



# Differences in mental index value in patients with type II diabetes mellitus using panoramic radiography

(Review based on the length of suffering at Ulin General Hospital Banjarmasin)

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## ABSTRACT

**Objectives:** This research is aimed to determine the mandibular cortical thickness by the Mental Index value using panoramic radiography in patients with type 2 DM based on length of suffering  $\leq 5$  years and  $> 5$  years.

**Materials and Methods:** This research is using unpaired comparative analytical design with a cross-sectional stratified random sampling method and unpaired T-test statistic.

**Results:** 34 samples of patients with type 2 DM showed that the mean mental index was  $4.219 \pm$

1.223. The two groups did not have a difference in the meaning of the MI value. The MI of the group with a shorter history of suffering ( $\leq 5$  years) was  $4.227 \pm 1.063$  and the group with a longer history of suffering ( $> 5$  years) was  $4.211 \pm 1.399$ . There were 8 people who experienced thinning bone from the whole age group, the most were from the age group of 51-60 years old.

**Conclusion:** Mental Index (MI) value is greater or exceeds the normal value ( $\geq 3,1$  mm) in both groups of patients with type 2 DM based on length of suffering  $\leq 5$  years and  $> 5$  years.

**Keywords:** Diabetes mellitus type 2, mental index, mandibular cortical bone, panoramic radiography

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## INTRODUCTION

The American Diabetes Society defines diabetes mellitus as a group of metabolic disorders resulting in hyperglycemia due to defects in insulin secretion or insulin action. The prevalence of diabetes mellitus sufferers in Indonesia is estimated at 6.2% with around 10 million people.<sup>1</sup> Based on 2018 Riskesdas data, the prevalence of diabetes mellitus sufferers in South Kalimantan reaches 1.30%, and especially in Banjarmasin City reaches 2.12%.<sup>2</sup>

The main characteristic of type 1 and type 2 DM is the presence of hyperglycemia or high blood glucose levels.<sup>3</sup> Hyperglycemia is considered to significantly affect decreasing bone quality in people with diabetes mellitus. Hyperglycemia is associated with the accumulation of Advanced Glycation End Products (AGEs) in the bone matrix.<sup>4</sup> AGEs can increase the expression of RANKL (Receptor Activator of Nuclear Factor Kappa B Ligand) and inhibit the performance of OPG (Osteoprotegerin).<sup>5</sup> RANKL is a protein that plays a role in increasing osteoclast activity so that increases bone resorption. OPG inhibits osteoclast maturation to reduce bone resorption. An imbalance between the processes of bone resorption and bone formation can lead to a decrease in Bone Mineral Density (BMD).<sup>6-8</sup>

The research generally shows that type 1 DM is associated with a decrease in BMD, but in type 2 DM this is still a matter of controversy. Research studies that have been conducted on BMD in type 2 DM patients have shown mixed results, namely, there may be an increase, decrease, or no change in BMD.<sup>9</sup> Dual Energy X-Ray Absorptiometry (DEXA) is the gold standard in measuring bone mineral density, especially in the lumbar vertebrae, collum femoris and antebrahium. DEXA measurement of mandibular BMD is rarely used because of superimposition and high costs. Panoramic radiography is a more economical alternative to assessing bone density. Panoramic radiography has been performed routinely in dental practice.<sup>9,10</sup> Panoramic Radiomorphometric Index can be used in measuring bone mineral density. This index consists of the Mandibular Cortical Index (MCI), Panoramic Mandibular Index (PMI), Mental Index (MI), Antegonial Index (AI), and Gonial Index (GI). One of the indices that is most often used and has the best accuracy is the Mental Index (MI). MI can measure mandibular cortical thickness by measuring from a perpendicular vertical line connecting the mental foramen to the tangent to the lower border of the mandibular bone. The normal value for Mental Index is  $\geq 3.1$  mm.<sup>9,11-14</sup>

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Diabetes mellitus is related to bone conditions. Previous studies still provide mixed results regarding BMD values in type 2 DM patients. Low BMD can increase the risk of fractures. Dentists have an important role in detecting the risk of bone fractures with systemic involvement, one of which is in diabetes. Panoramic radiography has been used to predict low BMD. This study aims to determine the condition of BMD through the thickness of the mandibular cortical bone in patients with type 2 DM through panoramic radiography. This study compared BMD values based on the duration of diabetes. Thus, our study carried out the measurements of mandibular cortical thickness of the mandible through the Mental Index value in type 2 DM patients using panoramic radiography which is reviewed based on a long history of suffering  $\leq 5$  years and  $> 5$  years.

## MATERIALS AND METHODS

This research was conducted after being declared ethically feasible by the Health Research Ethics Commission, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin No. 046/KEPKG-FKGULM/EC/III/2023. The research was carried out from April to June 2023 at the Ulin Hospital in Banjarmasin. Sampling locations were in the Internal Medicine Sub-Endocrine Metabolic

Polyclinic and the Diabetic Foot Polyclinic. X-ray samples were taken at the Radiology Installation. Sampling was carried out using a stratified random sampling technique in a cross-sectional manner. This study used an unpaired comparative analytic design. The study sample consisted of 34 people who were divided into 2 groups based on a long history of type 2 DM, namely  $\leq 5$  years and  $> 5$  years. The sample criteria were patients who were diagnosed with a history of type 2 DM without comorbidities by a doctor, were able to communicate, and were willing to become research respondents. The results of the panoramic radiographs that have been analyzed will be recorded on a ratio scale in millimeters (mm). The Mental Index values of the two groups will be measured from each left and right region, then the average will be taken. All data obtained will be statistically tested using the Shapiro-Wilk normality test, then continue with the hypothesis test, the unpaired T-test.

## RESULTS

Table 1 shows that the distribution of the study sample based on a long history of suffering  $\leq 5$  years and  $> 5$  years is the same. Most of the samples in this study were female, namely 19 people (56%), while 15 people (44%) were male.



Figure 1. Mental index measurement

Figure 1. Sample characteristic frequency distribution

Characteristic	Frequency	Percentage
Length of suffering		
$\leq 5$ years	17	50%
$> 5$ years	17	50%
<b>Total</b>	<b>34</b>	<b>100%</b>
Gender		
Male	15	44%
Female	19	56%
<b>Total</b>	<b>34</b>	<b>100%</b>

**Table 2.** Mental Index values on both sides of the jaws in Type 2 DM patients

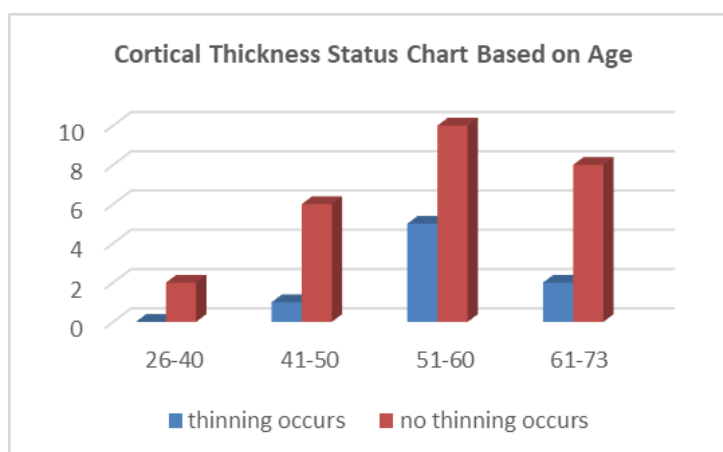
Length of suffering	N	Mental Index Value	
		Right side (Mean ± SD)	Left side (Mean ± SD)
≤ 5 years	17	4,210 ± 1,090	4,159±1,130
> 5 years	17	4,108±1,156	4,315±1,531
<b>P-value</b>		0,75	0,8

**Table 3.** Statistical analysis of differences in Mental Index values based on the length of suffering

Length of suffering	N	Mental Index Value				P
		Mean	SD	Min	Max	
≤ 5 years	17	4,227	1,063	2,216	6,234	0.971
> 5 years	17	4,211	1,399	1,665	6,342	
<b>Total</b>	17	4,219	1,223	1,665	6,342	

**Table 4.** Status of cortical bone thickness in patients with type 2 DM by measuring Mental Index values

Length of suffering	n	Status of cortical bone thickness	
		No thinning occurs	Thinning occurs
≤ 5 years	17	13	4
> 5 years	17	13	4
<b>Total</b>	34	26	8

**Figure 2.** Chart of the mandibular cortical thickness status based on age in patients with type 2 DM

The mean mental index values for the two groups on both sides of the jaw are shown in Table 2. Patients with a history of suffering for ≤ 5 years had a mean mental index value on the right side of 4.210 ± 1.090 and on the left side of 4.159 ± 1.130. Patients with a long history of suffering > 5 years have a mean mental index value of 4.108 ± 1.156 on the right side and 4.315 ± 1.531 on the left side. The p-value > 0.05 showed no difference in the MI values on both sides of the jaw in the two groups.

The mental index values in both groups based on the duration of suffering are shown in Table 3. The mean mental index in all type 2 DM patients

was 4.219 ± 1.223. The mean mental index in the ≤ 5 years group was 4.227 ± 1.063. The mean mental index in the > 5 years group was 4.211 ± 1.399. The results of the statistical analysis obtained a p-value > 0.05, which means that Ho is accepted so that the two groups have no significant difference related to the mental index value.

Table 4 shows the status of cortical bone thinning in patients with type 2 Diabetes Mellitus by measuring the mental index. The cut-off value of cortical bone thinning status is < 3.1mm. Patients with a long history of suffering ≤ 5 years had 13 people who did not experience bone

thinning and 4 people did. Patients with a long history of suffering > 5 years had 13 people who did not experience bone thinning and 4 people did.

Figure 2 shows individuals experiencing mandibular cortical bone thinning in terms of age ranges. There were 8 people who experienced bone thinning from the total age group. No individuals had bone thinning from the age group of 26-40. There was 1 person from the age group of 41-50 with bone thinning, 5 people from the age group of 51-60, and 2 people from the age group of 61-73.

## DISCUSSION

The results of this study showed a minimal difference in cortical thickness based on the MI value when viewed from both sides of the mandible. Based on Table 2, the group  $\leq 5$  years has thicker cortical bone on the right side. Group > 5 Years has thicker cortical bone on the left side. This could be due to several things. The difference in the cortical thickness of the mandibles of the right and left jaws can be associated with one-sided chewing patterns.<sup>15</sup> Loss of posterior teeth causes a person to experience limitations in carrying out masticatory activities.<sup>16</sup> The mandible is stimulated by the masticatory muscles, especially during the mastication process. This bone is composed of trabecular and cortical bones. Mandibular bone mineral density and cortical bone thickness are correlated with masticatory function and occlusal forces.<sup>17</sup>

The intraoral examination carried out during this study showed that there were attrition of teeth in some type 2 DM patients. Dental attrition is a type of tooth wear caused by contact between teeth resulting in loss of tooth tissue on the incisal or occlusal surfaces. Tooth attrition can be caused by bruxism, namely the habit of clenching and grinding carried out by a person.<sup>18</sup> Eninanc et al in 2021 stated that the habit of bruxism can also affect the MI value on each side of the jaw. The results of their research showed that individuals with bruxism had a greater MI value than control individuals, both on the right, left, and on the average from both sides. Bruxism causes a reactive response in the mandibular cortex due to the pressure exerted on the mandibular corpus by masticatory forces.<sup>11</sup>

Measurement using the MI method of cortical thickness of the mandible is considered to have the highest sensitivity.<sup>19</sup> Cortical bone of the mandible in the mental foramen area is thicker in size compared to cortical bone in other areas that are more posterior along the inferior border of the mandible.<sup>20</sup> This could indicate that if there is thinning of the cortical bone in the area of the mental foramen, then the cortical bone in other areas may also experience thinning.<sup>19,20</sup>

The Mental Index is a method for measuring the cortical width of the mandible in the mental foramen area. The normal value of the mental index is  $\geq 3.1$  mm.<sup>12-14</sup> Previous research that has been conducted on populations in Indonesia shows

that the thickness of the mandibular cortical bone under normal conditions has a value of 3-2.7mm in men and 3-2.6mm in women.<sup>10</sup> This study shows that the MI value is higher than the normal threshold. The results of this study are not in line with the results of the research by Epsilawati et al in 2018 and David et al in 2017 which stated that there was a decrease in the Mental Index value in patients with a history of type 2 DM. Various previous studies have also reported different results, namely there may be an increase, decrease, or no change in BMD in type 2 DM.<sup>9,10</sup>

Mathkoor & Abdullah in 2023 stated that type 2 DM patients had higher BMD values than the non-diabetic control group. They also observed that the condition of bone density and disease duration in diabetic patients did not have a significant relationship. This study is not in line with the study of Jang et al in 2018 which stated that lower groups with a longer duration of type 2 DM had lower BMD values than groups with shorter durations.<sup>21-23</sup> Type 2 DM disease allows a person to have higher bone density. Some of the things that might influence this include a history of obesity, physical activity, and also vitamin D intake.<sup>22-28</sup>

Obesity is very common among patients with a history of type 2 DM. Most of these patients have a body mass index above 30. Obese patients with type 2 DM may experience increased leptin levels and decreased adiponectin levels. These two adipokines have an influence on bone remodeling. Leptin can inhibit the process of osteoclastogenesis by increasing the ratio of OPG/RANKL in osteoblasts. Leptin can reduce bone resorption and increase bone growth by stimulating osteoblast proliferation and differentiation. Adiponectin is considered to be able to reduce the ratio of OPG/RANKL. The combined effect of high leptin levels and reduced adiponectin levels on bone formation and resorption is the reason for the high BMD in type 2 DM patients with a history of bone obesity.<sup>22,23</sup>

Physical activity plays an important role in the condition of bone density. This activity has been shown to be clinically significant in increasing bone density. Studies show that physical activity is one of the most effective and inexpensive non-pharmacological methods for the prevention and control of osteoporosis. Physical activity transmits mechanical forces to the bones and stimulates intracellular processes in the bone tissue through mechanical loads. Mechanical load is something that exerts an opposing force on the system so that the system requires more power to perform the activity. Mechanical loading on bone activates a series of signaling pathways within bone cells. This increases the deposition of minerals in the bones and results in increased density in the bone tissue thereby maintaining bone strength. Mechanical load is an important factor in maintaining bone mineral density. Physical activity increases bone density through activating anabolic processes and increased bone mineral density has been shown to increase by up to 20% in areas of bone that are subjected to mechanical stress.<sup>24-26</sup>

Levels of vitamin D also have a positive relationship with bone density. The role of vitamin D in calcium absorption and bone formation has a good influence because calcium is an important element of bones. High concentrations of vitamin D can increase bone mineral density in adults. Vegetables and fruits are also considered major natural sources of vitamins, which may benefit bone health. Calcium and vitamin D are recommended for people at risk for osteoporotic fractures.<sup>27,28</sup> The association between vitamin D and calcium with BMD in people with DM type 2 was observed by Reema et al in 2020. They demonstrated that the loss of BMD could be due to low calcium levels.<sup>29</sup>

The chart in Figure 2 shows that with the increasing age range of individuals, the status of thinning bones also increases. Although the age range of 61-73 has decreased slightly, this is due to the lack of comparison between the number of individuals in the group so the chart curve decreases.

Nachankar in 2021 observed an increase in bone density loss with age. These findings suggest that old age is a deterministic factor in the loss of bone mineral density in diabetic patients.<sup>27</sup> Type 2 DM patients have a high prevalence and are more prone to osteoporosis. Type 2 DM and Osteoporosis are the most common metabolic diseases in adults and the elderly. Osteoporosis is a metabolic bone disease characterized by lower bone mass, microstructural damage to bones, greater bone fragility, and a higher risk of fractures.<sup>30,31</sup> The prevalence of osteoporosis increases with age. People can significantly develop osteoporosis at an older age. Women over the age of 50 are 5 times more likely than the normal population to develop osteoporosis and twice as likely to have osteopenia than men. Osteoporosis occurs more frequently in women than men. The female has a risk factor for osteoporosis in old age. This has been associated with postmenopausal decreased estrogen in women. Estrogen has an important role in preventing bone resorption by inhibiting osteoclasts.<sup>32,33</sup>

Increasing age causes an imbalance between resorption and formation (higher resorption than formation), thereby increasing the loss of BMD. Increasing age can also result in degenerative changes thereby reducing one's physical activity. Reema et al in 2020 observed that increasing age may be associated with an increase in bone density loss.<sup>29</sup> Prakash et al in 2017 also observed that there was a relationship between loss of bone mineral density and old age.<sup>34</sup> The relationship between old age and loss of bone mineral density is a universal phenomenon that is seen in all populations regardless of type 2 DM status.<sup>34</sup>

The association between long history of type 2 DM and loss of BMD is often confused with aging. In studies with older patient samples, the duration of type 2 DM often coincides with increasing age. Amit Nachankar's research states that there is no relationship between the duration of type 2 DM and BMD which can be caused by the relatively

younger age of the patient.<sup>27</sup>

Mandibular cortex width also gradually decreases with age. The results of research using the mental index method conducted by Sghaireen et al in 2020 show that the width of the mandibular cortex is higher at younger ages and lower at older ages.<sup>35</sup> Hormonal factors are mentioned in this regard. Research by Sarifah et al in 2022 stated that the age group of women who are at risk for osteoporosis have the lowest mandibular cortical thickness values, namely in the age group of 51-60 years. This is of course in line with the analysis of mandibular cortical bone thinning which is reviewed based on the age range.<sup>15</sup>

## CONCLUSION

The mandibular cortical thickness of the mental index values obtained in type 2 DM patients based on the duration of suffering  $\leq 5$  years and  $> 5$  years are both greater or exceed the normal value ( $\geq 3.1$  mm). The two groups did not have significantly different MI values due to the possibility that the difference in long-suffering history was too close. The age of the sample used is still in the productive age range so it becomes a confounding factor in this study.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This study has received ethical approval approved by the Health Research Ethics Commission, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin (046/KEPKG-FKGULM/EC/III/2023 ). All procedures conducted were in accordance with the ethical standards.

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