International Journal of Current Research and Applied Studies, (IJCRAS)

ISSN: 2583-6781

available at https://ijcras.com/

Volume 4 Issue 1 Jan-Feb 2025, Page 32-44

To cite this article: Dr. Syeda Arshiya Ara, Dr. Manjunath Digasangikar, Dr. Syed Shahbaz and Dr. Saffora Maryam (2025). PREDICTIVE ANALYSIS OF OSTEOPOROSIS USING ORTHOPANTOMOGRAPH IMAGING IN BOTH MEN AND WOMEN AMONG KALABURAGI POPULATION- A RETROSPECTIVE STUDY, International Journal of Current Research and Applied Studies (IJCRAS) 4 (1): Article No. 107, Sub Id 180

PREDICTIVE ANALYSIS OF OSTEOPOROSIS USING ORTHOPANTOMOGRAPH IMAGING IN BOTH MEN AND WOMEN AMONG KALABURAGI POPULATION- A RETROSPECTIVE STUDY

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DOI: https://doi.org/10.61646/IJCRAS.vol.4.issue1.107

ABSTRACT

Osteoporosis is a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to bone fragility, and enhanced susceptibility to fractures. Dental panoramic images are used to predict bone mineral density.

AIM: To examine and analyze mandibular cortical thickness on orthopantomography as a representative preliminary diagnosis of osteoporosis

OBJECTIVES: To investigate influence of age and gender on Mandibular cortical index (MCI) and Panoramic mandibular index (PMI).
To assess Mandibular cortical index (MCI) and Panoramic mandibular index (PMI) in identifying risk group for osteoporosis
MATERIALS AND METHODS: The study utilized 200 OPG scans, consisting of 100 males' scans and 100 female scans obtained from archival records with the age group of 21-30yrs, 31-40yrs, 41- 50yrs, 51-60 yrs and 61-70yrs respectively. All the scans obtained were analyzed for linear measurements in DICOM software to determine the thickness of the mandibular cortical bone. Statistical methods such as analysis of variance (ANOVA) and correlation analysis were used to evaluate the relationship between age and mandibular cortical bone thickness ($p>0.05$)
RESULTS: The analysis of the 200 OPG 100 male group and 100 female group revealed a progressive decrease in thickness with advancing age. Statistical analysis confirmed a significant negative correlation between age and mandibular cortical bone thickness.
CONCLUSION: Mandibular cortical bone thickness can be used as an indicator of skeletal health in different age and sex groups. Further research and validation are necessary to solidify these findings and understand their clinical implication.

Keywords: Mandible, Panoramic Radiography, Mandibular Index.

1. INTRODUCTION

Osteoporosis is a systemic bone disorder marked by reduced bone mass and the deterioration of bone structure, leading to increased bone fragility and a higher risk of fractures. A significant challenge in managing osteoporosis is the difficulty in identifying affected individuals until clinical complications arise.[1] Therefore, early detection is crucial to prevent the risk of pathological fractures. Dental professionals can help identify this condition in its subclinical stage through routine panoramic radiographs. While previous studies have focused on correlating various panoramic indices with bone density to identify those at risk for osteoporosis, there has been limited research exploring the effects of age and gender on these indicators.[2]

2. AIM:

To examine and analyze mandibular cortical thickness on orthopantomography as a representative preliminary diagnosis of osteoporosis

3. OBJECTIVES:

1. To investigate influence of age and gender on Mandibular cortical index (MCI) and Panoramic mandibular index (PMI).
2. To assess Mandibular cortical index (MCI) and Panoramic mandibular index (PMI) in identifying risk group for osteoporosis

4. METHODOLOGY

4.1 Study type and sample:

Retrospective study in which 200 OPG scans of good quality were collected from the archival records of department of Radiology at ARDCH, Kalaburagi. The OPG device of care stream CS 9600 company and Dicom Imaging software was used.

4.2 Study sample:

The selected OPGSs scans were divided into 5 age groups and further distributed according to gender in respective age groups such as 21-30 years, 31-40 years, 41- 50 years, 51-60 years, 61-70 years of age groups.[3]

4.3 Inclusion Criteria:

- Good quality radiographs.
- Radiographs that cover area of interest.

4.4 Exclusion Criteria:

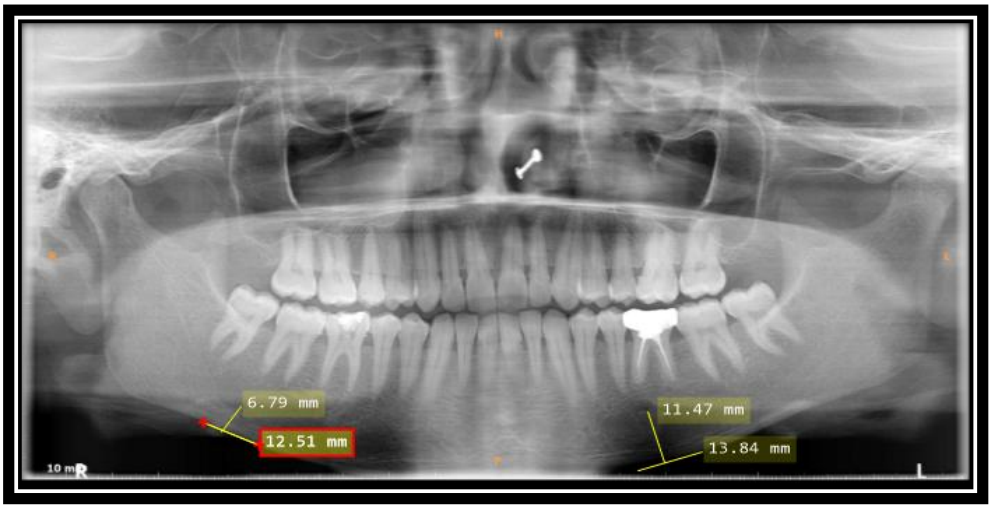
- The radiographs of the patients showing congenital, developmental anomalies or pathology of bone,
- Images of the patients showing history of trauma, Radiographs that do not cover the area of interest
- Bad quality radiographs were excluded from the study.

Evaluation criteria:
The selected OPG's scans were subjected to measure Panoramic Mandibular Index (PMI) and Mandibular cortical index (MCI) bilaterally by Dicom software.

4.5 Panoramic Mandibular Index:

PMI is the ratio of the mandibular cortical thickness measured on the line perpendicular to the bottom of the mandible, at the middle of the mental foramen, by the distance between the inferior mandibular cortex of the mandibular nerve and inferior border of the mandible.

Figure 1: Panoramic Mandibular Index



4.6 Mandibular Cortical Index:

The porosity of the inferior border of the mandible was described with cortical erosion and is related to the mandibular bone mineral density. This index involves measurements at the inferior mandibular cortex distal to the mental foramina part of the mandible, bilaterally, and findings are separated into three groups.

- (C1) Uniform inferior border of mandibular cortical bone margins. (Fig.2)
- (C2) Semilunar defects with moderate erosion along the mandibular margin. (Fig.3)
- (C3) Major erosion and cortical porosity. (Fig.4)

Figure 2: C1- Uniform Inferior Border of Mandibular Cortical Bone Margins

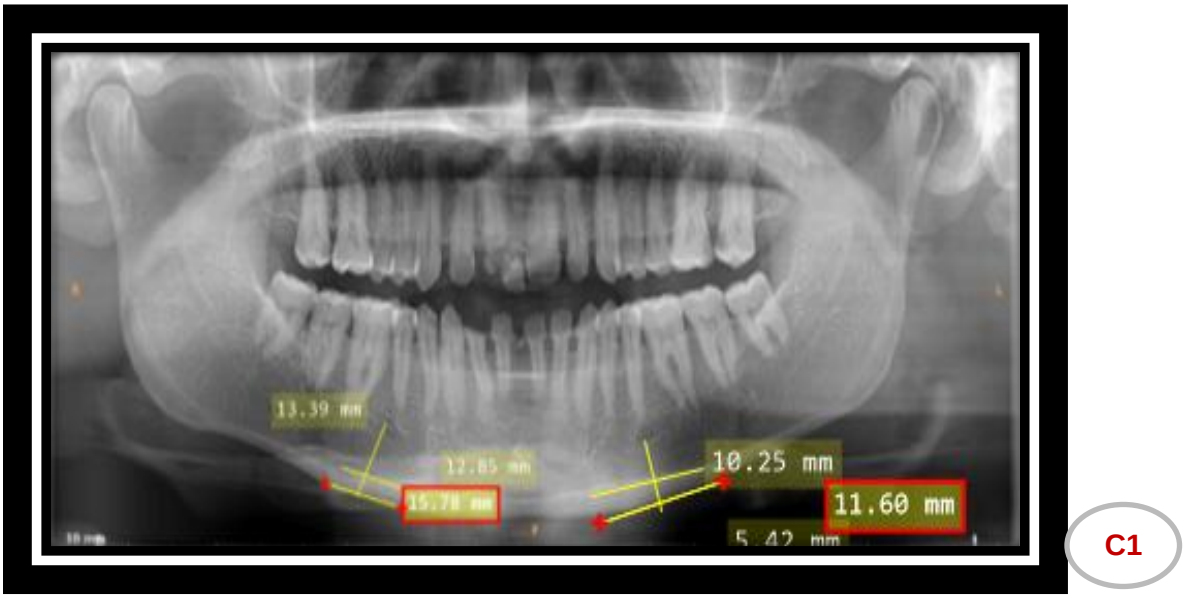


Figure 3: C2-Semilunar defects with moderate erosion along the mandibular margin

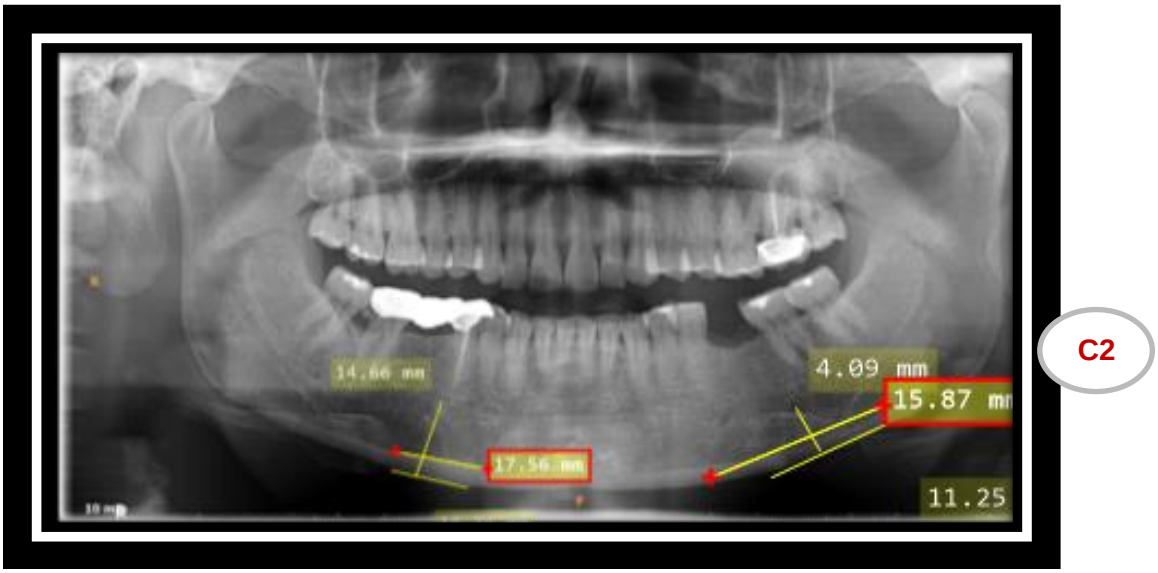
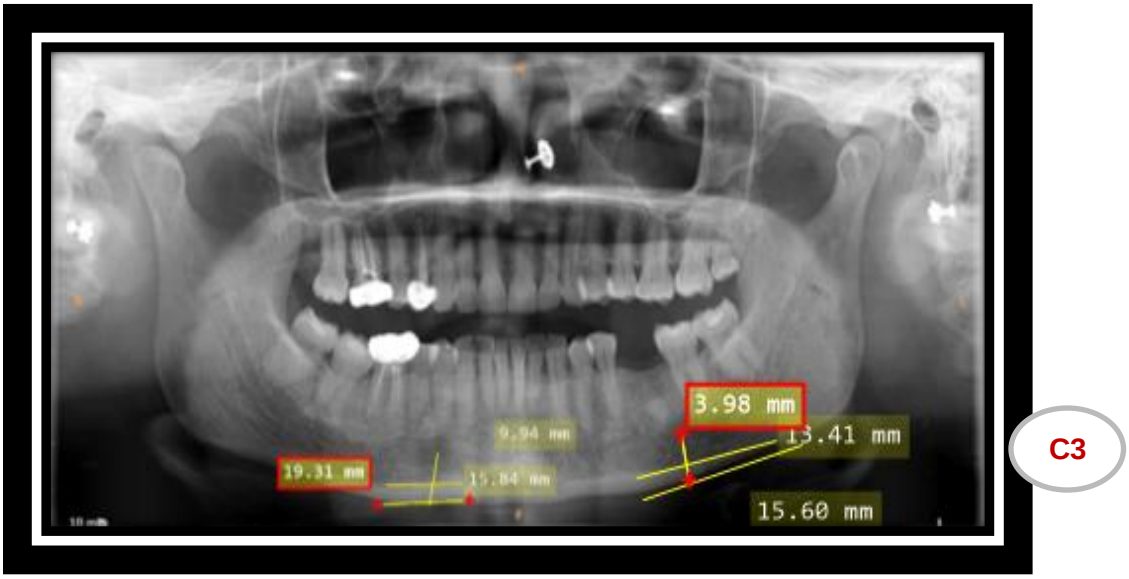


Figure 4: C3-Semilunar defects with severe erosion along the mandibular margin.



4.7 STASTICAL ANALYSIS :

The data obtained was subjected to suitable statistical analysis such as Chi square test, t test, and ANOVA test using SPSS 21.0 for MS windows and $p<0.05$ was considered statistically significant.

5. RESULT

In this retrospective study the OPG Scans were divided in five age groups among males and females, and PMI as well as MCI index were evaluated.

Table 1: Distribution of study population according to age groups and C types

Age years	Male			Females			Total
	C1	C2	C3	C1	C2	C3	
21-30	8	10	12	8	8	4	50
31-40	2	3	5	10	10	20	50
41-50	3	5	2	3	2	5	20
51-60	15	15	10	2	5	13	60
61-70	2	5	3	0	2	8	20
TOTAL	30	38	32	23	27	50	200
Chi square test	0.001 (significant)	0.005 (significant)	0.005 (significant)	0.005 (significant)	0.005 (significant)	0.005 (significant)	0.005 (significant)

Table 1 shows the study population was divided into six age groups (21-30, 31-40, 41-50, 51-60, and 61-70 years), with a total of 200 participants. In the 41-50 years group, C2 and C3 were more prevalent than C1, with a notable increase in the C3 category. The 51-60 years group shows a shift towards more C2 and C3, particularly for males (15 males with C2, and 10 males with C3), indicating increased erosion and porosity. For the 61-70 years group, C2 and C3 were clearly dominant, especially C3, with more males (8 individuals) and females (8 individuals) showing severe cortical changes. The Chi-square test results indicate significant differences in the distribution of mandibular cortical indices across age groups (p-values for each category was less than 0.05) tends to show more severe mandibular cortical changes (erosion and porosity) This suggests that as individuals age, there is a statistically significant increase in

the prevalence of C2 and C3, indicating that older age group represents age -wise distribution of mandibular cortical index noticed C1-younger age group and more erosion and porosity- C3 noticed in older groups. It shows the study population divided into six

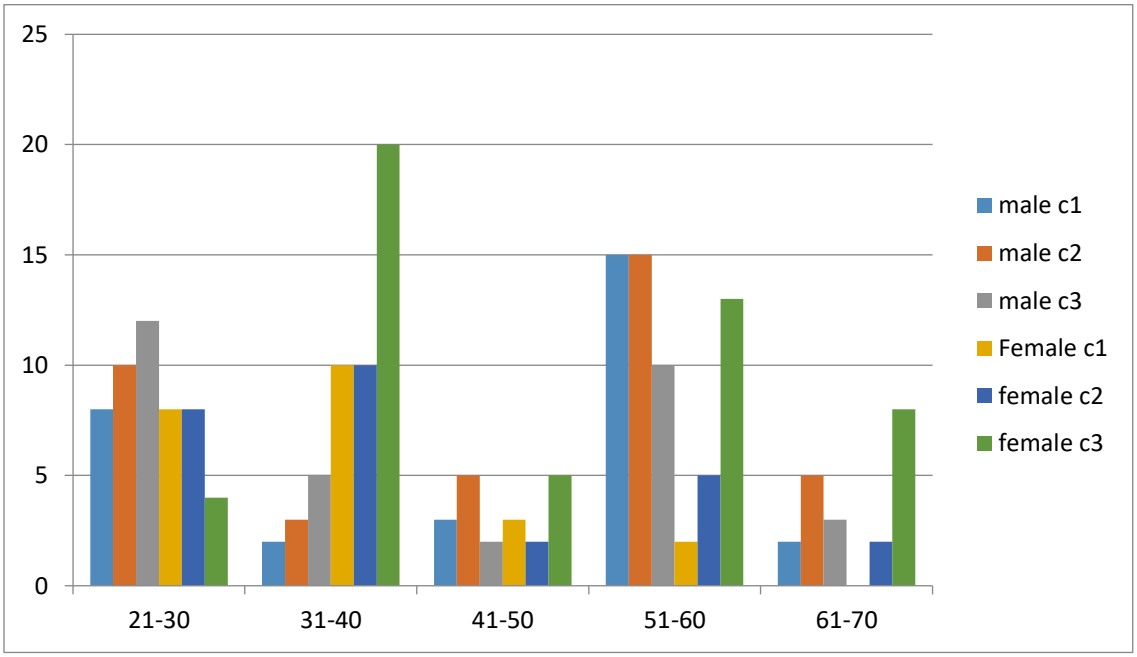


Table 2: Comparison of Mandibular cortical index with gender.

Age (in years)	Mandibular cortical index			
	C1	C2	C3	Total
Male	30	35	35	100
Female	32	28	40	100
Total	62	63	75	200
Chi square test	0.000 (Highly significant)	0.005 (Significant)	0.001 (Significant)	

P value-0.05 is statistically significant.

Table no 2 shows that out of 200 participants (100 males and 100 females), there is a notable distribution of C1, C2, and C3 categories. C1, which represents healthy cortical bone, is observed in nearly equal numbers in both males (30) and females (32), suggesting that younger individuals, regardless of gender, tend to have healthier mandibular cortexes. However, C2, which indicates mild erosion or porosity, is more common in males (35 males vs. 28 females), indicating that mild cortical changes may be more

prevalent in males. On the other hand, C3, which signifies significant erosion and porosity, is more commonly observed in females (40 females vs 35 males). This finding aligns with the well-established understanding that post-menopausal women are at a higher risk for osteoporosis, which could explain the higher incidence of severe cortical changes (C3) in females. The statistical analysis, using Chi-square tests, shows significant p-values for all categories: C1 ($p = 0.000$), C2 ($p = 0.005$), and C3 ($p = 0.001$).
Table 2 represented even endosteal margins of mandibular cortex (C1) is seen in females & semilunar defects of endosteal margins (C2) are seen in male group. (C3) is more severe erosion with major porosity and more Dispersed trabecular pattern of endosteal margin seen in female groups. MCI was statistically significant with p value- 0.001 revealing that C3 is most commonly seen in old age group. The study comparing the Mandibular Cortical Index (MCI) across genders reveals significant differences in the distribution of cortical bone types between males and females

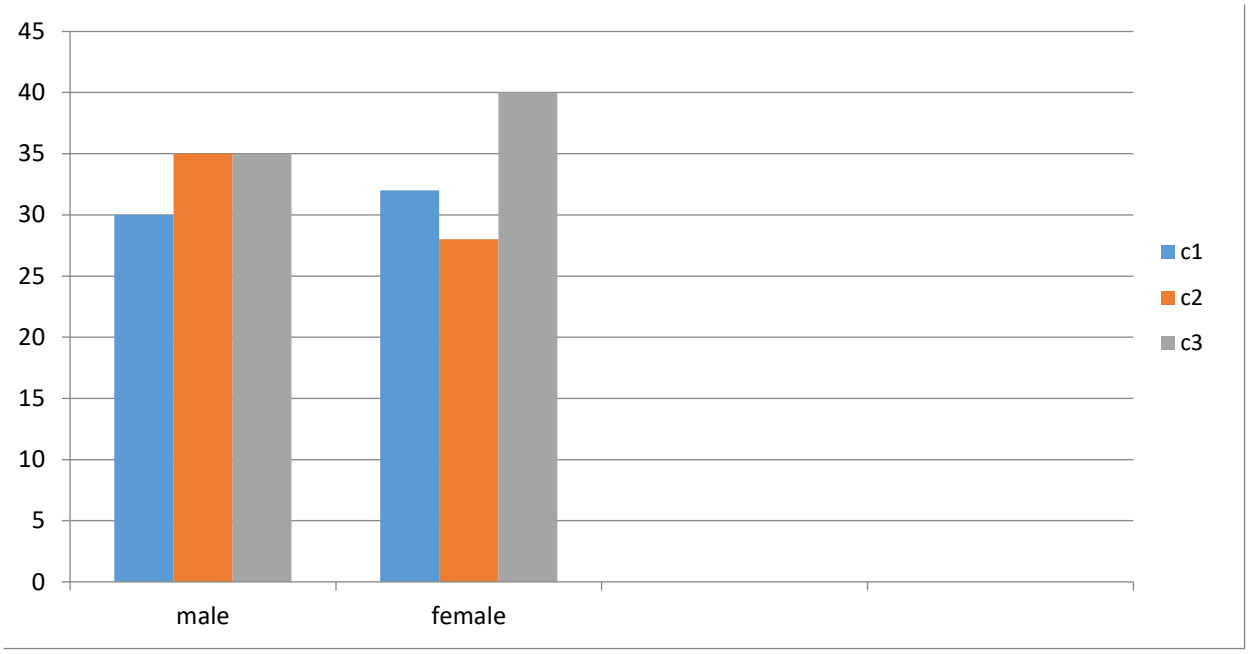


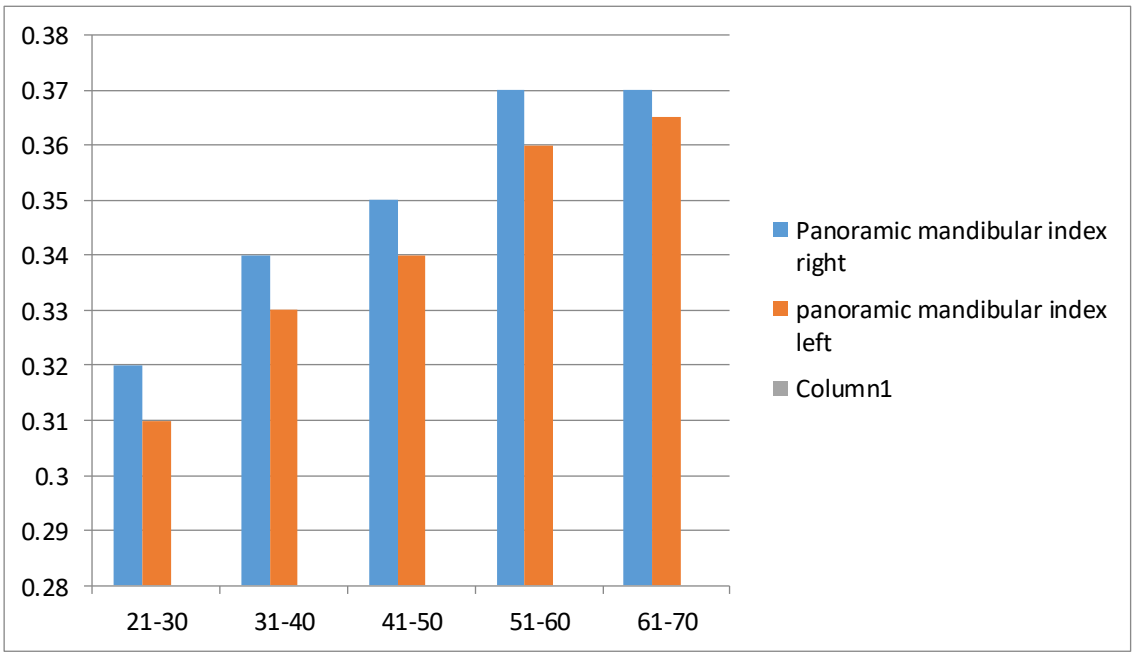
Table 3: Age -wise distribution of panoramic mandibular index on right and left side of mandible

	Age group years					TOTAL	
	21-30	31-40	41-50	51-60	61-70		
Panoramic mandibular index right MeanSD	0.32 ± 0.07	0.34 ± 0.08	0.35± 0.075	0.37 ± 0.072	0.378 ± 0.095	P=0.0045	Significant
Panoramic mandibular index left MeanSD	0.31 ± 0.06	0.33 ± 0.08	0.34 ± 0.075	0.36 ± 0.06	0.365 ± 0.095	P=0.003	Significant

P value-0.05 is statistically significant

Table 3 represented that statistically highly significant relationship between age, gender and the incidence of osteoporosis, according to age. PMI Index was statistically significant with p value< 0.001 revealing that C3 is most commonly seen in old age group. Illustrated the Panoramic Mandibular Index (PMI) across different age groups, comparing the right and left sides of the mandible. The PMI reflects the quality of mandibular bone, with higher values indicating poorer bone health. The study shows a statistically significant increase in PMI as age progresses, with p-values of 0.0045 for the right side and 0.003 for the left side, both of which are below the threshold of 0.05, indicating a significant relationship between age and mandibular bone health. For the right mandible, the mean PMI starts at 0.32 in the 21-30 age group and increases gradually to 0.37 in the 51-60 age group, reaching 0.378 in the 61-70 age group. The standard deviation (SD) also increases with age, reflecting more variability in the PMI values as individuals age. A similar trend is observed for the left mandible, where the mean PMI rises from 0.31 in the 21-30 age group to 0.365 in the 61-70 age group.

This increase in PMI on both sides of the mandible suggests a decline in bone quality as individuals get older. The result showed PMI increases with age for both the right and left sides of the mandible. The right side consistently shows slightly higher PMI values than the left, although both follow the same general upward trajectory. The significant rise in PMI with age reflects the deterioration of mandibular bone health, which is often associated with aging and conditions such as osteoporosis. These findings highlight the importance of monitoring mandibular bone health, particularly in older individuals, as the increase in PMI is indicative of worsening bone density and structure over time.



6. DISCUSSION:

World Health Organization (WHO) Defines Osteoporosis as a skeletal disease, characterized by low bone mass and micro - architectural deterioration of bone tissue leading to enhanced bone fragility, with consequent increase in fracture risk. [6]

A few researchers have raised a question of whether dental radiographs could have a role in the detection of osteoporosis. It has been suggested that there may be a relationship between mandibular osteopenia and osteoporosis of the remaining skeleton. [7]

- Our results showed statistically highly significant relationship between age, gender and the incidence of osteoporosis, according to age, mandibular cortical index revealing C1-younger age group and more erosion and porosity-C3 noticed in older groups. Endosteal margins of mandibular cortex (C1) is seen in females & semilunar defects of endosteal margins (C2) are seen in male group.
- In our study table 1 shows that C1 indicates a healthy mandibular cortex with no porosity or

erosion. C2 indicates mild erosion or porosity. C3 indicates significant erosion and porosity in the cortical bone. The participants are categorized into three types of mandibular cortical indices (C1, C2, C3) for each age group: The age trends shows among 21-30 years age group, C1 was the most common, with 16 individuals (8 males, 8 females), showing a healthier cortical status. In the 31-40 years group, C2 (3 males, 10 females) and C3 (5 males, 20 females) start to increase.

- The results showed that the younger age groups (21-30) have more individuals classified under C1, indicating healthy cortical bone, while older age groups (51-70) display higher numbers under C3, reflecting increased erosion and porosity. The trend clearly suggests a higher occurrence of C3 (severe porosity) with increasing age, especially in males. This could be indicative of age-related bone density loss or osteoporosis, which is commonly observed with advancing age. The study indicates that C1 (healthy bone) is predominantly found in younger age groups (21-30), while C2 and C3 (signifying erosion and porosity) become more prevalent in older age groups (51-70). The significant statistical findings confirm that the mandibular cortical index worsens with age, emphasizing the impact of aging on bone health and the increasing risk of osteoporosis or similar conditions in older adults.
- The study showed that table 2 suggested that gender significantly influences the distribution of mandibular cortical indices, with males showing more mild erosion (C2) and females showing more severe erosion (C3). The data also reflects the greater vulnerability of females to age-related bone changes, particularly in the mandibular cortex. Graphically, the bar graph representation further highlights that C1 is observed in both genders, but C2 is more prevalent in males, and C3 is more prevalent in females, further supporting the statistical significance of gender differences in the MCI distribution. In conclusion, this study underscores the significant gender differences in the mandibular cortical index, with males showing more mild changes (C2) and females showing more severe erosion (C3), likely due to age-related conditions such as osteoporosis, which disproportionately affect women. The statistical significance of these findings emphasizes the importance of considering gender when assessing mandibular cortical health and bone density.
- Our results in table 3 showed statistically highly significant relationship between age, gender and the incidence of osteoporosis, according to age, mandibular cortical index revealing C1-younger age group and more erosion and porosity- C3 noticed in older groups. Endosteal margins of mandibular cortex (C1) is seen in females & semilunar defects of endosteal margins (C2) are seen in male group. MCI was statistically significant with p value< 0.001 revealing that C3 is most commonly seen in old age group
- MCI was statistically significant with p value< 0.001 revealing that C3 is most commonly seen in old age group. These results are in accordance with the studies done by these authors Asha V et al6, Alapati S et al8 and Triantafyllopoulos, G et al2.
- The studies by Asha V et al6., Alapati S et al8., and Triantafyllopoulos G et al2. all contribute valuable insights into the relationship between age, gender, and the Mandibular Cortical Index (MCI), with each study providing significant findings. Asha V et al6. conducted a study with 56 patients, including 28 males and 28 females aged between 30 and 75 years. Their analysis revealed a statistically significant result for the MCI index, with a p-value of less than 0.05, indicating that

the mandibular cortical health was influenced by the variables examined. Alapati S et al8. studied a larger sample of 400 individuals, aged between 16 and 64 years, and found that the prevalence of C2 and C3 MCI patterns was notably higher in females (31.5%) compared to males (13%), with the results also being statistically significant. This suggests that females in the sample was more likely to exhibit signs of mild to severe cortical erosion. Lastly, Triantafyllopoulos G et al2. focused on 150 women aged between 45 and 86 years, observing significant findings regarding the MCI index in their study. The results were statistically significant, reinforcing the idea that aging and gender play important roles in mandibular cortical health. In all three studies, the findings were statistically significant, with p-values below 0.05, underscoring the relevance of the MCI index in assessing mandibular bone health across different age groups and genders.

- However, few studies done by Munhoz L et al3 and Cakur B et al7. showed different results to our study. As they found Bone marrow density is not relatable to MCI index and MCI is not reliable with osteoporosis.
- These varied results may be related to different study design, observer on all relevant studies, it is unquestionable that appropriate dentist knowledge and experience for evaluating patients dental radiographs and deciding on further referral, many contribute to early diagnosis of osteoporosis.
- Since osteoporosis is a preventable and early-detected disease, diagnostic procedures are very important. Dentists are often the most frequent physician visits in the geriatric population, and dental x-rays are the most commonly used imaging modality
- • Within the frame work of continuing education and professional development, dentist should be informed about possibility of screening osteoporotic patients by panoramic radiographs and, particularly by means of radiomorphometric indices [8].

7. CLINICAL SIGNIFICANCE:

● The oral radiologist can identify risk group for osteoporosis using simple screening analytical calibration [MI, PMI], non-calibration [MCI, MCW] mandibular cortical indices and Antegonial index [AI] and gonial index [GI].
● OPG machines are widely available and be cost effective
● The ratio morphometric are easy to measure. So that undetected osteoporosis can be detected.[9]

8. CONCLUSIONS

This Study revealing that Osteoporosis is a preventable condition that benefits from early detection, diagnostic methods are crucial. Dentists frequently serve as the primary healthcare providers for the elderly, and dental X-rays are among the most commonly utilized imaging techniques in this population. Mandibular Cortical Index can reliably be used as a diagnostic tool for screening patients with osteoporosis. Through this study, we conclude that radio morphometric indices can be used to measure cortical bone height and cortical bone thickness in relation to the location of the mental foramen on the OPG and predict the likelihood of osteoporosis in an individual. Our study despite having less sample size will definitely lay foundation for further extensive research in this arena.

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