ORIGINAL RESEARCH ARTICLE

Jurnal Radiologi Dentomaksilofasial Indonesia April 2026, Vol. 10, No. 1: 218-223
P-ISSN.2685-0249 | E-ISSN.2686-1321

http://jurnal.pdgi.or.id/index.php/jrdi/index

Analysis of mandibular length, width, and height in patients with hypertension and type II diabetes mellitus

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ABSTRACT

Objectives: This study aimed to analyze the mandible's length, width, and height in patients with hypertension and T2DM through panoramic radiography.

Materials and Methods: This study used the observational analytical description method, which has been used in this study with a cross-sectional approach. The sample consisted of 48 panoramic radiographs from 24 patients with hypertension and T2DM, divided into two age groups: those under 60 and those 60 years or older. The radiographs were analyzed using ImageJ to measure the mandible's length, height, and width, and the results were averaged.

Results: The study found no significant differences in the length, width, or height of the mandible between the disease groups or the age groups.

Conclusion: The mandible's length, width, and height values in hypertension and T2DM do not show statistically significant differences. This explains that the bone quality between patients with hypertension and T2DM is not much different.

Keywords: *Hypertension, type 2 diabetes mellitus, mandibular morphology, panoramic radiography, ImageJ*
Cite this article: Romdlon MA, Epsilawati L. *Analysis of mandibular length, width, and height in patients with hypertension and type II diabetes mellitus*. Jurnal Radiologi Dentomaksilofasial Indonesia 2026;10(1):218-223. https://doi.org/10.32793/jrdi.v10i1.1378

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Received on: April 2025
Revised on: April 2026
Accepted on: April 2026

INTRODUCTION

Hypertension is a medical condition characterized by elevated blood pressure, defined as having a systolic pressure of 140 millimeters of mercury (mmHg) or higher and a diastolic pressure of 90 mmHg or above.[1] The global prevalence of hypertension is approximately 1.28 billion cases, primarily affecting individuals aged 30–79 years. Research indicates that a significant proportion of adults with high blood pressure, approximately 46%, are unaware of their condition. Consequently, only about 20% of adults successfully manage their hypertension effectively. Furthermore, surveys have shown that hypertension is a major contributor to premature mortality worldwide.[2] In Indonesia, the 2018 Riskesdas report revealed that the prevalence of hypertension was 34.1% among individuals aged 18 years and older, 31.6% in the 31–44 age group, 45.3% in the 45–54 age group, and 55.2% in the 55–64 age group.[3] Based on these data, it can be concluded that a significant portion of the Indonesian population suffers from hypertension.

Diabetes mellitus is a widespread systemic disease with significant global prevalence. It is a metabolic disorder characterized by abnormally elevated blood glucose levels, medically referred to as hyperglycemia. The disease is classified into two primary types: Type 1 and Type 2 Diabetes Mellitus. Type 1 Diabetes Mellitus (T1DM) is a specific condition in which the pancreas experiences severe impairment in insulin production, resulting in extremely low or virtually no insulin generation.[4] Type 2 diabetes mellitus (T2DM) occurs due to insulin resistance, which leads to excessive glucagon secretion. T2DM is caused by mutations in pancreatic genes, particularly those responsible for beta-cell dysfunction, which results in impaired insulin secretion.[5] According to the 2018 Riskesdas report, there was a 2% increase in T2DM cases over the past 15 years, particularly among the younger age group (individuals over 15 years old), compared to 2013.[3]

Patients with hypertension and T2DM often require long-term treatment involving medication. One of the drugs commonly used to treat hypertension is a calcium channel blocker, also known as amlodipine. The use of this drug in Indonesia is widespread due to its affordability and inclusion in the list of medications covered by Indonesian health insurance. However, research suggests that using calcium channel blockers may negatively affect bone health, as these drugs tend

to inhibit calcium absorption in the blood, leading to calcium deficiency in bones. The longer this condition is, the more it will cause a decrease in the quality of bones.[6,7] In contrast to the problem with T2DM, in T2DM, physiologically, there is a disturbance in the absorption of calcium in the intestine, and the body will compensate for its needs by demineralizing calcium from bone. As a result, the bone density will decrease or become of poor quality.[8]

Dentists are healthcare professionals responsible for providing dental and oral health services to the community. Detecting the presence of hypertension and T2DM in patients is crucial, as it is directly related to the treatment that will be administered. One detection method involves assessing the macro and microstructure of bones through panoramic radiography.[9,10] Numerous researchers have conducted comprehensive analyses of bone quality, employing various measurement techniques to assess bone characteristics. These methods include vertical measurements and examinations of the mandibular angle as key indices for evaluating bone structure.[11] Macrostructural analysis of the bones, which is often done, measures the length, width, and height of the mandible, and by knowing these three measurements, we can see the quality of bone density.[12] This study aimed to analyze the condition of bone macrostructure in patients with hypertension and T2DM and compare the two to see which one affects the bone more between the two diseases.

MATERIALS AND METHODS

This research uses descriptive analysis with an observational method and a cross-sectional approach. The sample consisted of all panoramic radiographic data from hypertensive and T2DM patients available at the time of the study. The total population obtained was 48 radiographs for each group. The data were then categorized based on age into two groups: Adults (<60 years) and Advanced Adults (≥60 years). Measurements of the mandible's length, height, and width were conducted on panoramic radiographs using Fiji ImageJ software. The data were recorded in Microsoft Excel and subsequently analyzed using IBM SPSS Statistics 24. The Shapiro-Wilk normality test was applied because the sample size was <50, and the Mann-Whitney test was used to assess group differences.

The researchers measured the dimensions of the mandible, specifically recording the length, width, and height on both the right and left sides. These measurements were then processed by calculating the average values for each parameter, resulting in a single representative value for the mandible's length, width, and height. The assessment was performed by an intraobserver (the researcher themselves) and an extraobserver (a specialist in dentomaxillofacial radiology). The collected data were averaged for further analysis. The mandibular length is measured from the highest point of the lower border of the ramus, where it is joined to the body of the mandible (Antegonion/Ag), to the midpoint of the mandible (Midpoint/M), which is determined by being projected parallel to the vertical plane of the ANS. This is illustrated in Figure 1. The mandibular width is measured from the highest alveolar crest to the lowest point of the mandibular body through the mental foramen. The measurement process is demonstrated in an illustration in Figure 2. The mandibular height was measured from the highest point of the head of the condyle (Condylion or Co) to the most postero-inferior point at the angle of the mandible (Gonion or Go), as shown in Figure 3.

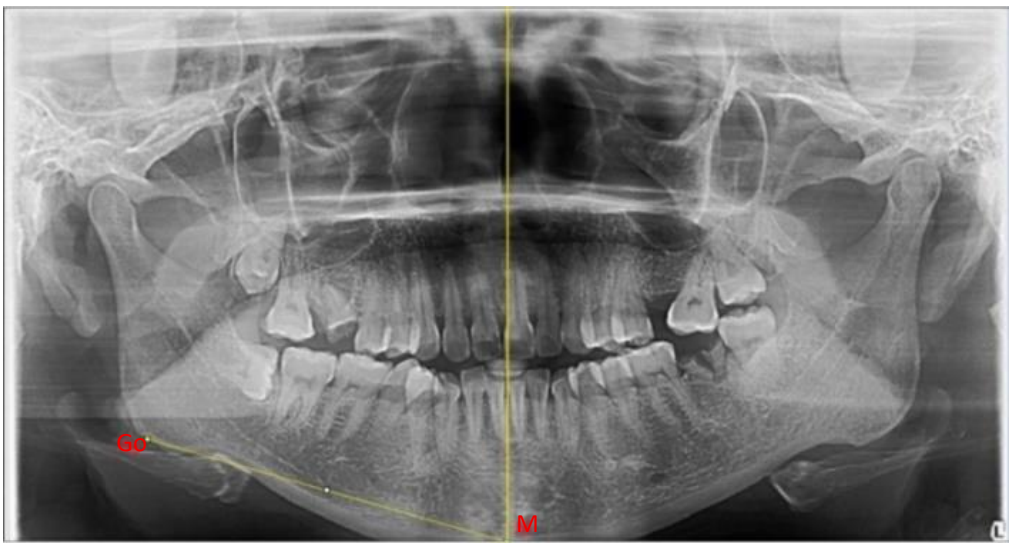

Figure 1. This figure illustrates how to measure mandibular length. The mandibular width was measured from the gonion (Go), the most lateral and inferior point of the mandibular angle, to the midpoint of the mandible (Midpoint/M), which was obtained by projecting parallel to the vertical plane of the ANS. Source: Processed Primary Data

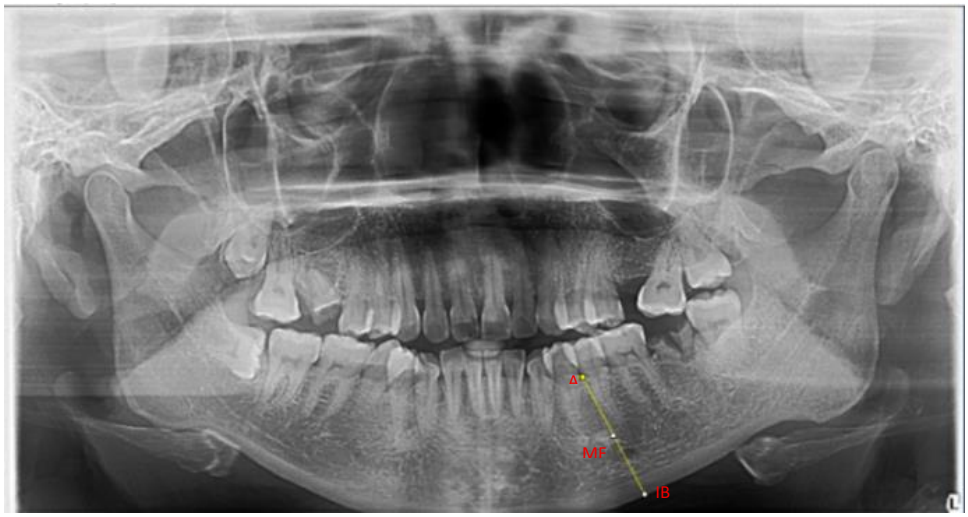

Figure 2. Shows an illustration of how to measure the mandibular width. The width of the mandible is measured from the highest alveolar crest (A) to the inferior point of the body of the mandible (IB) through the mental foramen (MF). Source: Processed Primary Data

Figure 3. Shows an illustration of how to measure the mandibular width. Mandibular height was measured from the highest point of the head of the condyle (Condylion) or Co to the most postero-inferior point at the angle of the mandible (Gonion) or Go. Source: Processed Primary Data

RESULTS

Table 1. Measurement results for patients with hypertension and T2DM

Disease	Age (yr)	Sample	Characteristic	Average (mm)
Hypertension	< 60	12	Mandibular Height	7,89
			Mandibular Length	10,27
			Mandibular Width	3,44
	>60	12	Mandibular Height	7,96
			Mandibular Length	10,57
			Mandibular Width	3,48
Type 2 Diabetes Mellitus	<60	12	Mandibular Height	7,86
			Mandibular Length	9,13
			Mandibular Width	3,47
	>60	12	Mandibular Height	7,63
			Mandibular Length	9,96
			Mandibular Width	3,37

Based on the data in Table 1, the average height and width of the mandible are shown to have the same value in patients with hypertension, both in the age group > 60 years and < 60 years, with only a 0.1 mm difference in value, while the width is moderate. In T2DM patients, the measurement results on the three characteristics have no significant difference, with an average difference of <1 mm.

Jurnal Radiologi Dentomaksilofasial Indonesia 2026; 10 (1); 218-223 | DOI: https://doi.org/10.32793/jrdi.v10i1.1378

Table 2. Normality Test Results for Hypertensive Patients and T2DM

Disease	Age (yr)	Sample	Characteristic	Sig.
Hypertension	< 60	12	Mandibular Height	.084
			Mandibular Length	.000
			Mandibular Width	.448
	>60	12	Mandibular Height	.107
			Mandibular Length	.964
			Mandibular Width	.710
Type 2 Diabetes Mellitus	<60	12	Mandibular Height	.349
			Mandibular Length	.026
			Mandibular Width	.370
	>60	12	Mandibular Height	.346
			Mandibular Length	.041
			Mandibular Width	.387

Based on the normality test results in Table 2, the data were not normally distributed, as the significance value exceeded 0.05. Therefore, the Mann-Whitney test was performed for differential analysis.

Table 3. Test Differences between length, width, and height in patients with hypertension and T2DM

Characteristic	Asymp. Sig. (2-tailed)
Mandibular Length HT < 60 years **Mandibular Length HT > 60 years**	.664
Mandibular Width HT < 60 years **Mandibular Width HT > 60 years**	.542
Mandibular Height HT < 60 years **Mandibular Height HT > 60 years**	.600
Mandibular Length T2DM < 60 year **Mandibular Length T2DM > 60 year**	.234
Mandibular Width T2DM < 60 year **Mandibular Width T2DM > 60 year**	.188
Mandibular Height T2DM < 60 year **Mandibular Height T2DM > 60 year**	0.57

The results of the Mann-Whitney test, presented in Table 3, demonstrate the differences in length, width, and height between patients with hypertension and T2DM. Based on Table 3, the data shows that the p-value> 0.05, which means there is no significant difference in length, width, and height between age groups in each disease.

Table 4. Test the differences in length, width, and height among patients with hypertension and T2DM. Test between groups

Characteristic	Sample	Asymp. Sig.
Mandibular L W H with HT<60	12	.474
Mandibular L W H with T2DM<60	12	
Mandibular L W H with HT<60	12	.370
Mandibular L W H with T2DM>60	12	
Mandibular L W H with HT>60	12	.209
Mandibular L W H with T2DM<60	12	
Mandibular L W H with HT>60	12	.197
Mandibular L W H with T2DM>60	12	

The test differences in length, width, and height among patients with hypertension and T2DM between groups are presented in Table 4. Based on the Mann-Whitney test, the p-value was greater than 0.05, indicating no significant difference was proven between patients with hypertension and T2DM.

DISCUSSION

The mandibular bone macrostructure measurements in patients with hypertension and Type 2 Diabetes Mellitus (T2DM) have not been widely conducted. However, numerous studies on bone quality in these two diseases have been reported using different measurement techniques. The research findings reveal that the morphometric measurements of mandibular dimensions, including length, width, and height, show minimal variation between patients diagnosed with hypertension and those with T2DM. The study suggests a notable similarity in mandibular morphology between these two patient groups. These values also indicate that, in both diseases, mandibular bone morphology in terms of length, width, and height is nearly identical in both the <60-year and ≥ 60-year age groups. This implies a similarity in morphological values between the two diseases. However, these findings do not conclusively explain whether there is a decline in bone quality based on the results of bone morphology. The values only describe morphological similarities between patients with hypertension and T2DM.

Epsilawati et al.'s research on mandibular cortical bone height in T2DM patients compared with the Indonesian population standard found no significant difference in mandibular cortical height between T2DM patients and the normal population, as the difference was only approximately 0.1 mm.[13] In a similar study, Epsilawati et al compared the alveolar bone height in T2DM patients and found that the reduction in alveolar bone height was less pronounced than the reduction in cortical bone height.[14] This study also confirmed that the decline in bone quality occurs more rapidly in spongy bone than in compact bone, such as dense cortical bone. Research on bone quality was also described by David et al., who explained a significant change in the size of the Antegonial Index (AI) and Gonial Index (GI) of T1DM and T2DM patients compared to non-diabetic patients.[15]

He et al. explained that in hypertension, there is a correlation between changes in calcium metabolism, increased calcium loss, activation of the parathyroid glands, and increased movement of calcium from bone.[16] This condition causes an imbalance in calcium homeostasis, resulting in a decrease in bone density. Husein and Fatah conducted a study comparing cortical thickness in the gonial area between non-hypertensive and hypertensive patients.[17] The results showed statistically significant differences between the two groups, with non-hypertensive patients having thicker cortical plates. Another study describing the effect of antihypertensive drugs on bone was conducted by Takaoka et al. In their research, it was explained that there was an increased risk of fracture in users of antihypertensive drugs, especially in postmenopausal women with complications of type 2 diabetes.[18] A meta-analysis conducted by Ye in 2017 also confirmed that hypertension affects bone mineral density (BMD) reduction, which increases the risk of fracture.[19]

Some of these studies demonstrate that patients with hypertension and diabetes mellitus (DM) experience a decline in bone quality, particularly in bone microstructure. This can be explained through research on mandibular cortical and alveolar bone quality. Several studies have shown significant differences in bone quality between patients with hypertension and Type 2 Diabetes Mellitus (T2DM) compared to the normal population. However, macrostructural research, particularly on the mandible's length, width, and height, does not reveal significant differences between the two diseases or when compared to the morphology of the normal Indonesian population. No studies have been found that specifically measure these macrostructural parameters.

Another possible explanation for the lack of difference between the two diseases could be that the patients included in this study all had controlled conditions, and the duration of their illness was not recorded. As a result, it is unclear how long the patients had been affected by hypertension or metabolic disorders associated with T2DM. This aligns with a study by Patil et al., which found that patients with controlled T2DM showed no significant changes in bone density.[20]

Some studies, such as Javed et al., suggest that the use of antihypertensive drugs has no significant effect on bone quality.[21] Found no correlation between bone mineral density (BMD), bone density, or bone quality and hypertension. This study was conducted on an elderly African-American female population. Similarly, Kaplan et al. investigated the relationship between postmenopausal women's blood pressure (BP) and bone mineral density (BMD).[22] Their results demonstrated no association between BP and BMD, regardless of menopausal status or the type of BP measurement (systolic or diastolic blood pressure). Another study conducted by Lary et al. explained that there was no correlation between antihypertensive drugs, calcium beta blockers, and bone mineral density.[23] There was no significant difference in this study, but based on the theory, the mandible size of older humans will change. This is in accordance with the research conducted by Ozturk et al., which examined the age of the mandible.[24] In this study, it was explained that the size of the mandibular body from gnation to gonion showed a change according to the level of age and status of the teeth. Still, when measuring the gonial angle, there was no difference in size according to the age and status of the teeth. The decrease in bone that occurs along the inferior border of the body and the posterior border of the body is caused by the loss of masticatory strength with increasing age. Another study from Mughals et al. also explained that after the age of 40 years, the bone density of the skeleton will decrease, and by the age of 65 years, one will lose up to a third of bone mineral.[25] Theoretically, as humans age, physiological changes occur in the mandible. The condition of muscle function and habitual factors can also affect bone resorption.[3] Bone resorption

Jurnal Radiologi Dentomaksilofasial Indonesia 2026; 10 (1); 218-223 | DOI: https://doi.org/10.32793/jrdi.v10i1.1378

that occurs will directly affect the thickness of the measured mandibular body.

CONCLUSION

The study's results on measuring the length, width, and height of the mandible in patients with hypertension and T2DM showed no significant differences. This explains that the bone quality between patients with hypertension and T2DM is not much different. This study could not prove a decrease in bone quality in both diseases because no other studies explained bone morphology, especially the mandible's length, width, and height in normal patients.

ACKNOWLEDGMENTS

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FOOTNOTES

No conflict of interest.

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