Advances in Dentistry & Oral Health
ISSN: 2472-6389

Juniper Publishers
key to the Researchers

Research Article
Volume 18 Issue 2 - April 2025
DOI: 10.19080/ADOH.2025.18.555983

Adv Dent & Oral Health

The Influence of Age and Gender on Panoramic Mandibular Indices

Mahfud F Mohamed*

Postgraduate Program Director in the Department of Orthodontics, Faculty of Dentistry, University of Benghazi-Libya

Submission:March 22, 2025; **Published:** April 08, 2025

***Corresponding author:** Mahfud F Mohamed, Postgraduate Program Director in the Department of Orthodontics, Faculty of Dentistry, University of Benghazi-Libya

Abstract

Radiographic Mandibular Indices are easy and relatively cheap tools for evaluating bone mineralization.

Objectives: To examine the effect of age and gender on three mandibular indices: the panoramic mandibular index (PMI), the mandibular ratio (MR) and the mandibular cortical index (MCI), among the Libyan population.

Methods: the three indices were measured on 317 digital (OPGs) of adult humans (155 males, 162 females). The sample was divided into six age groups (from 18-25 years to 56 65 years). The measurements were analyzed for interactions with age and sex, using SPSS (Statistical Package for Social Studies) software version no. 22. The tests employed were one-way ANOVA, the unpaired T-test and the chi-square test.

Results: The mean PMI fluctuated between 0.37 (S.D. 0.012) and 0.38 (S.D. 0.012) among the sixth age groups. One-way ANOVA statistical test revealed no significance of age on PMI. On the other hand, gender variation affects PMI, since an independent sample t-test disclosed that the difference between the means of the males' and females' PMI was statistically significant ($P < 0.05$). ANOVA test showed that the means of MR among age groups showed a negative correlation i.e. MR mean declined from 3.01 in the 18-25 age group to 2.7 in the 55-65 age group. On the contrary, gender showed no effect on MR according to the unpaired t-tests at $p > 0.05$. In regards to MCI, statistical analysis showed that it was affected by age that is C1 was decreased by age while C2 and C3 were increased by age. Using the chi-square test, the result indicated that there is a significant difference among the different age groups and the two genders in MCI readings.

Conclusion: Females have a higher PMI than males, but age does not influence PMI. Females have higher MR than males, and it is negatively affected by age. MCI is affected by both age and gender.

Keywords: Radiographic indices; Panoramic mandibular index; Mandibular ratio; Mandibular cortical index

Abbreviations: PMI: Panoramic mandibular index; MR: Mandibular ratio; MCI: Mandibular cortical index; BMD: Bone Mineral Density; DXA: Dual-energy x-ray absorptiometry; OPG: Otrthodpantographic; SPSS: Statistical Package for Social Studies

Introduction

In humans and vertebrae, osteoid tissue represents the scaffold with which the body can stand. In addition, it is the main reservoir of calcium and growth factors and cytokines that are essential for well-being [1,2]. To fulfil these functions, bone undergoes lifelong remodeling, a physiologic phenomenon of breakdown and buildup [3]. Remodeling of the osseous tissues enables the bones to cope with all mechanical physiologic demands such as chewing in the case of the mandible. For healthy sound bone, the two parts of remodeling (resorption and apposition) must be in balance otherwise bone cannot be able to withstand the physiologic demands of the organ [4,5]. Healthy osteoid tissue, which is capable of regeneration and rebuilding, is a crucial factor in successful results in almost all dental treatments [6]. For example, healthy and sound jaws with a minimal requirement of quantity and quality of bone are a prerequisite for planning dental implants, orthodontic implants, prosthodontic replacements, and pre-prosthodontic surgical preparations [7]. Hence evaluation of bone quality and quantity or density and mineralization should be done before dental services. Several factors can influence bone density and mineralization, such as genetics, age, gender, and metabolic diseases. Osteoid disorders can be manifested in the bone of the mandible, such as osteoporosis which can be detected by studying the status of bone tissues of the mandible [8,9]. Osteoporosis is the most common metabolic abnormality affecting bones; it is defined as a skeletal disorder characterized by low bone mass and micro-architectural deterioration of bone tissue leading to bone fragility, and risking bone fracture [1]. At about the age of 30 years, bone mass reaches its peak, nevertheless to a greater extent in males than females. But with age, bone density decreases especially during the postmenopausal period in females [10].

For the evaluation of bone density and defect detection in the osteoid tissues, there are several ways applied, including Bone Mineral Density (BMD) that is applied by using dual-energy x-ray absorptiometry (DXA) [11]. On the other hand, some indices are applied on the Otrthodpantographic (OPG) such as the Panoramic Mandibular Index (PMI), Mandibular Ratio, and Mandibular Cortical Index (MCI) [12-15]. Dhandapani K and Mariamichael A [16], using mandibular indices, concluded that bone density is influenced by age and gender. The older the fewer bone minerals are found in the mandible, and females show less bone density in the mandible than males. Mağat G and Şener Ö [17] demonstrated that age and gender affect the remodeling of the gonial, antigonial, and ramus regions. This remodeling influenced specific areas in the mandible. Esin Hastara H. et.al. [18] found statistically significant differences between the Mandibular Cortical Index (MCI) and the Panoramic Mandibular Index (PMI) values when gender is used as an independent variable. This study aimed to evaluate the effect of age and gender on bone density using three indices that are Panoramic Mandibular Index (PMI), Mandibular Ratio (MR), and Mandibular Cortical Index (MCI).

Material and Method

Assessment indices

The following indices were used: Panoramic mandibular index (PMI) which is the ratio of "CI" to "h"; (PMI) = $^{(CI)}/_{h}$, where CI is the length in mm of the mandibular cortex measured in a line perpendicular to the lower border of the mandibular at the mental region (Figure 1, A); and "h" is the length of the vertical line that extends perpendicularly between the lower border of the mandibular cortex and the inferior rim of the mental foramen [19] (Figure 1, B). Mandibular ratio (MR) is the ratio of the mandibular height symbolled as "H" to the "h". The mandibular height (H) is the distance between the upper and lower borders of the mandible at the mental region (MR) = $^{H}/_{h}$) [20] (Figure 2). Mandibular cortical index (MCI) is a qualitative measure that assesses the demarcation between cortical and spongy bone. MCI is graded into three grades: C1 when the cortical bone edge is identified from the spongy bone (Figure 3, a), and C2 when the cortical bone edge is not a continuous line and shows fragmentation. (Figure 3, b), and C3 when the end of the cortical bone cannot be detected because of the heavy porosity of the cortical bone, (Figure 3, c).

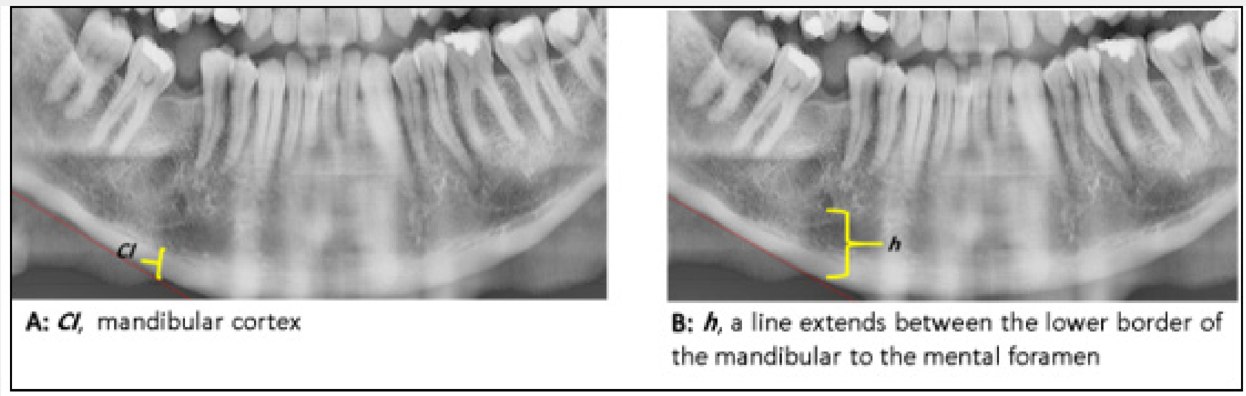

Figure 1: (A) Mandibular cortex and (CI),
(B) distance between lower border and mental foramen (h).

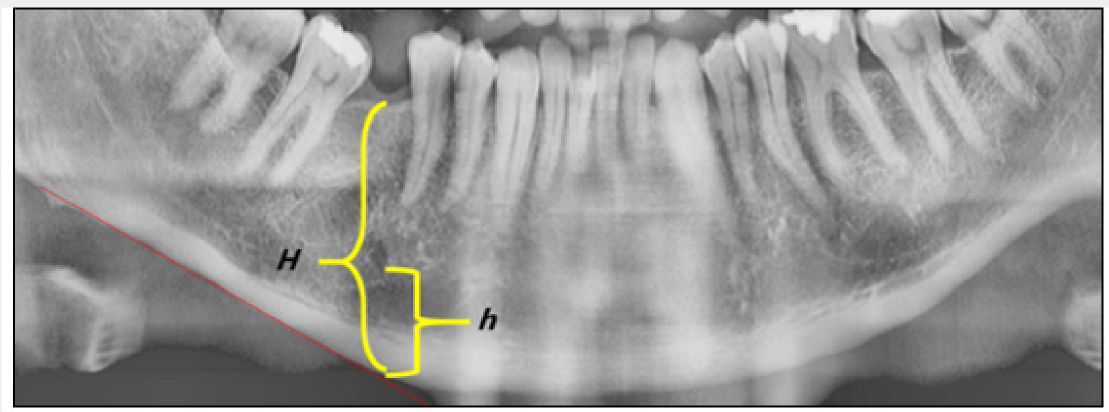

Figure 2: Mandibular ratio (MR) = H/h.

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

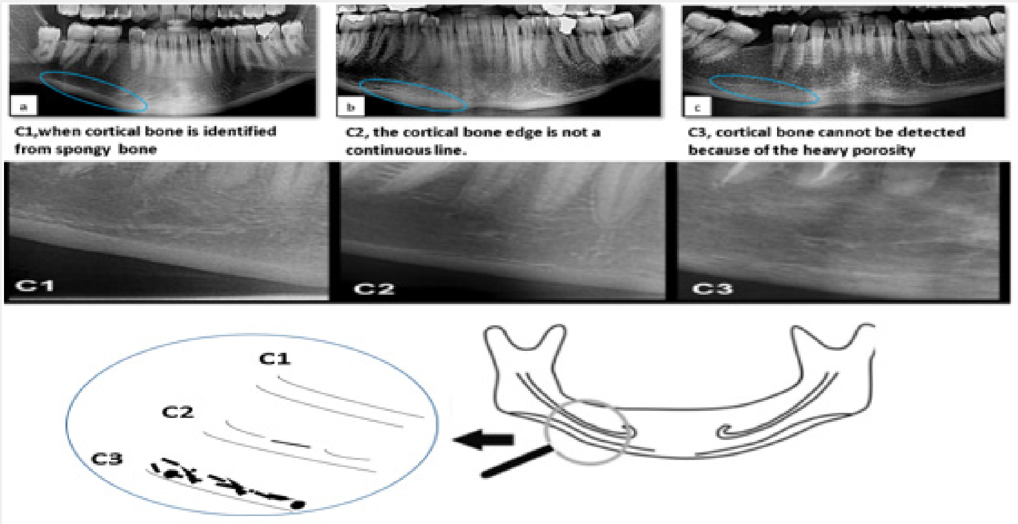

Figure 3: The Mandibular cortical index (MCI): a qualitative measure that assesses the demarcation between cortical and spongy bone.

Method of Sampling and Software Assessment

The sample (OPGs of dental patients) was retrieved from several public and private dental clinics in Benghazi, Libya for three years from January 2022 to November 2024. Initially, 975 OPGs were examined, but 24 OPGs were excluded after the inclusion and exclusion criteria were applied. Exclusion of the 24 OPGs was done if distortion, artefact, haziness, or errors in OPG were found and if the patient was medically compromised such as diabetes mellitus, hormonal upset, and bone diseases. OPGs were loaded on the investigator's personal computer using Digora® software to calculate the Panoramic Mandibular Index (PMI) and the Mandibular Ratio (MR). In contrast, the Mandibular Cortical Index (MCI) assessment was done qualitatively. Statistical analysis: The Statistical Package for Social Studies (SPSS) IBM® software Version 27 was used to calculate and analyze the results. The unpaired t-test was used to compare PMR and MR means among the two genders. The One-way ANOVA test was used to assess the effect of age on the PMR and MR. Correlation coefficient (r) was used to evaluate the association between the age and the two indices. The Chi-square test was applied to assess the effect of age and gender on MCI.

Results

The sample

Out of 951 OPGs, 486 were for Females (51.1%), and 465 were for males (48.9%). The sample's average age was 40.71, and the S.D. was 14.35 (Table 1) (Figure 4).

Table 1: Frequency distribution of the two genders in the sample.

Gender	Frequencies	%	
F	486	51.1	
M	465	48.9	
Total	951	100.0	

Statistics of the indices

The Panoramic Mandibular Index (PMI) sample's mean was 2.878 & S.D.=0.485. The mean PMI for females was 0.385 & S.D. = 0.078 while the mean PMI for males was 0.363 & S.D. = 0.081 (Table 2). The Mandibular ratio (MR) sample's mean was 2.877, and S.D. = 0.485. The mean of MR for females was 2.92, and S.D. = 0.52, while the mean of MR for males was 2.83, and S.D. = 0.44 (Table 2). Regarding the Mandibular Cortical Index (MCI), Class C1 of MCI was found in 350 OPGs, 218 for females and 132 for males; the class of MCI was found in 356 OPGs, 155 for females and 201 for males; and C3 class of MCI was found in 245 OPGs, 113 for females and 132 for males (Table 3) (Figure 5).

Table 2: Statistics of MPI and MR.

	Sample's Mean s.d.	Males' mean s.d.	Females' mean s.d.
MPI	0.375	0.363	0.385
	0.080	0.081	0.078
MR	2.877	2.831	2.919
	0.4850	0.440	0.521

Table 3: Statistics of MCI.

	C1	C2	C3	Total
F	218	155	113	486
M	132	201	132	465
Total	350	356	245	951

Influence of age

i. **The Panoramic Mandibular Index (PMI)**: The ANOVA test resulted in statistically insignificant differences between the six age groups' means of PMI (f=2.152, p = 0.057) (Table 4). Moreover, no statistically significant correlation existed between age (not grouped) and PMI (r =0.040, p = 0.222 (Table 5).

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

ii. The Mandibular ratio (MR): The ANOVA test resulted in statistically significant differences between the six age groups' means of MR (f=6.443, p <0.001) (Table 4). There was a statistically significant negative correlation coefficient between the age and MR (r = -0.159, p < 0.001) (Table 5).

iii. Mandibular Cortical Index (MCI): Table 6 shows a noticeable variability in the distribution of the three classes of MCT among the six age groups. This variability was found to be statistically significant according to the Person's Chi-square Test (Chi sq.= 86.523, p< 0.001) (Table 7).

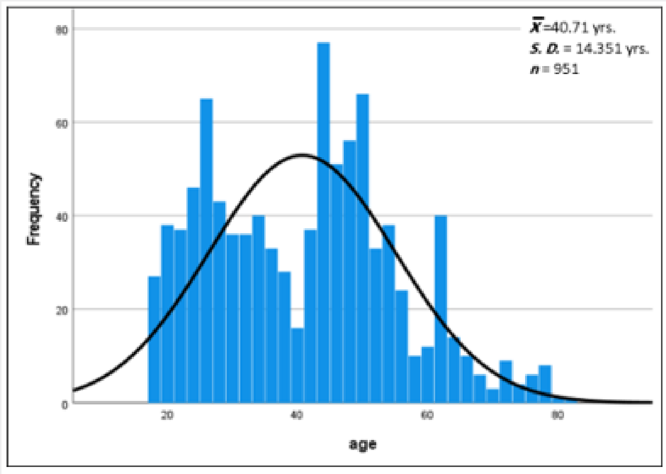

Figure 4: Age distribution of the sample.

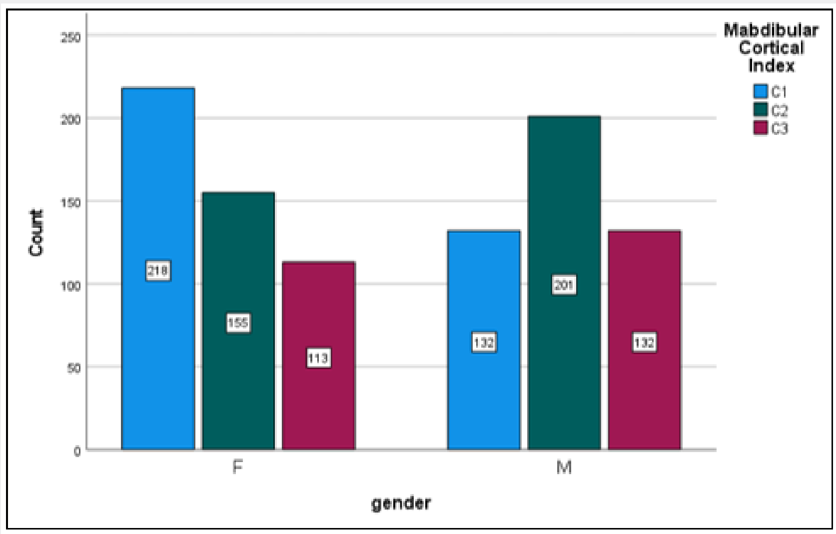

Figure 5: MCI distribution among the two genders.

Table 4: means and standard deviations of PMI and MR in the six age groups.

Age Group	Statistics	PMI	MR
<25	x	0.370	2.980
	n	174	174
	S. D.	0.085	0.464
26-35	x	0.366	2.914
	n	200	200

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

	S. D.	0.084	0.480
36-45	x	0.380	2.848
	n	212	212
	S. D.	0.070	0.533
46-55	x	0.371	2.863
	n	217	217
	S. D.	0.076	0.460
56-65	Mean	0.393	2.849
	n	110	110
	S. D.	0.088	0.450
>65	x	0.366	2.516
	n	38	38
	S. D.	0.081	0.371
ANOVA	f	.2.152	6.443
	P	0.057	0.000

Table 5: Correlation (r) output of PMI and MR vs. age.

		age	P MI	MR
age	Pearson Correlation	1	.040	-.159-**
	Sig. (2-tailed)		.222	.000
	N	951	951	951
PMI	Pearson Correlation	.040	1	.438**
	Sig. (2-tailed)	.222		.000
	N	951	951	951
MR	Pearson Correlation	-.159-**	.438**	1
	Sig. (2-tailed)	.000	.000	
	N	951	951	951
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 6: Distribution of C1, C2, and C3 classes of MCI among the sex age groups.

Age groups	C1	C2	C3	Total
<25	76	70	28	174
26-35	92	84	24	200
36-45	90	65	57	212
46-55	61	91	65	217
56-65	28	34	48	110
>65	3	12	23	38
Total	350	356	245	951

Table 7.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	86.523[a]	10	.000
Likelihood Ratio	88.371	10	.000
N of Valid Cases	951		

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

Influence of gender

i. Panoramic Mandibular Index (PMI): the overall mean of PMI was 2.878 & S.D.=0.485. The mean PMI for females was 0.385 & S.D. = 0.078 while the mean PMI for males was 0.363 & S.D. = 0.081 (Table 8). This difference between the means of PMI of the two genders was statistically significant (t= -4.203 p< 0.001) (Table 8).

ii. Mandibular ratio (MR): The overall mean of MR was 2.877, and S.D. = 0.485. The mean of MR for females was 2.92, and S.D. = 0.52, while the mean of MR for males was 2.83, and S.D. = 0.44 (Table 8). This difference between the means of MR of the two genders was statistically significant (t= -2.18, p=0.005) (Table 8).

iii. Mandibular Cortical Index (MCI): Class C1 of MCI was found in 350 OPGs, 218 for females and 132 for males; the class of MCI was found in 356 OPGs, 155 for females and 201 for males; and C3 class of MCI was found in 245 OPGs, 113 for females and 132 for males (Table 3) (Figure 5). This variability of the distribution of the three MCI classes was statistically significant (Chi sq.= 28.099, p< 0.001) (Table 9).

Table 8: Mean, Std. deviation of PMI and MR, the whole sample, and the male and Female subgroups

	Sex	N	Mean	Std. Deviation	t	Sig.
PMI	Both	951	2.878	0.485		
	M	465	0.363	0.0814		
	F	486	0.385	0.0781	-4.203	P = 0.000
MR	Both	951	2.877,	0.485		
	M	465	2.831	0.440		
	F	486	2.919	0.521	-2.815	P = 0.005

.

Table 9: Pearson Chi-Sq. test, and Fisher exact test results of MCI gender distribution.

	C1	C2	C3	Total	Chi-sq.	Sig.
F	218	155	113	486		
M	132	201	132	465	28.099	P = 0.000
Total	350	356	245	951		

Discussion

It has been suggested that OPG is an easy diagnostic tool and a cost-effective and reliable screening tool for studying the bone mass density (BMD) of the jaws, particularly the mandible [21-23]. The panoramic radiograph is a simple diagnostic tool that is frequently used by dentists for patient management, and radio morphometric indices applied on panoramic radiographs are useful means for the evaluation of bone mineralization and bone mass.

Influence of age

i. Panoramic Mandibular Index (PMI): According to this study, age does not affect the PMI. The ANOVA test revealed no statistically significant differences between the six age groups' means of PMI (f =2.152 P > 0.05) (Table 4). Furthermore, studying the correlation between age (not grouped) and the PMI revealed no association between the change in age and the values of PMI (r =0.040 P > 0.05) (Table 5). This finding is consistent with Mostfa et. al. [24] while it differs from others such as Eninanç et al. [25] and Bozdag G, and Sener S [26], who advocated that there is an association between age and PMI. This variability in the results of this study, in regards to age influence on PMI, can be attributed to the differences in ethnicities, the target population and the sample type, methods, and sample variations.

ii. Mandibular Ratio (MR): This study indicates that age negatively affects the value of MR, in other words, the relative bone height of the mandible declines with age. This finding was based on the ANOVA test results which indicated significant differences between the six age groups' means of MR (f=6.443, p <0.001) (Table 4). Also, it was based on the negative correlation coefficient between MR and age (r = -0.159, p < 0.001) (Table 5). This finding agrees with Drozdzowska B. et. al. [14], Goyushov S. et. al. Hinagankar et. al. [27], Arthanari A et. al. [28] and others [5,16,29] who concluded that older people have lowered quantitative mandibular indices. The decrease in the values of MR can be attributed to senile changes that take place in the dentoalveolar apparatus and the mandibular body, such as lowered levels of the alveolar process, bone loss due to dental extractions, and the decrease in the bone mass and density. Nevertheless, this study and other studies [14,30,31] found no effect of age on the measurement (h) which is the distance between the mandibular inferior margin and the lower margin of the mental foramen, in other words, there was no significant correlation between the two variables (r = 0.025, P= 0.448). While there is a significant statistical correlation between (H) and age (r= 0.077 p= 0.017). As a result of this behaviour of the nominator and dominator of MR (H/h) under the influence of age, we can adopt the above-mentioned explanation of the decrease of MR values as age progresses.

iii. Mandibular Cortical Index (MCI): this study revealed that age influences the distribution of MCT classes in different age stages. It showed that Class I and Class II tend to be predominant in younger age groups and decline with age, while Class III fluctuates as age process, however, it tends to be more frequent in elderly age groups than younger people Table 7. This variability was statistically significant according to the Person's Chi-square Test (Chi sq.= 86.523, p< 0.001) (Table 7). Since Class I indicates sound bone and healthy bone mineralization and Class III indicates decreased bone density and bone demineralization, this finding seems consistent with this fact. In other words, age affects the bone density and mass negatively. These findings go well with the findings of Keenan MJ et al. [32-35] who indicated the negative effect of age on bone density and mass.

Influence of gender

i. Panoramic Mandibular Index (PMI): the results indicated that the PMI mean is higher in females than males the statistically significant difference (t= -4.203 p< 0.001) (Table 8).

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

This finding is consistent with conclusions revealed by Govindraju P and Chandra P [36] who postulated that females' MRI is higher than that of males ow to the fact that the distance(h) which is the vertical difference between the mandibular inferior cortex and the lower mental foramen rim is less in females than males due to skeletal morphological differences between the two genders [24]. Though, Mostafa RA et al. [24] found no association between gender and the PMI value. On the contrary, Hastar E, Yilmaz HH, and Orhan H [18] revealed that Turkish males have a higher mean PMI value than Turkish females, and he emphasized that this difference is statistically significant. The difference between this study's findings and Master et. al.'s findings could be due to the difference in the sample which they selected. They investigated a sample of Turkish elderlies (60-88 years) while our sample age range was 18 to 75 years old.

ii. Mandibular ratio (MR): The females' MR mean was higher than the males' mea, which were 2.92 and 2.877 respectively (Table 8). This difference between the means of MR of the two genders was statistically significant (t= -2.18, p=0.005) (Table 8). This finding is in agreement with the finding of Drozdzowska B et al. [14] who assessed the relation between mandibular bone mineral density and mandibular indices revealing the mean value of h in males was higher than females' mean value, which reflects the effect of gender on the MR ratio.

iii. Mandibular Cortical Index (MCI): The variability of MCI classification frequency distribution in males and females was statistically significant indicating an association between the sex of the patient and MCI class (Figure 5) (Table 9). This agrees with Haster E et al. [18] Uysal S's [37], and Mordi et. al. [38] who concluded that females have higher MCI than males. Nevertheless, Mordi et al. [38] disvalued the importance of mandibular indices in the detection of demineralization of the bone.

Conclusion

Females have a higher PMI than males, but age does not influence PMI. Females have higher MR than males, and it is negatively affected by age. MCI is affected by both age and gender.

References

1. Hildebolt CJDR (1997) Osteoporosis and oral bone loss. Dentomaxillofac Radiol 26(1): 3-15.
2. Taichman RSJB (2005) Blood and bone: two tissues whose fates are intertwined to create the hematopoietic stem-cell niche105(7): 2631-2639.
3. Watson EL, Katz R, Adelezzi R, Gift HC, Dunn SJ (1995) ScidopotAAoHD the Academy of Dentistry for the Handicapped. Dentistry tASfG. The measurement of mandibular cortical bone height in osteoporotic vs. non-osteoporotic postmenopausal women 15(3): 124-128.
4. Lowe JS, Anderson PG, Anderson SI (2023) Stevens & Lowe's Human Histology-E-Book: Stevens & Lowe's Human Histology-E-Book: Elsevier Health Sciences.
5. Kierszenbaum AL, Tres L (2015) Histology and Cell Biology: an introduction to pathology E-Book: Elsevier Health Sciences.
6. Papadakis I, Spanou A, Kalyvas DJJoOI (2021) Success rate and safety of dental implantology in patients treated with antiresorptive medication: a systematic review 47(2): 169-180.
7. Busenlechner D, Fürhauser R, Haas R, Watzek G, Mailath G, et al. (2014) Long-term implant success at the Academy for Oral Implantology: 8-year follow-up and risk factor analysis 44(3): 102-108.
8. Moraschini V, Poubel LdC, Ferreira V, dos Sp Barboza EJIjoo, Surgery M (2015) Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review 44(3): 377-388.
9. Moy PK, Medina D, Shetty V, Aghaloo TLJIJoO (2005) Dental implant failure rates and associated risk factors. Int J Oral Maxillofac Implants 20(4): 569-577.
10. Recker RR, Kimmel DB, Dempster D, Weinstein R, Wronski T, et al. (2011) Issues in modern bone histomorphometry. Bone 49(5): 955-964.
11. Keenan MJ, Hegsted M, Jones KL, Delany JP, Kime JC, et al. (1997) Comparison of bone density measurement techniques: DXA and Archimedes' principle. J Bone Miner Res 12(11): 1903-1907.
12. Gulsahi A, Paksoy C, Ozden S, Kucuk N, Cebeci A, et al. (2010) Assessment of bone mineral density in the jaws and its relationship to radiomorphometric indices 39(5): 284-289.
13. Devlin H, Horner KJOi (2002) Mandibular radiomorphometric indices in the diagnosis of reduced skeletal bone mineral density. Osteoporos Int 13: 373-38.
14. Drozdzowska B, Pluskiewicz W, Tarnawska BJDR (2002) Panoramic-based mandibular indices in relation to mandibular bone mineral density and skeletal status assessed by dual energy X-ray absorptiometry and quantitative ultrasound. Dentomaxillofac Radiol 31(6): 361-367.
15. Heuchert J, Kozieł S, Spinek AEJOI (2024) Radiomorphometric indices of the mandible as indicators of decreased bone mineral density and osteoporosis–meta-analysis and systematic review 35(3): 401-412.
16. Dhandapani K, Mariamichael AJOJoBS (2015) Influence of age and gender on mandible among South Indian population 15(1): 23.
17. Mağat G, Özcan Şener S (2008) The morphological changes in the mandible bone: the effects of age, gender and dental status.
18. Hastar E, Yilmaz HH, Orhan HJEjod (2011) Evaluation of mental index, mandibular cortical index and panoramic mandibular index on dental panoramic radiographs in the elderly 5(1): 60-67.
19. Benson BW, Prihoda TJ, Glass BJ (1991) Variations in adult cortical bone mass as measured by a panoramic mandibular index. Oral surgery, oral medicine, oral pathology 71(3): 349-356.
20. Ortman L, Hausmann E, Dunford R (1989) Skeletal osteopenia and residual ridge resorption. The Journal of prosthetic dentistry 61(3): 321-325.
21. Kale IP, Mhapuskar AA, Hiremutt DRP, Rao PR, Karmarkar PH, et al. (2024) Reliability of Orthopantomogram in Predicting Bone Mineral Density as Compared to Dual Energy X-Ray Absorptiometry in Post-menopausal Indian Females: A Radiological Original Study 36(3): 283-287.
22. Tounta (2017) Diagnosis of osteoporosis in dental patients. TSJJ of sarcopenia, falls 2(2): 21.
23. López López J, Estrugo Devesa A, Jané Salas E, Ayuso Montero R, Gómez Vaquero CJMO, et al. (2011) Early diagnosis of osteoporosis by means of orthopantomograms and oral x-rays: a systematic review 16(7): 905-913.

How to cite this article: Mahfud F M. The Influence of Age and Gender on Panoramic Mandibular Indices. Adv Dent & Oral Health. 2025; 18(2): 555983. DOI: 10.19080/ADOH.2025.18.555983

24. Mostafa RA, El-Ashiry MK, Farid MMJEJoO, Surgery M (2011) Effect of age, sex, and dental status on mental and panoramic mandibular indices of the mandible: a retrospective study 2(1): 22-26.

25. Eninanç İ, Hergüner TJTJoS (2022) Comparison of radio morpometric index measurements in the mandible of completely edentulous elderly and middle-aged individuals. Health 3(3): 147-156.

26. Bozdag G, Sener S (2015) The evaluation of MCI, MI, PMI and GT on both genders with different age and dental status. Dentomaxillofacial Radiology 44(9).

27. Hinagankar T, Patel S, Patel A, Mohod SC, Reche A, et al. (2024) Age- and Gender-Related Variations in Cortical Bone Density of the Mandible using Cone-Beam Computed Tomography in Central Indian Population 19(3): 441-444.

28. Arthanari A, Sureshbabu S, Ramalingam K, Ravindran V, Prathap L, et al. (2024) Analyzing Mandibular Characteristics for Age and Gender Variation Through Digital Radiographic Techniques: A Retrospective Study. Cureus 16(4): e58500.

29. Alves C, Munhoz M, Nascimento G, Nícoli G, Paleari A, et al. (2018) The Influence of Age, Gender, Mandibular Bone Height, Previous Experience with Prostheses, and Fabrication Methods on Masticatory Performance of Complete Denture Wearers: Masticatory Performance and Complete Dentures. Journal of Prosthodontics 28(1): e34-e40.

30. Kalinowski P, Różyło-Kalinowska IJFm (2011) Panoramic radiomorphometric parameters in Polish patients. Folia Morphol 70(3): 168-174.

31. Zmysłowska E, Ledzion S, Jędrzejewski KJFm (2007) Factors affecting mandibular residual ridge resorption in edentulous patients: a preliminary report 66(4): 346-352.

32. Keenan MJ, Hegsted M, Jones KL, Delany JP, Kime JC, et al. (1997) Comparison of bone density measurement techniques: DXA and Archimedes' principle. Journal of bone and mineral research: the official journal of the American Society for Bone and Mineral Research 12(11): 1903-1097.

33. Taguchi A, Suei Y, Ohtsuka M, Otani K, Tanimoto K, et al. (1996) Usefulness of panoramic radiography in the diagnosis of postmenopausal osteoporosis in women. Width and morphology of inferior cortex of the mandible. Dento maxillo facial radiology 25(5): 263-267.

34. Klemetti E, Kolmakow S (1997) Morphology of the mandibular cortex on panoramic radiographs as an indicator of bone quality. Dento maxillo facial radiology 26(1): 22-25.

35. Klemetti E, Kolmakov S, Kröger H (1994) Pantomography in assessment of the osteoporosis risk group. Scandinavian journal of dental research 102(1): 68-72.

36. Govindraju P, Chandra P (2014) Radiomorphometric indices of the mandible - an indicator of osteoporosis. Journal of clinical and diagnostic research: JCDR 8(3): 195-198.

37. Uysal S, Çağırankaya BL, Hatipoğlu MGJH (2007) Do gender and torus mandibularis affect mandibular cortical index? A cross-sectional study. Head Face Med 3: 1-6.

38. Moradi M, Tofangchiha M, Soltanmohammadi E, Golshahi H, Mojtahedi NJAoDS (2017) The influence of age, gender and dental status on the mandibular radiomorphometric and morphological indices 5(2): 63-67.