension profile in patients with DM at Surya Melati Muhammadiyah Hospital, Kediri, in 2021. Samples for this study were selected using the total sampling method. The population in this study consisted of patients with DM who were admitted to Surya Melati Muhammadiyah Hospital, Kediri, in 2021. The research variables were DM, hypertension, age, and sex. The data were entirely taken from the patient's medical record. All statistical data analyses were conducted using Microsoft Excel.[17]

Results

In this study, a total of 520 patients with DM were studied. It was found that the youngest DM 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. Nine 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 seven patients (1.3%) were 81-90 years old. Most patients (44.8%) were 51-60 years old, while the least represented group was those aged 81-90 years old,

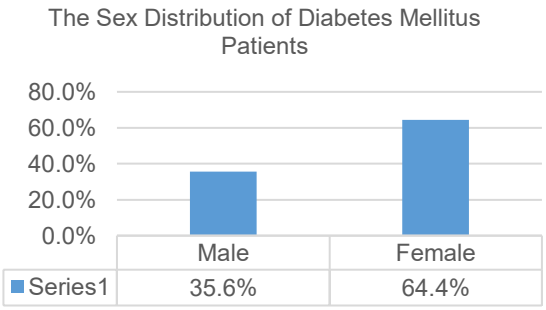
comprising only 1.3% of the total patients. The age characteristic of diabetic patients is summarized in Table 1.

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%

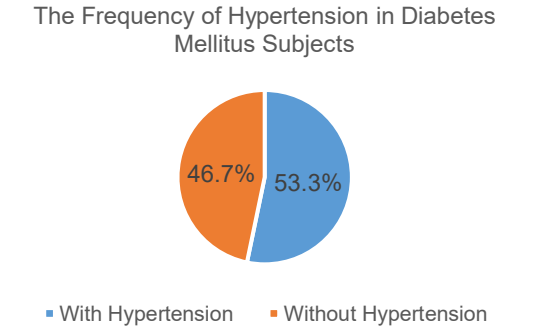
Source: Research data, processed

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



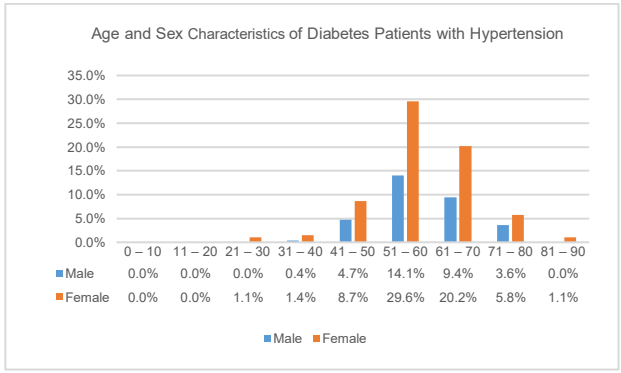
Source: Research data, processed
Figure 1. The sex distribution of diabetes mellitus patients

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



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

The age and sex characteristics 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 was 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 females than males. They were mostly 51-60 years old, with 121 patients (39 males, 82 females). There were also patients aged 21-30 years old and 81-90 years old, with three patients (0 males, 3 females) in each age group. The 31-40 year old group consisted of five patients (one male, four females). The 41-50 year old group consisted of 37 patients (13 males, 24 females). The 61-70 years old group consisted of 82 patients (26 males, 56 females). The 71-80 years old group consisted of 26 patients (10 males, 16 females).



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 DM patients increased with age, reaching its peak at the age of 51-60 years, then decreased as they entered the elderly stage, from 61-70 years old to 81-90 years old. Age is a risk factor for DM aside from obesity, lack of physical activity, and family history. Approximately, there are 415 million people (20 to 79 years old) who had DM in 2015.[6] The incidence increased as people get older. The majority of people with T2DM are over 45 years old. About 25% of people over the age of 65 years old suffer from DM. If only considering the age, people aged less than 25 years old have a low risk, whereas those aged more than 45 years old are already at risk of suffering from DM.[6]

The global population of older adults (those aged 60 years old and above) is expected to continue growing, increasing from approximately 900 million in 2015 to a projected 2 billion by 2050.[9] As age increases, the risk of metabolic syndrome and chronic diseases, including T2DM, also increases. This is related to chronic inflammation that triggers insulin resistance and impaired lipid metabolism, which leads to the accumulation of body fat and increased levels of free fatty acids in the bloodstream. As a result, older adults are more susceptible to T2DM. However, limited studies confirm that aging is an independent risk factor. Some studies suggest that the risk of diabetes increases with age only in overweight individuals, while moderate-intensity physical activity can reduce the risk. Therefore, aging is more appropriately

considered a triggering factor that strengthens the link between other risk factors and diabetes.[9] However, further research is needed to confirm its role as an independent factor.[9] The incidence rate decreases when the elderly are aged compared to those aged 51-60 years old, because it is at this age that many people start to die.

This study found that in patients with DM, there were more female patients than male patients. According to the International Diabetes Federation (IDF) 2018, T2DM was estimated to affect 221 million males and 204 million females globally in 2017.[18] According to historical patterns, the age-standardized prevalence of DM (% [95% CI]) grew from 4.3% (2.4, 7.0) in males and 5.0% (2.9, 7.9) in females worldwide between 1980 and 2014.[18] The prevalence may be higher in males than in females in some regions.[18]

There was no sex difference in the age-standardized T2DM patients in the United States (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.[18] Additionally, there may be sex differences in T2DM prevalence that change throughout a person's lifetime, as the rates are significantly higher in childhood for females than for males, but then become very similar later in life for both sexes.[18]

In this study, the frequency of DM patients with hypertension increased with age until the age of 51-60 years old and decreased from 61-70 years old. Females have a higher frequency than males both generally and at all ages. Sex and race can influence the relationship between insulin resistance and diabetes-related hypertension. Up to age 64 years old, 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.[16] It is interesting to note that males with comparably impaired glucose homeostasis have a lower incidence of hypertension than females with impaired glucose tolerance and DM.[16]

This study found that there were more patients with DM and hypertension than those without it. Diabetes mellitus is associated with damage to both macrovascular (large arteries) and microvascular (small arteries and capillaries) systems. 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] Several mechanisms might be the cause. A chronic hyperglycemic state can both increase the formation of advanced glycation end products (AGEs) and activate their receptors, the receptors for advanced glycation end products (RAGE), thus inducing abnormal changes in the AGE-RAGE axis. Additionally, insulin resistance can increase oxidative stress and promote inflammation. All of these conditions can play a role in the development of vascular damage, thus inducing hypertension. In addition, recent studies have shown that a small molecule in cells, micro ribonucleic acids (miRNAs), may also contribute to diabetic vasculopathy.[15,20] The common risk factor that contributes to the development of hypertension in diabetic states can be seen in Figure 4.

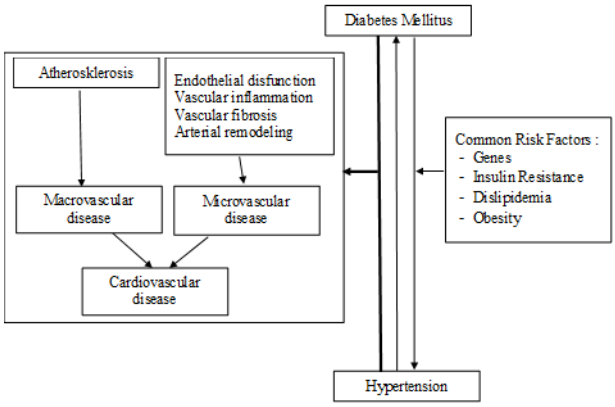


Figure 4. Common risk factors that contribute to the development of hypertension in the diabetic state[15]

Hypertension is characterized by vascular dysfunction and injury similar to that which occurs in DM. Thus, it is a significant risk factor for diabetes-related vascular problems. The strong association between DM and CVD is likely due to common mechanisms, including abnormal stimulation of the RAAS pathway and the autonomic sympathetic nervous system, oxidative stress, inflammation, and activation of the immune system (Figure 5).[15,16,20]

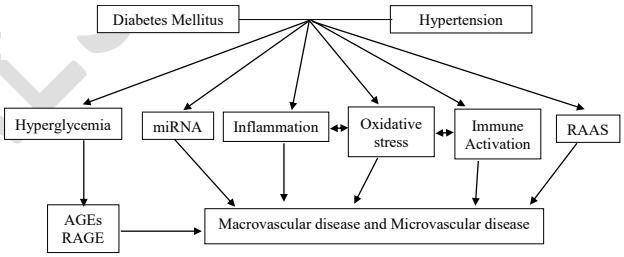


Figure 5. Hypothesized mechanisms via which vascular disease is brought on by diabetes and hypertension.[15] miRNA: micro ribonucleic acids;RAAS: renin-angiotensin-aldosterone system; AGEs: advanced glycation end products; RAGE: receptors for advanced glycation end products.

While DM and insulin resistance can lead to hardening of the arteries and consequent hypertension and CVD, hypertension causes blood vessel remodeling and can cause DM. Insulin resistance, which often accompanies hyperinsulinemia, may, according to recent findings, act as a separate risk factor for atherosclerosis.[16] Another study investigated the relationship between the arterial stiffness index and measures of serum insulin and glucose tolerance in a biracial sample of 4,701 patients (male and female patients aged 45-64 years old).[16] It was found that patients with abnormal glucose tolerance limits had stiffer arteries compared to those with normal glucose tolerance.[16] 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 T2DM.[16]

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 underlie the development of both insulin resistance and T2DM-induced hypertension 2 (Figure 6).[16,21]

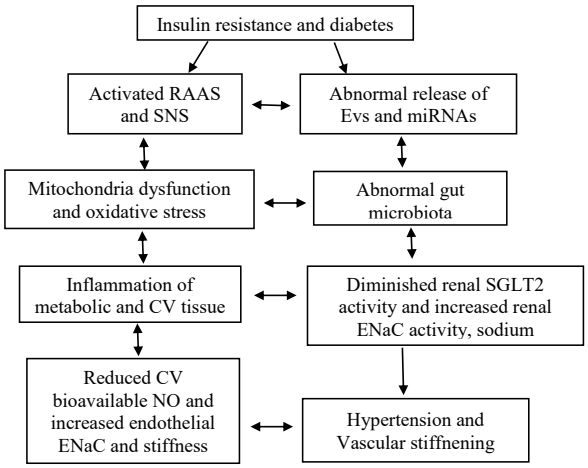


Figure 6. Diabetes, hypertension, and insulin resistance are associated with metabolic syndrome.[16] RAAS: renin-angiotensin-aldosterone system; SNS: sympathetic nervous system; miRNA: micro ribonucleic acids; CV: cardiovascular; SGLT2: sodium-glucose cotransporter 2; EnNaC: endothelial sodium channel; NO: nitric oxide.

Changes in lipid profiles and lipoproteins are the primary causes of atherosclerosis in T2DM. Atherosclerosis is known to be a risk factor for people with high levels of lipoprotein (a)/Lp (a).[22] According to several studies, T2DM macrovascular problems are associated with high levels of Lp(a). According to another study, the levels of Lp(a) in T2DM patients did not fluctuate and were not associated with either arterial stiffness or the diabetic state.[22]

Patients with T2DM frequently have elevated low-density lipoprotein (LDL) levels, followed by rising oxidized LDL levels, which contribute to kidney fibrosis, oxidative stress, and inflammation. This is a result of increased leptin levels, mechanical stress, and fat accumulation in renal sinuses, which have toxic consequences, leading to glomerular hypertrophy, podocyte death, and constriction of blood arteries in the kidneys.[23]

Tumor necrosis factor (TNF)-α is a proatherosclerotic cytokine produced by several atherosclerotic cell types, including macrophages, endothelial cells, and smooth muscle cells. The risk of atherosclerotic problems associated with diabetes-induced inflammation can be assessed using TNF-α. Moreover, increasing peripheral tissue insulin resistance is influenced by inflammatory mediators.[24]

Strengths and Limitations

This study provides important details about the age, sex, and composition of DM with and without hypertension in research subjects in a specific region of Indonesia. A reasonably large sample size and greater representativeness of the sample were made possible by using medical records as a data source and the entire population as the sampling frame, respectively. The results may not apply to other locations or individuals, as the study was conducted at a single public health facility in Indonesia.

Conclusion

Diabetic mellitus subjects with hypertension are mostly elderly. Diabetic subjects have hypertension more than those without hypertension. There were more female subjects than male subjects, both overall and among DM subjects and those with DM and hypertension.

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Conflict of Interest

The authors declared there is no conflict of interest.

Funding

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Ethical Clearance

This study had received approval from Surya Melati Muhammadiyah Hospital, Kediri (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 and revising the manuscript: FAP.

Data Availability

N/A.

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