

# Ankle Brachial Index in Diabetic Patients

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**Abstract:** *Chronic hyperglycemia in diabetes mellitus (DM) can induce micro and macrovascular complications. The study aimed to determine the blood pressure and Ankle Brachial Index (ABI) in diabetic patients in Badung Tengah, Indonesia. The study was conducted with a cross-sectional study method on subjects recorded as DM patients in eight community health care centers in Badung Tengah. In 140 of the total participant, the mean brachial systolic pressure was  $143.79 \pm 21.57$  mmHg and  $85.62 \pm 11.42$  mmHg for brachial diastolic pressure. Most people with diabetes had stage II hypertension (65%), and stage I hypertension (19%). The average ABI was  $1.23 \pm 0.15$ , with a high ABI category of 30% and 2.86% of people with diabetes experiencing peripheral artery disease (PAD). The ABI findings in this study are slightly better compared to the results of ABI in other studies may be due to the sample size, the tools, the method, and study design. Diabetic patients tend to have high blood pressure, which stages II hypertension more frequent than stage I hypertension. The ABI index in most diabetic patients in Badung Tengah was standard.*

**Keywords:** Blood Pressure, Ankle Brachial Index, Diabetes mellitus

## 1. Introduction

Non-communicable diseases are a public health problem, both globally, regionally, nationally, and locally. Among those that take up a lot of attention are Diabetes Mellitus (DM) and hypertension. Threats arise due to diseases and the complications they cause. Lately, both types of diseases have increased very rapidly. The International Diabetes Organization or International Diabetes Federation estimates that in 2013, there were 382 million people with diabetes in the world. This number is expected to increase rapidly to 592 million by 2035 [1].

The number of DM in Indonesia in 2014 reached 9.1 million. This result ranked Indonesia as 5th country as the most DM country in the world. The number of DM in Indonesia is expected to increase to 14.1 in 2035 [2].

The rapid increased in DM occurs as a result of changes in traditional-rural behavior [3]. One area in Bali that is experiencing traditional-rural development is Central Badung. The Head of the Bali Regency Health Office stated that out of nine regencies/cities in Bali, prominent cases of DM occurred in Badung Regency [4].

The incidence of hypertension in the world is much higher compared to diabetes mellitus. World Health Organization (WHO) reported that in 2008, around 1 billion (40%) of adults aged 25 years and over worldwide had been diagnosed with hypertension. The incidence of hypertension is likely to increase to 29.2% in 2025 [5].

The prevalence of hypertension in Indonesia is slightly lower than the world prevalence. Based on the Riskesdas 2013 data, the prevalence of hypertension in Indonesia is 25.8%. The prevalence is expected to continue to increase. The National Health Indicator Survey (Sirkesnas) in 2016 showed that the prevalence of hypertension increased by 32.4% in the population aged 18 years and above [6].

Hypertension is a comorbid disease that is quite common in diabetes mellitus. Research shows that the prevalence of hypertension in DM is 12.7% compared to 9.7% in non-DM patients [7]. The risk of hypertension in patients with DM reaches 1.5-3 times higher compared to patients in the general population [8].

Cardiovascular complications in DM are also triggered by dyslipidemia, endothelial damage, and neuropathy. Dyslipidemia results in blocking of blood flow, especially in the lower extremities, whereas endothelial damage and neuropathy result in reduced blood vessel elasticity. Blockage of blood vessels and impaired its elasticity marked by changes in the Ankle Brachial Index (ABI) in DM. The prevalence of ABI with a low category in DM reaches 4.47% experienced by men and 4.67% in women. ABI with a high category reaches 14% in men and 10.45% in women [9].

Cardiovascular complications in DM can be prevented by controlling hypertension and avoiding disruption of blood flow to the lower extremities (ABI). Therefore, this study aims to determine the picture of blood pressure and ABI in a diabetic patient in Central Badung.

## 2. Materials and Methods

The study was conducted with a cross-sectional study method in eight community health care centers in Badung Tengah, Bali Indonesia, during July - August 2018. Based on medical records, as many as 140 subjects (with diabetes) can be traced. Measurements were made at the subject's residence using a digital sphygmomanometer. The blood pressure classification used in this study refers to the American Heart Association (AHA) classification in 2017, namely: (1) normal (systolic pressure  $<120$  mmHg and diastolic pressure  $<80$  mmHg); (2) Elevated (systolic pressure  $120 - 129$  mmHg and diastolic pressure  $<80$  mmHg); (3) stage 1 hypertension (systolic pressure  $130 - 139$  mmHg or diastolic pressure  $80-89$  mmHg); (2) stage 2

hypertension (systolic pressure > 140 mmHg or diastolic pressure > 90 mmHg). The Ankle Brachial Index is classified into 5, namely: (1) Peripheral Arterial Disease (PAD) if ABI < 0.90, (2) Borderline (ABI 0.90-0.99), (3) Low normal ABI (ABI 1, 00 - 1.09), (4) ABI normal (ABI 1.10 - 1.29), and (5) ABI high (ABI > 1.30). It was taken by calculating the systolic ankle pressure, divided by the systolic brachial pressure. The highest pressure of the two arteries at the ankle and two brachial arteries were used, without doppler. All procedures performed in studies involving humans were by the ethical standards of the institution or practice at which the studies were conducted No: LB.02.03/EA/KEPK/0258/2018.

### 3. Result

In this study, the youngest was 35 years old, and the oldest was 91 years old. The average number of people with diabetes was 61.71 ± 0.67 years, with 95% CI 60.37-63.04 years. The average duration of DM diagnosis was 6.45 years. The diabetic patient was distributed in 8 Community health care centers in Badung Tengah. Most of the participants were male (52.14%), female (47.86). The gender description of the subjects according to the community health care center working area is presented in Table 1.

**Table 1:** Research subjects by gender

No	Community Health Centers	Gender		n
		Male	Female	
1.	Abiansema I	9	7	16
2.	Abiansema II	18	12	30
3.	Abiansema III	9	10	19
4.	Abiansema IV	10	9	19
5.	Mengwi I	2	7	9
6.	Mengwi II	14	2	16
7.	Mengwi III	9	15	24
8.	Kuta Utara	2	5	7
9.	Total	73	67	140

\*n=number of participant

The distribution of systolic brachial pressure is presented in Table 2.

**Table 2:** Distribution of systolic brachial pressure

No	Systolic Pressure	n	%	Cum Freq <	%
1	90 – 99	1	0.71	140	100
2	100 – 109	3	2.14	139	99.29
3	110 – 119	13	9.29	136	97.14
4	120 – 129	18	12.86	123	87.86
5	130 – 139	25	17.86	105	75
6	140 – 149	28	20	80	57.14
7	150 – 159	24	17.14	52	37.14
8	160 – 169	8	5.71	28	20
9	170 – 179	8	5.71	20	14.29
10	180 – 189	9	6.43	12	8.57
11	190 – 199	1	0.71	3	2.14
12	200 - 209	2	1.43	2	1.43
	Total	140	100		

\*n=number of the participant; Cum Freq= Cumulative frequency

The brachial diastolic pressure distribution is presented in table 3.

**Table 3:** Distribution of brachial diastolic pressure

No	Diastolic Pressure	n	%	Cum Freq <	%
1	50 – 59	2	1.43	140	100
2	60 – 69	7	5	138	98.57
3	70 – 79	26	18.57	131	93.57
4	80 – 89	51	36.43	105	75
5	90 – 99	41	29.29	54	38.57
6	100 – 109	9	6.43	13	9.29
7	110 – 119	4	2.86	4	2.86
	Total	140	100		

\*n=number of participant; Cum Freq= Cumulative frequency

The classification of blood pressure of people with diabetes based on AHA 2017 is presented in Table 4.

**Table 4:** Distribution of blood pressure

No	Blood pressure classification	n	%
1	Normal BP	14	10
2	Elevated BP	8	6
3	Hypertension Stage I	27	19
4	Hypertension Stage II	91	65
	Total	140	100

\*n=number of participant; BP= blood pressure

The ABI classification is presented in Table 5.

**Table 5:** Distribution of ABI classification in Diabetic patients

No	ABI Classification	n	%
1	PAD (ABI < 0,9)	4	2,86
2	Borderline (ABI 0,90-0,99),	2	1,43
3	Low Normal (ABI 1,00 – 1,09)	21	15
4	Normal ( ABI 1,10 – 1,29)	71	50,71
5	High (ABI > 1,03)	42	30
	Total	140	100

\*ABI= ankle-brachial index; PAD= peripheral arterial disease; n=number of participant

### 4. Discussion

The average age is not much different from the average DM patients in Langsa Public Hospital, which is 58.03 ± 7.29 [10]. The results of the Basic Health Research also found that the prevalence of DM was the highest in the age group of 55 years and above. At the age of 60 years, the aging process becomes faster, which results in the body's failure to maintain homeostasis. Indeed, impaired glucose tolerance has begun at the age of 30 years. Thus, increasing age causes the disorder to get worse so that the prevalence of DM increases [11]. In this study, the average systolic pressure is lower than the results of other studies that found an average systolic pressure of 147.49-162,12 mmHg [12]. The findings of this study indicate the unsuccessful control of blood pressure in people with diabetes in Badung Tengah. Indicators of controlling blood pressure in DM in Indonesia are systolic pressure less than 140 mmHg and diastolic pressure less than 90 mmHg [13]. Blood pressure control targets of DM in Indonesia are in line with JNC VIII. JNC VIII recommends the administration of antihypertensive drugs if DM patients have systolic pressure > 140 mmHg and diastolic pressure >90 mmHg. These limits are a bit laxer than the AHA recommendations, which target hypertension control in DM 130/80 mmHg [14].

The prevalence found in this study is higher than the prevalence of hypertension in DM in Indonesia. The prevalence of hypertension in DM in Indonesia reaches 40% at the age of 45 years and increases to 60% at the age of 75 years [15]. Hypertension can occur together with DM (comorbid) or can be caused due to insulin resistance and impaired kidney function in DM [16]. Prolonged hyperglycemia due to DM stimulates the formation of reactive oxygen species (ROS). ROS cause endothelial damage. Endothelial damage can include thickening of the basement membrane, arteriolar thrombosis, increased platelet aggregation, and reduced erythrocyte deformability. The presence of hypertension in DM will aggravate endothelial dysfunction and increase the risk of coronary heart disease. Coronary arteries experience early atherosclerosis, interstitial fibrosis, the formation of collagen, and hypertrophy of heart muscle cells. The results found one-third of DM women and one-fifth of DM male patients experience coronary heart disease [12]. Considering the risks that can be caused by hypertension in DM, patients with blood pressure > 120/80 are recommended to make lifestyle changes [2].

The ABI findings in this study are slightly better compared to the results of ABI in other studies that found ABI in males of 1.14 and 1.089 in females, maybe due to the sample size, the tools to obtain the blood pressure, the method and study design [17].

The prevalence of PAD in this study is lower than other studies, which found a PAD prevalence of 3.7% [17]. The prevalence of PAD in ten community health care centers in Medan city reaches 44% [18]. PAD is a chronic complication that can trigger diabetic foot. Until now, diabetic foot is still one of the main problems in Indonesia because the amputation rate reaches 30%, the mortality rate is 32%, and (80%) as the leading cause of diabetes has to be hospitalized. Diabetic foot requires treatment costs 1.3 to 1.6 million rupiahs per month [19].

## 5. Conclusion

Diabetic patients tend to have high blood pressure, which stages II hypertension more frequent than stage I hypertension. The ABI index in a most diabetic patient in Badung Tengah was normal.

## 6. Conflict of Interest

None

## 7. Acknowledgment

None

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