



Study of Incidence of Hypertension in Type II Diabetes and It's Correlation

Nur Nunu Prihantini ^{a*}, Kurniyanto ^a
and Putu Moradha Kharisma Putri ^a

^a Faculty of Medicine, Universitas Kristen Indonesia, Jakarta, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: to evaluate the relationship between Type 2 Diabetes Mellitus (T2DM) patients and the incidence of hypertension at the Indonesian Christian University Hospital from 2020-2022.

Study Design: The design used in this study was analytical and observational. The approach is cross-sectional, data collection uses medical records of patients registered at the Indonesian Christian University RSU in 2020-2022.

Place and Duration of Study: The location of data collection was carried out at the Christian University RSU Indonesia which will be held in May 2024.

Methodology: The population in this study were all diabetes mellitus patients with either outpatient or inpatient status hospitalized at the Indonesian Christian University General Hospital 2020–2022, while samples were taken using a total sampling technique with a total sample of 112 patients. Data collection took the form of secondary data, namely medical records of T2DM patients at the Indonesian Christian University General Hospital for the period 2020-2022.

*Corresponding author: Email: nur.nunu@uki.ac.id;

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Results: The results showed that 80.4% of patients suffered from T2DM, while 19.6% did not suffer from DM. The highest prevalence of hypertension patients was in grade 1 hypertension, which was 63.4%. In addition, the age group ≥ 66 years has the highest prevalence of hypertension at 40.7%, and female gender dominates with 66.3% of hypertensive patients. Statistical analysis using the Chi-square test showed a significant relationship between T2DM and hypertension ($p = 0.000$). However, 71.4% of the T2DM patient group experienced more hypertension than Non-DM patients.

Conclusion: Based on these results, although there is a statistical relationship between T2DM and the incidence of hypertension, age, and gender factors still have a significant effect on the prevalence of hypertension. That indicates the need for further monitoring of high-risk patients with hypertension, especially among T2DM patients.

Keywords: Type 2 diabetes mellitus, hypertension, incidence hypertension.

1. INTRODUCTION

The prevalence of Diabetes Mellitus (DM), which is a chronic, progressive hyperglycemic condition continues to grow globally (International Diabetes Federation, 2019). According to the International Diabetes Federation (IDF) in 2021, the prevalence is 10.5% of adults aged 20-79 years in the world, around 537 million people suffer from DM. At that time, Indonesia's DM sufferers reached 19.5 million people, the 5th country with the highest number of DM sufferers in the world related to its complications (International Diabetes Federation, 2021). According to 2018 Basic Health Research data, DKI Jakarta province had the highest number of DM sufferers in Indonesia, amounting to 3.4% (Pangribowo, 2020). Based on general categories, DM can be classified as Type 2 Diabetes Mellitus (T2DM) (American Diabetes Association, 2014).

The prevalence of T2DM continues to increase worldwide as more and more lifestyle factors are associated with low energy expenditure and high-calorie consumption, especially in low-income and developing countries. It is estimated that the number of T2DM cases will increase from 415 million to 642 million this year 2040 (Ogurtsova et al., 2017). The cause of T2DM is not fully known but exists relationship with increasing age, ethnicity, and genetics.² Apart from that, some risk aspects can be changed, such as dyslipidemia, obesity or excess body weight, lack of physical activity, stress, smoking habits, and unhealthy eating patterns, for example consuming alcohol, coffee, and caffeine, (Alam et al., 2021; Ismail et al., 2021). Uncontrolled hyperglycemia in DM can cause complications, both acute and chronic. These acute complications include hypoglycemia, diabetic ketoacidosis, and conditions of high blood sugar with high osmolarity (hyperosmolar hyperglycemia). Chronic microvascular such as

nephropathy and retinopathy, while chronic macrovascular includes Coronary Artery Disease (CAD), Peripheral Arterial Disease (PAD), and cerebrovascular. Every year it can be estimated that 1.4 to 4.7% of diabetes sufferers experience cardiovascular disease (CVD) (Akalu & Birhan, 2020; Patoulias et al., 2020).

T2DM is characterized by a condition of hyperglycemia resulting from the body's cells being unable to fully respond to insulin (insulin resistance) (International Diabetes Federation, 2021). Hyperglycemia conditions often arise with metabolic syndrome, one of which is hypertension because blood sugar affects the rise and fall of blood pressure.¹⁰ Hyperglycemia causes intravascular fluid resistance which results in hypervolemia accompanied by damage to the vascular system which results in higher peripheral arterial resistance, which is the basis of hypertension (Ohishi, 2018). A person suffering from hypertension occurs if their systolic or diastolic blood pressure exceeds 140 mmHg or 90 mmHg. Two out of three people with DM have hypertension (Pavlou et al., 2018). According to Riskesdas data (2018), there is an increase in the prevalence of hypertension in Indonesia, with 34.1% of the population of around 260 million experiencing this condition (Riskesdas Ministry of Health of the Republic of Indonesia, 2018). For this reason, the author is interested in carrying out research to determine and determine the relationship between T2DM and the incidence of hypertension at the Indonesian Christian University General Hospital in 2020-2022.

2. MATERIALS AND METHODS

The design used in this study was an analytical observational and cross-sectional approach, data collection used patient medical records recorded at the Indonesian Christian University General Hospital in 2020-2022.

2.2 Research Location and Time

2.2.1 Research location

The location data collection was carried out at the Christian University RSU Indonesia.

2.2.2 Research time

The research was carried out in May – August 2024.

2.3 Research Population and Sample

2.3.1 Research population

The population for this study is all outpatients and inpatients at the Indonesian Christian University RSU 2020–2022.

2.3.2 Research Sample

The sample for this research is total sampling. There were 112 cases of outpatient and inpatient treatment at RSU UKI from 2020 to 2022 which met the inclusion criteria in this study.

2.4 Research Criteria

2.4.1 Inclusion criteria

- Patients who have blood pressure records.
- Recorded in the medical records of the Indonesian Christian University General Hospital from 2020 – 2022.
- Age > 25 years.

2.4.2 Exclusion criteria

- Incomplete demographic data.
- Incomplete medical records.

2.5 Data Retrieval

The secondary data needed comes from the medical records of T2DM patients at the Indonesian Christian University General Hospital for 2020 - 2022. To produce data that will be used later in this study, researchers will select the data according to inclusion and exclusion criteria.

2.6 Data Analysis Methods

Data collection and processing used the SPSS ver.26 application. Univariate and bivariate analyses will be used in this research. The data collection will explain the frequency, highest value, lowest value, and maximum value of the research variables will be identified through univariate analysis. The purpose of the bivariate analysis is to analyze the relationship between the T2DM variable and the Hypertension variable using the Chi-Square Test.

3. RESULTS AND DISCUSSION

3.1 Research Result

Data was collected from May to August 2024. In this case, data was obtained from medical records in the 2020-2022 period, it was found that 112 patients underwent treatment at the internal medicine clinic at the Indonesian Christian University General Hospital. Tables & figures should be placed inside the text. Tables and figures should be presented as per their appearance in the text. It is suggested that the discussion about the tables and figures should appear in the text before the appearance of the respective tables and figures. No tables or figures should be given without discussion or reference inside the text.

Table 1. Distribution of T2DM Patients Based on Age

Age (year)	T2DM			
	No		Yes	
	Frequency (n)	Percentage (%0	Frequency (n)	Percentage (%0
26 – 35	0	0	1	1.1
36 – 45	1	4.5	4	4.4
46 – 55	6	27.3	15	16.7
56 – 65	9	40.9	30	33.3
≥ 66	6	27.3	40	44.4
Total	22	100	90	100

3.2 Univariate Analysis

Univariate analysis aims to explain the distribution of patients for each research variable. In this study, the distribution of T2DM and hypertension patients was described by univariate analysis based on sociodemographic characteristics, including age and gender. The results of the univariate analysis are shown in Tables 1 to 7.

The data in Table 1 shows that the distribution of T2DM patients is based on age. From the age variable, it is known that the highest number of T2DM patients was in the age group ≥ 66 years, namely 40 people (44.4%) and the lowest was in the 26 - 35 year age group, 1 person (1.1%).

Table 2 is a description of the distribution of hypertensive patients based on age. From the age variable, it is known that the highest number of hypertensive patients is in the ≥ 66 year old

group, namely 35 people (40.7%) and the lowest is in the 26 - 35 year old group, 0 people (0%).

Table 3 is a description of the distribution of T2DM patients based on gender. Referring to the gender variable, the number of female sufferers reached 58 people (64.4%) suffering from T2DM, while the total number of men was 32 people (35.6%).

Table 4 is a description of the distribution of hypertensive patients according to gender. Based on the gender variable, the number of female sufferers reached 57 people (66.3%) suffering from hypertension, whereas there were 29 male sufferers (33.7%).

Table 5 is a description of the distribution of patients suffering from T2DM. From the T2DM variable, it is known that the number of T2DM patients was 90 people (80.4%) and the number of patients without T2DM was 22 people (19.6%).

Table 2. Distribution of Hypertension Patients Based on Age

Age (year)	Hypertension			
	No		Yes	
	Frequency (n)	Percentage (%0)	Frequency (n)	Percentage (%0)
26 – 35	1	3.8	0	0
36 – 45	1	3.8	4	4,7
46 – 55	4	15.4	17	19,8
56 – 65	9	34.6	30	34,9
≥ 66	11	42.3	35	0,7
Total	22	100	86	100

Table 3. Distribution of T2DM Patients Based on Gender

Gender	T2DM			
	No		Yes	
	Frequency (n)	Percentage (%0)	Frequency (n)	Percentage (%0)
Male	14	63.6	58	64.4
Female	8	36.4	32	35.6
Total	22	100	90	100

Table 4. Distribution of Hypertension Patients Based on Gender

Gender	T2DM			
	No		Yes	
	Frequency (n)	Percentage (%0)	Frequency (n)	Percentage (%0)
Male	15	57.7	57	66.3
Female	11	42.3	29	33.7
Total	26	100	86	100

Table 5. Distribution of Patients Based on T2DM

T2DM	Frequency (n)	Percentage (%)
No	22	19.6
Yes	90	80.4
Total	112	100

Table 6. Distribution of Patients Based on Hypertension Level

Hypertension Level	Frequency (n)	Percentage (%)
Normal	26	23.2
Pre-Hypertension	10	8.9
Hypertension level-1	71	63.4
Hypertension level-2	5	4.5
Total	112	100

Table 6 is a description of the distribution of patients based on blood pressure levels. From the blood pressure variable, it is known that the most patients in the grade 1 hypertension group reached 71 people (63.4%), the normal group reached 26 people (23.2%), the pre-hypertension group reached 10 people (8.9%) and the lowest number was in the hypertension group. degree 2, namely 5 people (4.5%).

3.3 Bivariate Analysis

The purpose of this analysis is to determine the relationship between the independent and dependent variables. The independent variable studied was T2DM sufferers, while the dependent variable was hypertension patients. Bivariate analysis is described in the following table with the Chi-Square statistical test.

Table 7. Distribution of Hypertensive Patients

Hypertension	Frequency (n)	Percentage (%)
No	26	23.2
Yes	86	76.8
Total	112	100

Table 8. Relationship between T2DM and Hypertension

T2DM	Hypertension		Total	p-value
	No	Yes		
No	16 (14.3%)	6 (5.4%)	22 (19.6%)	0.000
Yes	10 (8.9%)	80 (71.4%)	90 (80.4%)	
Total	26 (23.2%)	86 (76.8%)	112 (100%)	

Table 9. Relationship between age and the incidence of T2DM

Age (year)	T2DM		Total	p-value
	No	Yes		
26 – 35	0 (0%)	1 (0.9%)	1 (0.9%)	0.580
36 – 45	1 (0.9%)	4 (3.6%)	5 (4.5%)	
46 – 55	6 (5.4%)	15 (13.4%)	21 (18.8%)	
56 – 65	9 (8.0%)	30 (26.8%)	39 (34.8%)	
≥ 66	6 (5.4%)	40 (35.7%)	46 (41.1%)	
Total	22 (19.6%)	90 (80.4%)	112 (100%)	

Based on Table 8, it was found that 80 respondents (71.4%) experienced this T2DM and hypertension. It is known that the Pearson Chi-Square value is 0.000 ($p < 0.05$). In this study, it was discovered that there was a significant relationship between T2DM patients and the incidence of hypertension.

Table 9 shows the Pearson Chi-Square value of 0.580 ($p > 0.05$). In the study, it was found that there was no relevant relationship between age and T2DM. From the age variable, it is known that the highest number of T2DM patients aged ≥ 66 years was 40 people (35.7%) and the very lowest at the age of 26 – 35 years, namely 1 person (0.9%).

Table 10 shows the Pearson Chi Square value of 0.470 ($p > 0.05$). In this study it was found that there was no relevant relationship between age and the incidence of hypertension. From the age variable, it is known that the highest number of hypertensive patients aged ≥ 66 years, namely 35 people (31.3%).

Table 11 shows the Pearson Chi-Square value of 0.943 ($p > 0.05$). In this study, it was found that there was no relevant relationship between gender and T2DM. From the gender variable, it is known that the highest number of T2DM patients was in the female group, namely 58 people (51.8%).

Table 10. Relationship between age and the incidence of hypertension

Age (year)	Hypertension		Total	p-value
	No	Yes		
26 – 35	1 (0.9%)	1 (0%)	1 (0.9%)	0.470
36 – 45	1 (0.9%)	4 (3.6%)	5 (4.5%)	
46 – 55	4 (3.6%)	17 (15.2%)	21 (18.8%)	
56 – 65	9 (8.0%)	30 (26.8%)	39 (34.8%)	
≥ 66	11 (9.8%)	35 (31.3%)	46 (41.1%)	
Total	26 (23.2%)	86 (76.8%)	112 (100%)	

Table 11. Relationship between gender and the incidence of T2DM

Gender	T2DM		Total	p-value
	No	Yes		
Female	14 (12.5%)	58 (51.8%)	72 (64.3%)	0.943
Male	8 (7.1%)	32 (28.6%)	40 (35,7%)	
Total	22 (19.6%)	90 (80.4%)	112 (100%)	

Table 12. Relationship between gender and the incidence of hypertension

Gender	Hypertension		Total	p-value
	No	Yes		
Female	15 (13.4%)	57 (50.9%)	72 (64.3%)	0.423
Male	11 (9.8%)	29 (25.9%)	40 (35,7%)	
Total	26 (23.2%)	86 (76.8%)	112 (100%)	

Table 7 is a description of the distribution of hypertensive patients. From the hypertension variable, it is known that the number of hypertensive patients was 86 people (76.8%) and the number of non-hypertensive patients was 26 people (23.2%).

Table 12 shows the Pearson Chi-Square value of 0.423 ($p > 0.05$). In this study, it was stated that there was no relevant relationship between gender and the incidence of hypertension. From the gender variable, it is known that the highest number of hypertension sufferers is women 57 people (50.9%).

3.4 Discussion

In the results of this study, T2DM occurred most often in female patients, namely 58 (51.8%) and 40 patients aged ≥ 66 years (35.7%). The results of this study are in line with a study conducted by Kurniawati (2021), the number of patients diagnosed with T2DM was highest in female patients and elderly patients, this shows that T2DM is more common in women because it has a very large chance of increasing BMI and the risk of obesity, which can interfere with insulin sensitivity and is also influenced by the hormone estrogen when entering post-menopause

(Kurniawati et al., 2021). When entering old age, physiological functions The body will change due to aging. Death of pancreatic beta cells causes increased production of insulin and glucose in the liver, as well as insulin resistance and decreased insulin secretion (Fajar, Stevani, & Kamarrudin, 2020).

Based on the results of research carried out at the Indonesian Christian University RSU in 2020-2022, the age variable found that the highest number of hypertensive patients was in the age group ≥ 66 years, namely 35 people. The results are in accordance with Ririhena (2023) where in 2020 to 2022 at RSU UKI found that, of 100 patients with hypertensive heart disease, patients aged 65-74 years were 39 people (39%), those aged ≥ 75 years, namely 21 people (21%) and 55-64 years, namely 16 people (16%) (Ririhena, 2023). In research conducted by Dinda (2020), $p = 0.004$ was obtained when comparing the elderly age group with the adolescent age group. The results of this study state that there is a relevant relationship between elderly age and hypertension (Ayukhaliza, 2020). According to Lemauk Research (2022), it was found that most hypertensive patients were aged 55-64 (35%) and aged 65-74 (27%), and blood pressure increased because large arteries became less

elastic and stiffened as they got older.age (Lemauk, 2022).

The results of this study were that the prevalence of hypertension was highest in the range 56-65 and ≥ 66 years. It can be said that as the age progresses the prevalence of hypertension in RSU UKI increases. In the results of this study, hypertension was most common in female patients, namely 57 (50.9%) while in male patients it was 29 (25.9%). This is thought to be because the hormone estrogen protects women who have not yet entered menopause and helps increase HDL levels, women are more likely to develop hypertension in old age than men. In premenopausal women, the hormone estrogen gradually begins to disappear, which has been preventing damage to blood vessels. High and low levels of LDL and HDL cholesterol have an impact on atherosclerosis and increased blood pressure (Novitaningtyas, 2014). According to research results by Meidikayanti et al, states that when women experience menopause there will be a change in the hormone estrogen to become lower so the insulin sensitivity response decreases which can increase the risk of suffering from T2DM (Meidikayanti & Wahyuni, 2017). These results are in line with research by Ririhena (2023) where from 2020 to 2022 at RSU UKI found that, of 100 patients with hypertensive heart disease, 54 women (54%) and 46 men (46%). Apart from that, a study conducted by Kusumawaty et al stated that the prevalence of hypertension is closely related to gender. Hypertension occurs more often in older women and blood pressure increases in menopausal women (Kusumawaty, 2016).

The results of the univariate analysis showed that the number of T2DM respondents was 90 people (80.4%) and the number of non-T2DM respondents was 22 people (19.6%). In the study results, the incidence of hypertension occurred more frequently in grade 1, namely 71 people (63.4%), the normal group was 26 people (23.2%) and the lowest number of respondents was in grade 2 hypertension, namely 5 (4.5%). JNC VII states that grade 1 hypertension occurs because blood pressure is more than 140/90 mmHg to 159/99 mmHg, and grade 2 occurs when blood pressure reaches $\geq 160/100$ mmHg (National High Blood Pressure Education Program, 2003). People with grade 1 hypertension usually never undergo examination at a hospital or health center because they do not experience significant symptoms. This is following Lemauk's (2022) research on grade 1

hypertension of 76 (66%) respondents, grade 2 hypertension of 21 (18%) respondents, and pre-hypertension of 18 (16%) respondents.

In the statistical test results of the relationship between T2DM and the incidence of hypertension at the Indonesian Christian University General Hospital in 2020–2022, the result was $p=0.000$. With this, there is a relevant relationship between T2DM and the incidence of hypertension. Therefore, the null hypothesis (H_0) can be rejected. The results of this study are in line with Winta et al, through the Spearman Rank test that the p value = 0.017, which means there is a substantial relationship between blood sugar levels and blood pressure in T2DM patients (Winta et al., 2018). These results indicate that uncontrolled blood sugar levels can triggers various comorbidities, both acute and chronic. Narrowed blood vessel damage reduces blood flow to the kidneys, nerves, eyes, and other parts of the body, which is a common cause of diabetes complications (Rahayuningsih et al., 2022).

During the oxidation process, proteins in the blood vessel walls react with blood sugar, and high levels of sugar will later stick to the blood vessel walls, resulting in the formation of AGEs (Advanced Glycosylated Endproducts). AGEs are compound bonds formed in the combination of blood sugar and protein. As a result, the inner walls of blood vessels are damaged, resulting in cholesterol sticking and an inflammatory reaction occurring. The walls of blood vessels harden and become stiff due to plaque formed by platelet cells, leukocyte cells and other materials that accumulate to form plaque. Furthermore, blockages are formed, which causes blood pressure to change or hypertension (Tanto & Hustrini, 2014; Winta et al., 2018). The results of the bivariate analysis are in line with Amin et al's research which states with a significance level of 0.00 that there is a correlation between blood glucose levels and blood pressure. A person tends to have high blood pressure if their glucose levels are also high. Therefore, research by Raphaeli (2017) found that there was no significant correlation between blood sugar levels when with systolic and diastolic blood pressure (Raphaeli, 2017).

The results of statistical tests regarding the relationship between age and T2DM were found to be $p=0.580$ ($p>0.05$), that there is no relevant relationship between age and T2DM, because today's unhealthy lifestyles result in more and

more people being obese and T2DM appearing at a young age. In Rohmatulloh et al's (2024) research, a p-value of 0.397 ($p > 0.05$) was obtained which stated that there was no relationship between age and the incidence of T2DM (Rohmatulloh et al., 2024). This result was different from Rosita et al (2022) in their research which showed that there was a relationship between age and T2DM (p -value 0.046 < 0.05) (Rosita et al., 2022). In the statistical test results of the relationship between age and the incidence of hypertension, it was found that $p = 0.470$ ($p > 0.05$), that there was no significant correlation between age and hypertension. In Melika et al's research, it was found that $p = 0.75$, so there was no significant correlation between age and hypertension (Melika & Firdaus, 2023). However, in Muhammad et al's research, the p value = 0.000, meaning there was a relationship between age and the incidence of hypertension. As age increases, the aging process occurs which results in an increase in systolic blood pressure, mean arterial pressure and pulse pressure (Yunus et al., 2021).

The statistical test results for the relationship between gender and T2DM show $p = 0.943$, that there is no relevant correlation between gender and T2DM, because both women and men can get T2DM due to unhealthy eating patterns and lifestyles. In Rohmatulloh et al's (2024) research, the score was $p = 0.470$, meaning there was no relationship between gender and the incidence of T2DM (Rohmatulloh et al., 2024). This result is different from Rosita et al's (2022) research, where the result was $p = 0.012$, meaning that if there is a correlation between gender and T2DM and based on the Prevalence Odds Ratio value, women have a 2.15 times greater risk of developing T2DM than men (Rosita et al., 2022). The results of statistical tests on the relationship between gender and the occurrence of hypertension showed a score of $p = 0.423$, that there was no relevant correlation between gender and hypertension. These results are in accordance with research by Muhammad et al, obtained a p value = 0.841 or there is no correlation between gender and hypertension (Yunus et al., 2021).

However, in Nurhayati et al's research on the correlation test with the Spearman Rank test, it was found that $p = 0.000$, so H_1 was accepted and H_0 was rejected, so it could be concluded that there was a relevant correlation between gender and the incidence of hypertension,

because menopausal women experience decreased estrogen levels (Nurhayati et al., 2018).

4. CONCLUSION

From the research results, conclusions were obtained including: 1) The highest number of patients suffering from T2DM was found to be ≥ 66 years old, namely 40 people (44.4%) and 35 people suffering from hypertension (40.7%); 2) The highest number of patients suffering from T2DM were women, 58 people (64.4%) and 57 people suffering from hypertension (66.3%); 3) The number of T2DM patients is 90 people or 80.4%; 4) The number of hypertensive patients was found to be the highest degree hypertensive patients 1 as many as 71 people or 63.4%; 5) The number of hypertensive patients is 86 people or 76.8%; 6) The number of T2DM patients suffering from hypertension was found to be 80 people (71.4%); 7) There is a significant relationship between T2DM and the incidence of hypertension. This is proven by the results of bivariate analysis which found a p -value of 0.000 ($p < 0.05$); 8) There is no relevant relationship between age and T2DM. This is proven by the results of the bivariate analysis test which found a p -value of 0.580 ($p > 0.05$); 9) There is no relevant relationship between age and the incidence of hypertension. This is proven by the results of the bivariate analysis which found a p -value 0.470 ($p > 0.05$); 10) There is no relevant relationship between gender and T2DM. This is proven by the results of bivariate analysis which found a p -value of 0.943 ($p > 0.05$); 11) There was no relevant relationship between gender and hypertension rates. This can be seen from the results of bivariate analysis, it was found that the p -value was 0.423 ($p > 0.05$).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

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