**REPUBLIQUE DU CAMEROUN**
***Paix-Travail-patrie***
---
**UNIVERSITE DE YAOUNDE I**
---
**FACULTE DE MEDECINE ET DES SCIENCES BIOMEDICALES**
---
**DÉPARTEMENT DE RADIOLOGIE ET D'IMAGERIE MÉDICALE**

**REPUBLIC OF CAMEROON**
***Peace-Work-Fatherland***
---
**THE UNIVERSITY OF YAOUNDE I**
---
**FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES**
---
**DEPARTMENT OF RADIOLOGY AND MEDICAL IMAGING**

# PROFILE OF MANDIBULAR BONE MINERAL DENSITY IN CAMEROONIAN WOMEN OF ADULT AGE: A PANORAMIC RADIOGRAPHIC ANALYSIS (2021- 2024) at the Laboratory of Implantology and Periodontology, University of Yaoundé I

Thesis written and publicly defended in partial fulfilment of the requirements for the award of a Doctorate degree in Dental Medicine by:

**ACHUMBOM HAGGAI AKUMBOM**

Matricule N°: 17M217

**Director**

**Pr. ZEH ODILE FERNANDE**

*Professor of Radiology and Medical Imaging*

**Co-directors**

**Dr. NDJOH JULES JULIEN**

*Senior Lecturer in Implantology and Periodontology*

**Dr. METOGO NTSAMA JUNIE ANNICK**

*Senior Lecturer in Obstetrics and Gynaecology*

*Academic year 2023-2024*

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# PROFILE OF MANDIBULAR BONE MINERAL DENSITY IN CAMEROONIAN WOMEN OF ADULT AGE: A PANORAMIC RADIOGRAPHIC ANALYSIS (2021- 2024) at the Laboratory of Implantology and Periodontology, University of Yaoundé I

Thesis written and defended with a view to obtaining a Doctorate in Dental Medicine by:

**ACHUMBOM HAGGAI AKUMBOM**

Matricule N°: 17M217

Date of thesis defence: 29th of June 2024

**Jury:**

**President of Jury**

Pr. GUEGANG E.

**Reporter**

Pr. ZEH Odile Fernande

**Members**

Pr. NGO UM MEKA

Dr. MBEDE NGAH

**The supervision team :**

**Director**

**Pr. ZEH ODILE FERNANDE**
*Professor of Radiology and Medical Imaging*

**Co-directors**

**Dr. METOGO NTSAMA JUNIE ANNICK**
*Senior Lecturer in Obstetrics and Gynaecology*

**Dr. NDJOH JULES JULIEN**
*Senior Lecturer in Implantology and Periodontology*

*Academic year 2023-2024*

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# DEDICATION

To my late Mother

**ABESOMO SALOME**

## ACKNOWLEDGEMENTS

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- Dr. NDJOH JULES JULIEN, a true embodiment of empathy and excellence. You serve as an exceptional role model, and I aspire to one day follow in your esteemed footsteps. I am deeply grateful for all that you have done and continue to do.
- Dr. METOGO NTSAMA JUNIE ANNICK, for your outstanding guidance and exceptional teaching. Your expertise and dedication have been invaluable to my academic growth and development.
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- Dr. ZILEFAC Brian Ngokwe, for your invaluable academic mentorship. Your unwavering commitment to excellence has served as a guiding light throughout my educational journey. I am profoundly grateful for your generous contributions and unwavering support, both financially and morally.
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- My beloved parents, NKWENTI Martin ACHUMBOM and ACHUMBOM Magdalene, for the exceptional upbringing you have provided and your unwavering support throughout my academic journey. Your love and encouragement have been my constant source of strength.

- My beloved uncle, Professor Pius Wuchu AKUMBU, for the invaluable life lessons and principles you continue to instil in us. Your wisdom and guidance have shaped us into the individuals we are today.
- My beloved uncles and aunts, for your unwavering moral support and encouragement. Your presence in my life has been a source of comfort and strength.
- All my cousins, nephews, and nieces, for your constant moral support and well wishes. Your encouragement has been a motivating factor in my academic pursuits.

My esteemed classmates of the 49th batch of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I, especially those who collaborated with the Implantology Laboratory, for the cherished moments of mutual assistance and joy shared throughout the entire process, from the conception to the finalization of this work.

I am deeply grateful for the collective contributions of everyone mentioned above, as they have been instrumental in the successful completion of this academic endeavour.

# LIST OF ADMINISTRATIVE AND TEACHING STAFF OF FMBS(UY1) 2023-2024

## 1. ADMINISTRATIVE PERSONNELS

- **Dean :** Pr ZE MINKANDE Jacqueline
- **Vice-Dean in charge of programming and monitoring academic activities**: Pr NTSAMA ESSOMBA Claudine Mireille
- **Vice-Dean for Research and Cooperation**: Pr ZEH Odile Fernande
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- **Deputy Head of the Schooling and Statistics Department:** Ms FAGNI MBOUOMBO AMINA married name ONANA
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- **Materials accountant**: Mr MOUMEMIE NJOUNDIYIMOUN MAZOU

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- **Coordinator of the Specialization Cycle in Gynecology and Obstetrics**: Pr DOHBIT Julius SAMA
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- **Coordinator of the Specialization Cycle in Public Health**: Pr TAKOUGANG Innocent
- **Continuing education coordinator:** Pr KASIA Jean Marie
- **Project focal point:** Pr NGOUPAYO Joseph
- **CESSI Pedagogical Manager**: Pr ANKOUANE ANDOULO Firmin

**3. CUSS HONORARY DIRECTORS**

- Pr MONEKOSSO Gottlieb (1969-1978)
- Pr EBEN MOUSSI Emmanuel (1978-1983)
- Pr NGU LIFANJI Jacob (1983-1985)
- Pr CARTERET Pierre (1985-1993)

**4. HONORARY DEANS OF THE FMSB**

- Pr SOSSO Maurice Aurélien (1993-1999)
- Pr NDUMBE Peter (1999-2006)
- Prof. TETANYE EKOE Bonaventure (2006-2012)
- Prof. EBANA MVOGO Côme (2012-2015)

## 5. TEACHING STAFF

| N° | FULL NAME | GRADE | DISCIPLINE |
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| | **DEPARTMENT OF SURGERY AND SPECIALTIES** | | |
| 1 | **SOSSO Maurice Aurélien (CD)** | P | General Surgery |
| 2 | DJIENTCHEU Vincent de Paul | P | Neurosurgery |
| 3 | **ESSOMBA Arthur (Acting CD)** | P | General Surgery |
| 4 | HANDY EONE Daniel | P | Orthopaedic Surgery |
| 5 | MOUAFO TAMBO Faustin | P | Pediatric Surgery |
| 6 | NGO NONGA Bernadette | P | General Surgery |
| 7 | NGOWE NGOWE Marcellin | P | General Surgery |
| 8 | OWONO ETOUNDI Paul | P | Anaesthesia and intensive care |
| 9 | ZE MINKANDE Jacqueline | P | Anaesthesia and intensive care |
| 10 | BAHEBECK Jean | AP | Orthopaedic Surgery |
| 11 | BANG GUY Aristide | AP | General Surgery |
| 12 | BENGONO BENGONO Roddy Stéphan | AP | Anaesthesia and intensive care |
| 13 | FARIKOU Ibrahima | AP | Orthopaedic Surgery |
| 14 | JEMEA Bonaventure | AP | Anaesthesia and intensive care |
| 15 | BEYIHA Gérard | AP | Anaesthesia and intensive care |
| 16 | EYENGA Victor Claude | AP | Surgery/Neurosurgery |
| 17 | GUIFO Marc Leroy | AP | General Surgery |
| 18 | NGO YAMBEN Marie Ange | SL | Orthopaedic Surgery |
| 19 | TSIAGADIGI Jean Gustave | SL | Orthopaedic Surgery |
| 20 | BELLO FIGUIM | SL | Neurosurgery |
| 21 | BIWOLE BIWOLE Daniel Claude Patrick | SL | General Surgery |
| 22 | FONKOUE Loïc | SL | Orthopaedic Surgery |
| 23 | KONA NGONDO François Stéphane | SL | Anaesthesia and intensive care |
| 24 | MBOUCHE Landry Oriole | SL | Urology |
| 25 | MEKEME MEKEME Junior Barthelemy | SL | Urology |
| 26 | MULUEM Olivier Kennedy | SL | Orthopedics-Traumatology |
| 27 | SAVOM Eric Patrick | SL | General Surgery |
| 28 | AHANDA ASSIGA | L | General Surgery |
| 29 | AMENGLE Albert Ludovic | L | Anaesthesia and intensive care |
| 30 | BIKONO ATANGANA Ernestine Renée | L | Neurosurgery |
| 31 | BWELE Georges | L | General Surgery |
| 32 | EPOUPA NGALLE Frantz Guy | L | Urology |

| | | | |
|---|---|---|---|
| 33 | FOUDA Jean Cédrick | L | Urology |
| 34 | IROUME Cristella Raïssa BIFOUNA married NTYO'O NKOUMOU | L | Anaesthesia and intensive care |
| 35 | MOHAMADOU GUEMSE Emmanuel | L | Orthopaedic Surgery |
| 36 | NDIKONTAR KWINJI Raymond | L | Anaesthesia and intensive care |
| 37 | NWAHA MAKON Axel Stéphane | L | Urology |
| 38 | NYANIT BOB Dorcas | L | Pediatric Surgery |
| 39 | OUMAROU HAMAN NASSOUROU | L | Neurosurgery |
| 40 | ARROYE BETOU Fabrice Stéphane | AL | Thoracic and Cardiovascular Surgery |
| 41 | ELA BELLA Amos Jean-Marie | AL | Thoracic Surgery |
| 42 | FOLA KOPONG Olivier | AL | Surgery |
| 43 | FOSSI KAMGA GACELLE | AL | Pediatric Surgery |
| 44 | GOUAG | AL | Anaesthesia and intensive care |
| 45 | MBELE Richard II | AL | Thoracic Surgery |
| 46 | MFOUAPON EWANE Hervé Blaise | AL | Neurosurgery |
| 47 | NGOUATNA DJEUMAKOU Serge Rawlings | AL | Anaesthesia and intensive care |
| 48 | NYANKOUE MEBOUINZ Ferdinand | AL | Orthopaedic and Traumatological Surgery |

**DEPARTMENT OF INTERNAL MEDICINE AND SPECIALTIES**

| | | | |
|---|---|---|---|
| 49 | **SINGWE Madeleine née NGANDEU (CD)** | P | Internal Medicine/Rheumatology |
| 50 | ANKOUANE ANDOULO | P | Internal Medicine/ Hepato-Gastro-Enterology |
| 51 | ASHUNTANTANG Gloria Enow | P | Internal medicine/nephrology |
| 52 | BISSEK Anne Cécile | P | Internal Medicine/Dermatology |
| 53 | KAZE FOLEFACK François | P | Internal medicine/nephrology |
| 54 | KUATE TEGUEU Calixte | P | Internal Medicine/Neurology |
| 55 | KOUOTOU Emmanuel Armand | P | Internal Medicine/Dermatology |
| 56 | MBANYA Jean Claude | P | Internal Medicine/Endocrinology |
| 57 | NDJITOYAP NDAM Elie Claude | P | Internal Medicine/ Hepato-Gastro-Enterology |
| 58 | NDOM Paul | P | Internal Medicine/Oncology |
| 59 | NJAMNSHI Alfred KONGNYU | P | Internal Medicine/Neurology |
| 60 | NJOYA OUDOU | P | Internal Medicine/Gastroenterology |
| 61 | SOBNGWI Eugène | P | Internal Medicine/Endocrinology |
| 62 | PEFURA YONE Eric Walter | P | Internal Medicine/Pneumology |
| 63 | BOOMBHI Jérôme | AP | Internal Medicine/Cardiology |
| 64 | FOUDA MENYE Hermine Danielle | AP | Internal Medicine/Nephrology |
| 65 | HAMADOU BA | AP | Internal Medicine/Cardiology |
| 66 | MENANGA Alain Patrick | AP | Internal Medicine/Cardiology |
| 67 | NGANOU Chris Nadège | AP | Internal Medicine/Cardiology |
| 68 | KOWO Mathurin Pierre | SL | Internal Medicine/ Hepato-Gastro-Enterology |
| 69 | KUATE née MFEUKEU KWA Liliane Claudine | SL | Internal Medicine/Cardiology |
| 70 | NDONGO AMOUGOU Sylvie | SL | Internal Medicine/Cardiology |
| 71 | DEHAYEM YEFOU Mesmin | SL | Internal Medicine/Endocrinology |
| 72 | ESSON MAPOKO Berthe Sabine Épouse PAAMBOG | SL | Internal Medicine/Medical Oncology |
| 73 | ETOA NDZIE Épouse ETOGA Martine Claude | SL | Internal Medicine/Endocrinology |
| 74 | MAÏMOUNA MAHAMAT | SL | Internal medicine/nephrology |
| 75 | MASSONGO MASSONGO | SL | Internal Medicine/Pneumology |
| 76 | MBONDA CHIMI Paul-Cédric | SL | Internal Medicine/Neurology |

| | | | |
|---|---|---|---|
| 77 | NDJITOYAP NDAM Antonin Wilson | SL | Internal Medicine/Gastroenterology |
| 78 | NDOBO Épouse KOE Juliette Valérie Danielle | SL | Internal Medicine/Cardiology |
| 79 | NGAH KOMO Elisabeth | SL | Internal Medicine/Pneumology |
| 80 | NGARKA Léonard | SL | Internal Medicine/Neurology |
| 81 | NKORO OMBEDE Grâce Anita | SL | Internal Medicine/Dermatologist |
| 82 | OWONO NGABEDE Amalia Ariane | SL | Internal Medicine/Interventional Cardiology |
| 83 | NTSAMA ESSOMBA Marie Josiane Épouse EBODE | SL | Internal Medicine/Geriatrics |
| 84 | ATENGUENA OBALEMBA Etienne | L | Internal Medicine/Medical Oncology |
| 85 | FOJO TALONGONG Baudelaire | L | Internal Medicine/Rheumatology |
| 86 | KAMGA OLEN Jean Pierre Olivier | L | Internal Medicine/Psychiatry |
| 87 | MENDANE MEKOBE Francine Épouse EKOBENA | L | Internal Medicine/Endocrinology |
| 88 | MINTOM MEDJO Pierre Didier | L | Internal Medicine/Cardiology |
| 89 | NTONE ENYIME Félicien | L | Internal Medicine/Psychiatry |
| 90 | NZANA Victorine Bandolo Épouse FORKWA MBAH | L | Internal medicine/nephrology |
| 91 | ANABA MELINGUI Victor Yves | AL | Internal Medicine/Rheumatology |
| 92 | EBENE MANON Guillaume | AL | Internal Medicine/Cardiology |
| 93 | ELIMBY NGANDE Lionel Patrick Joël | AL | Internal medicine/nephrology |
| 94 | KUABAN Alain | AL | Internal Medicine/Pneumology |
| 95 | NKECK Jan René | AL | Internal Medicine |
| 96 | NSOUNFON ABDOU WOUOLIYOU | AL | Internal Medicine/Pneumology |
| 97 | NTYO'O NKOUMOU Arnaud Laurel | AL | Internal Medicine/Pneumology |
| 98 | TCHOUANKEU KOUNGA Fabiola | AL | Internal Medicine/Psychiatry |

**MEDICAL IMAGING AND RADIOLOGY DEPARTMENT**

| | | | |
|---|---|---|---|
| 99 | **ZEH Odile Fernande (CD)** | P | Radiology/Medical Imaging |
| 100 | GUEGANG GOUJOU. Emilienne | P | Medical Imaging/Neuroradiology |
| 101 | MOIFO Boniface | P | Radiology/Medical Imaging |
| 102 | ONGOLO ZOGO Pierre | SL | Radiology/Medical Imaging |
| 103 | SAMBA Odette NGANO | SL | Biophysics/Medical Physics |
| 104 | MBEDE Maggy Épouse ENDEGUE MANGA | L | Radiology/Medical Imaging |
| 105 | MEKA'H MAPENYA Ruth-Rosine | L | Radiotherapy |
| 106 | NWATSOCK Joseph Francis | L | Radiology/Medical Imaging Nuclear Medicine |
| 107 | SEME ENGOUMOU Ambroise Merci | L | Radiology/Medical Imaging |
| 108 | ABO'O MELOM Adèle Tatiana | AL | Radiology and Medical Imaging |

**GYNECOLOGY-OBSTETRICS DEPARTMENT**

| | | | |
|---|---|---|---|
| 109 | **NGO UM Esther Juliette Épouse MEKA (CD)** | P | Gynecology and obstetrics |
| 110 | FOUMANE Pascal | P | Gynecology and obstetrics |
| 111 | KASIA Jean Marie | P | Gynecology and obstetrics |
| 112 | KEMFANG NGOWA Jean Dupont | P | Gynecology and obstetrics |
| 113 | MBOUDOU Émile | P | Gynecology and obstetrics |
| 114 | MBU ENOW Robinson | P | Gynecology and obstetrics |
| 115 | NKWABONG Elie | P | Gynecology and obstetrics |
| 116 | TEBEU Pierre Marie | P | Gynecology and obstetrics |
| 117 | BELINGA Etienne | AP | Gynecology and obstetrics |
| 118 | ESSIBEN Félix | AP | Gynecology and obstetrics |
| 119 | FOUEDJIO Jeanne Hortence | AP | Gynecology and obstetrics |
| 120 | NOA NDOUA Claude Cyrille | AP | Gynecology and obstetrics |
| 121 | DOHBIT Julius SAMA | AP | Gynecology and obstetrics |
| 122 | MVE KOH Valère Salomon | AP | Gynecology and obstetrics |
| 123 | METOGO NTSAMA Junie Annick | L | Gynecology and obstetrics |
| 124 | MBOUA BATOUM Véronique Sophie | L | Gynecology and obstetrics |
| 125 | MENDOUA Michèle Florence Épouse NKODO | L | Gynecology and obstetrics |
| 126 | NSAHLAI Christiane JIVIR FOMU | L | Gynecology and obstetrics |
| 127 | NYADA Serge Robert | L | Gynecology and obstetrics |

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|---|---|---|---|
| 128 | TOMPEEN Isidore | L | Gynecology and obstetrics |
| 129 | EBONG Cliford EBONTANE | AL | Gynecology and obstetrics |
| 130 | MPONO EMENGUELE Pascale Épouse NDONGO | AL | Gynecology and obstetrics |
| 131 | NGONO AKAM Marga Vanina | AL | Gynecology and obstetrics |

**DEPARTMENT OF OPHTHALMOLOGY, EAR, NOSE AND THROAT AND STOMATOLOGY**

| | | | |
|---|---|---|---|
| 132 | **DJOMOU François (CD)** | P | ENT |
| 133 | EBANA MVOGO Côme | P | Ophthalmology |
| 134 | ÉPÉE Émilienne Épouse ONGUENE | P | Ophthalmology |
| 135 | KAGMENI Gilles | P | Ophthalmology |
| 136 | NDJOLO Alexis | P | ENT |
| 137 | NJOCK Richard | P | ENT |
| 138 | OMGBWA EBALE André | P | Ophthalmology |
| 139 | BILLONG Yannick | AP | Ophthalmology |
| 140 | DOHVOMA Andin Viola | AP | Ophthalmology |
| 141 | EBANA MVOGO Stève Robert | AP | Ophthalmology |
| 142 | KOKI Godefroy | AP | Ophthalmology |
| 143 | MINDJA EKO David | AP | ENT/Maxillofacial surgery |
| 144 | NGABA Olive | AP | ENT |
| 145 | ANDJOCK NKOUO Yves Christian | SL | ENT |
| 146 | MEVA'A BIOUELE Roger Christian | SL | ENT-CCF |
| 147 | MOSSUS Yannick | SL | ENT-CCF |
| 148 | MVILONGO TSIMI Épouse BENGONO Caroline | SL | Ophthalmology |
| 149 | NGO NYEKI Adèle-Rose Épouse MOUAHA-BELL | SL | ENT-CCF |
| 150 | NOMO Arlette Francine | SL | Ophthalmology |
| 151 | AKONO ZOUA Épouse ETEME Marie Evodie | L | Ophthalmology |
| 152 | ASMAOU BOUBA Dalil | L | ENT |
| 153 | ATANGA Léonel Christophe | L | ENT-CCF |
| 154 | BOLA SIAFA Antoine | L | ENT |

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|---|---|---|---|
| | | | Ophthalmology |
| 155 | NANFACK NGOUNE Chantal | L | |

**PEDIATRICS DEPARTMENT**

| | | | |
|---|---|---|---|
| 156 | **ONGOTSOYI Angèle Épouse PONDY (CD)** | P | Pediatrics |
| 157 | KOKI NDOMBO Paul | P | Pediatrician |
| 158 | ABENA OBAMA Marie Thérèse | P | Pediatrics |
| 159 | CHIABI Andreas | P | Pediatrics |
| 160 | CHELO David | P | Pediatrics |
| 161 | MAH Evelyn | P | Pediatrics |
| 162 | NGUEFACK Séraphin | P | Pediatrics |
| 163 | NGUEFACK Épouse DONGMO Congratulated | P | Pediatrics |
| 164 | NGO UM KINJEL Suzanne épse SAP | AP | Pediatrics |
| 165 | KALLA Ginette Claude née MBOPI KEOU | AP | Pediatrics |
| 166 | MBASSI AWA Hubert Désiré | AP | Pediatrics |
| 167 | NOUBI Nelly Épouse KAMGAING MOTING | AP | Pediatrics |
| 168 | EPEE Épouse NGOUE Jeannette | SL | Pediatrics |
| 169 | KAGO TAGUE Daniel Armand | SL | Pediatrics |
| 170 | MEGUIEZE Claude-Audrey | SL | Pediatrics |
| 171 | MEKONE NKWELE Isabelle | SL | Pediatrician |
| 172 | TONY NENGOM Jocelyn | SL | Pediatrics |

## DEPARTMENT OF MICROBIOLOGY, PARASITOLOGY, HEMATOLOGY AND INFECTIOUS DISEASES

| | | | |
|---|---|---|---|
| 173 | **MBOPI KEOU François-Xavier (CD)** | P | Bacteriology/ Virology |
| 174 | ADIOGO Dieudonné | P | Microbiology/Virology |
| 175 | GONSU née KAMGA Hortense | P | Bacteriology |
| 176 | LUMA Henry | P | Bacteriology/ Virology |
| 177 | MBANYA Dora | P | Hematology |
| 178 | OKOMO ASSOUMOU Marie Claire | P | Bacteriology/ Virology |
| 179 | TAYOU TAGNY Claude | P | Microbiology/Hematology |
| 180 | CHETCHA CHEMEGNI Bernard | AP | Microbiology/Hematology |
| 181 | LYONGA Emilia ENJEMA | AP | Medical Microbiology |
| 182 | TOUKAM Michel | AP | Microbiology |
| 183 | NGANDO Laure Épouse MOUDOUTE | AP | Parasitology |
| 184 | BEYALA Frédérique | L | Infectious Diseases |
| 185 | BOUM II YAP | L | Microbiology |
| 186 | ESSOMBA Réné Ghislain | L | Immunology |
| 187 | MEDI SIKE Christiane Ingrid | L | Infectious diseases |
| 188 | NGOGANG Marie Paule | L | Clinical Biology |
| 189 | NDOUMBA NKENGUE Annick Épouse MINTYA | L | Hematology |
| 190 | VOUNDI VOUNDI Esther | L | Virology |
| 191 | ANGANDJI TIPANE Prisca Épouse ELLA | AL | Clinical Biology / Hematology |
| 192 | Georges MONDINDE IKOMEY | AL | Immunology |
| 193 | MBOUYAP Pretty Rosereine | AL | Virology |

## PUBLIC HEALTH DEPARTMENT

| | | | |
|---|---|---|---|
| 194 | **KAMGNO Joseph (CD)** | P | Public health/Epidemiology |
| 195 | ESSI Marie José | P | Public Health/Medical Anthropology |
| 196 | TAKOUGANG Innocent | P | Public Health |
| 197 | BEDIANG Georges Wilfred | AP | Medical Informatics/Public Health |
| 198 | BILLONG Serges Clotaire | AP | Public Health |
| 199 | NGUEFACK TSAGUE | AP | Public health /Biostatistics |
| 200 | EYEBE EYEBE Serge Bertrand | L | Public health/Epidemiology |
| 201 | KEMBE ASSAH Félix | L | Epidemiology |
| 202 | KWEDI JIPPE Anne Sylvie | L | Epidemiology |

| | | | |
|---|---|---|---|
| 203 | MOSSUS Tatiana née ETOUNOU AKONO | L | Expert in Health Promotion |
| 204 | NJOUMEMI ZAKARIAOU | L | Public Health/Health Economics |
| 205 | ABBA-KABIR Haamit-Mahamat | AL | Pharmacist |
| 206 | AMANI ADIDJA | AL | Public Health |
| 207 | ESSO ENDALLE Lovet Linda Augustine Julia | AL | Public Health |
| 208 | MBA MAADJHOU Berjauline Camille | AL | Public Health/Nutritional Epidemiology |
| | **MORPHOLOGICAL SCIENCES-PATHOLOGICAL ANATOMY DEPARTMENT** | | |
| 209 | **MENDIMI NKODO Joseph (CD)** | AP | Anatomy Pathology |
| 210 | SANDO Zacharie | P | Anatomy Pathology |
| 211 | BISSOU MAHOP Josue | AP | Sports Medicine |
| 212 | KABEYENE OKONO Angèle Clarisse | AP | Histology/Embryology |
| 213 | AKABA Désiré | AP | Human anatomy |
| 214 | NSEME ETOUCKEY Georges Eric | AP | Forensic Medicine |
| 215 | NGONGANG Gilbert FranK Olivier | AP | Forensic Medicine |
| 216 | MENDOUGA MENYE Coralie Reine Bertine épse KOUOTOU | L | Anatomopathology |
| 217 | ESSAME Eric Fabrice | AL | Anatomopathology |
| | **BIOCHEMISTRY DEPARTMENT** | | |
| 218 | **NDONGO EMBOLA née TORIMIRO Judith (CD)** | P | Molecular Biology |
| 219 | PIEME Constant Anatole | P | Biochemistry |
| 220 | AMA MOOR Vicky Joceline | P | Clinical Biology/Biochemistry |
| 221 | EUSTACE BONGHAN BERINYUY | L | Biochemistry |
| 222 | GUEWO FOKENG Magellan | L | Biochemistry |
| 223 | MBONO SAMBA ELOUMBA Esther Astrid | AL | Biochemistry |

**PHYSIOLOGY DEPARTMENT**

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|---|---|---|---|
| 224 | **ETOUNDI NGOA Laurent Serges (CD)** | P | Physiology |
| 225 | ASSOMO NDEMBA Peguy Brice | AP | Physiology |
| 226 | AZABJI KENFACK Marcel | L | Physiology |
| 227 | DZUDIE TAMDJA Anastase | L | Physiology |
| 228 | EBELL'A DALLE Ernest Remy Hervé | L | Human physiology |

**DEPARTMENT OF PHARMACOLOGY AND TRADITIONAL MEDICINE**

| | | | |
|---|---|---|---|
| 229 | **NGONO MBALLA Rose ABONDO (CD)** | AP | African pharmacotherapeutics |
| 230 | NDIKUM Valentine | L | Pharmacology |
| 231 | ONDOUA NGUELE Marc Olivier | AL | Pharmacology |

**DEPARTMENT OF ORAL, MAXILLOFACIAL AND PERIODONTAL SURGERY**

| | | | |
|---|---|---|---|
| 232 | **BENGONDO MESSANGA Charles (CD)** | P | Stomatology |
| 233 | EDOUMA BOHIMBO Jacques Gérard | SL | Stomatology and Surgery |
| 234 | LOWE NANTCHOUANG Jacqueline Michèle Épouse ABISSEGUE | L | Pediatric dentistry |
| 235 | MBEDE NGA MVONDO Rose | L | Oral medicine |
| 236 | MENGONG Épouse MONEBOULOU Hortense | L | Pediatric dentistry |
| 237 | NDJOH Jules Julien | L | Dental Surgeon |
| 238 | NOKAM TAGUEMNE M.E. | L | Dental Medicine |
| 239 | GAMGNE GUIADEM Catherine M | AL | Dental Surgery |
| 240 | KWEDI Karl Guy Grégoire | AL | Oral surgery |
| 241 | NIBEYE Yannick Carine Brice | AL | Bacteriology |
| 242 | NKOLO TOLO Francis Daniel | AL | Oral surgery |

**PHARMACOGNOSY AND PHARMACEUTICAL CHEMISTRY DEPARTMENT**

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|---|---|---|---|
| 243 | **NTSAMA ESSOMBA Claudine (CD)** | P | Pharmacognosy/Pharmaceutical chemistry |
| 244 | NGAMENI Bathélémy | P | Phytochemistry/Organic Chemistry |
| 245 | NGOUPAYO Joseph | P | Phytochemistry/Pharmacognosy |
| 246 | GUEDJE Nicole Marie | AP | Ethnopharmacology/Plant biology |
| 247 | BAYAGA Hervé Narcisse | AL | Pharmacy |

**PHARMACOTOXICOLOGY AND PHARMACOKINETICS DEPARTMENT**

| | | | |
|---|---|---|---|
| 248 | **ZINGUE Stéphane (CD)** | AP | |
| 249 | FOKUNANG Charles | P | Molecular Biology |
| 250 | TEMBE Estella married name FOKUNANG | AP | Clinical Pharmacology |
| 251 | ANGO Yves Patrick | AL | Chemistry of natural substances |
| 252 | NENE AHIDJO Épouse NJITUNG TEM | AL | Neuropharmacology |

**DEPARTMENT OF GALENIC PHARMACY AND PHARMACEUTICAL LEGISLATION**

| | | | |
|---|---|---|---|
| 253 | **NNANGA NGA Emmanuel (CD)** | P | Galenic Pharmacy |
| 254 | MBOLE Jeanne Mauricette née MVONDO M. | L | Quality management, Quality control of healthcare products and foodstuffs |
| 255 | NYANGONO NDONGO Martin | L | Pharmacy |
| 256 | SOPPO LOBE Charlotte Vanessa | L | Drug quality control |
| 257 | ABA'A Marthe Dereine | AL | Drug Analysis |
| 258 | FOUMANE MANIEPI NGOUOPIHO Jacqueline Saurelle | AL | Pharmacology |
| 259 | MINYEM NGOMBI Aude Périne Épouse AFUH | AL | Pharmaceutical regulations |

**KEY**

- P= Professor
- AP= Associate Professor
- SL= Senior Lecturer
- L= Lecturer
- AL = Assistant Lecturer

# THE PHYSICIAN'S OATH

*[Declaration of Geneva adopted by the Geneva Assembly of the World Medical Association in Geneva, Switzerland, September 1948 and amended by the 22nd World Medical Assembly, Sydney, Australia (August 1968)].*

*On admission to the medical profession:*
*I will solemnly pledge myself to consecrate my life to the service of humanity*

*I will give my teachers the respect and gratitude which is their due*

*I will practice my profession with conscience and dignity*

*The health of my patients will be my first consideration*

*I will respect secrets confided in me, even after the patient has died*

*I will maintain by all the means in my power the honour and noble traditions of the medical profession*

*My colleagues will be my brothers*

*I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient*

*I will maintain the utmost respect for human life from the time of Conception, even under threat I will not use my medical knowledge contrary to the laws of humanity .*

*I make these promises solemnly, freely and upon my honour.*

# ABSTRACT

**Introduction:** Osteoporosis is a systemic skeletal disorder characterized by low bone mass and deterioration of bone tissue. It mainly affects women due to estrogen deficiency, typically after their third or fourth decade of life, leading to disabilities from sudden fractures. While dual-energy X-ray absorptiometry (DXA) is the preferred diagnostic method, panoramic radiography, a common dental imaging technique, could provide a potentially accessible and cost-effective screening alternative.

**Objective:** This study aimed to investigate the profile of mandibular bone mineral density (BMD) in pre- and postmenopausal Cameroonian women using panoramic radiographic analysis

**Materials and methods:** We carried out an analytical cross-sectional study, at the Laboratory of Implantology and Periodontology at the Faculty of medicine and Biomedical Science of the University of Yaounde I. Panoramic radiographs from 2021 to 2024 were used to assess the mandibular bone profile of pre- and postmenopausal women's bone mineral density. A total of 189 panoramic radiographs, which exhibited clear visibility of the mental foramen on both sides without any blurring, motion artefacts, surgical errors, overlapping hyoid bone, or inferior mandibular cortex was selected. Radio morphometric indices (MCI) were used to investigate bone texture and thickness in an image processing program (SmartDent)

**Results:**

Our study population (n=188) had a mean age of 43.15 ± 15.2 years, ranging from 25 to 86 years, with 50% in the 25-39 age group. Comparison of dental and periodontal health between premenopausal (n=157) and postmenopausal (n=31) women revealed no significant differences in partial edentulism, furcation defects, vertical bone loss, and periapical radiolucency. These findings suggest that menopausal status may not be a major determinant of dental and periodontal conditions in this population. No significant differences were found in mandibular cortical bone mineral density or radiographic indices (GI, AI, MCW/MI, PMI) between premenopausal and postmenopausal women ($p>0.05$), however the Mandibular cortical Index of Class I and II where prevalent in the premenopausal group than in the postmenopausal group and Class III was less prevalent. Age showed a statistically significant negative correlation with the left Gonial Index (GI) in both premenopausal ($r=-0.120$, $p=0.179$) and postmenopausal ($r=-0.273$, $p=0.036$) women. In premenopausal women, age was also significantly correlated with the left Antegonial Index (AI) ($r=-0.179$, $p=0.042$) and Mandibular Cortical Index (MCI) ($p=0.000$).

**Conclusion:**

Panoramic radiographic indices are reliable tools for assessing mandibular bone mineral density in Cameroonian women, with minimal differences observed between premenopausal and postmenopausal women. While some age-related changes were noted in specific indices, the overall impact of age on mandibular bone morphology was limited. These findings support the utility of

panoramic radiography in assessing bone health and highlight the need for further research in diverse populations.

**Key words:** Mandibular bone, Bone Mineral Density, Premenopausal, Postmenopausal, Dental Panoramic Radiograph

# RESUME

**Introduction :** L'ostéoporose est un trouble systémique du squelette caractérisé par une faible masse osseuse et une détérioration du tissu osseux. Elle touche principalement les femmes en raison d'une carence en œstrogènes, généralement après leur troisième ou quatrième décennie de vie, entraînant des handicaps dus à des fractures soudaines. Bien que l'absorptiomètre radiologique biphotonique (DXA) soit la méthode de diagnostic privilégiée, la radiographie panoramique, une technique d'imagerie dentaire courante, pourrait constituer une alternative de dépistage potentiellement accessible et rentable.

**Objectif :** Cette étude visait à étudier le profil de la densité minérale osseuse (DMO) mandibulaire chez des femmes camerounaises pré et post-ménopausées à l'aide d'une analyse radiographique panoramique

**Matériels et méthodes :** Nous avons réalisé une étude transversale a visée analytique au laboratoire d'implantologie et de parodontologie de la faculté de médecine et des sciences biomédicales de l'université de Yaoundé I. Des radiographies panoramiques réalisées entre 2021 et 2024 ont été utilisées pour évaluer le profil osseux mandibulaire des femmes pré et post-ménopausées et leur densité minérale osseuse. Un total de 189 radiographies panoramiques, qui présentaient une visibilité claire du foramen mental des deux côtés sans flou, artefacts de mouvement, erreurs chirurgicales, chevauchement de l'os hyoïde ou de la corticale mandibulaire inférieure, a été sélectionné. Les indices radiomorphométriques (MCI) ont été utilisés pour étudier la texture et l'épaisseur de l'os dans un programme de traitement d'images (SmartDent)

**Résultats :**

Notre population d'étude (n=188) avait un âge moyen de 43,15 ± 15,2 ans, allant de 25 à 86 ans, avec 50% dans le groupe d'âge 25-39 ans. La comparaison de la santé dentaire et parodontale entre les femmes préménopausées (n=157) et postménopausées (n=31) n'a révélé aucune différence significative en ce qui concerne l'édentation partielle, les défauts de furcation, la perte osseuse verticale et la radiotransparence périapicale. Ces résultats suggèrent que le statut ménopausique n'est pas un déterminant majeur des conditions dentaires et parodontales dans cette population. Aucune différence significative n'a été trouvée dans la densité minérale osseuse corticale mandibulaire ou les indices radiographiques (GI, AI, MCW/MI, PMI) entre les femmes préménopausées et postménopausées (p>0,05), cependant l'indice cortical mandibulaire de classe I et II était plus répandu dans le groupe préménopausé que dans le groupe postménopausé et la classe III était moins répandue. L'âge a montré une corrélation négative statistiquement significative avec l'indice Gonial gauche (IG) à la fois chez les femmes préménopausées (r=-0,120, p=0,179) et postménopausées (r=-0,273, p=0,036). Chez les femmes préménopausées, l'âge était également corrélé de manière

significative avec l'indice antégonien (AI) gauche (r=-0,179, p=0,042) et l'indice cortical mandibulaire (ICM) (p=0,000).

**Conclusion :**

Les indices radiographiques panoramiques évaluent efficacement la densité minérale osseuse (DMO) mandibulaire chez les femmes camerounaises, avec une différence minime observée entre les femmes pré- et postménopausées. Bien que certains changements liés à l'âge aient été notés dans des indices spécifiques, l'impact global de l'âge sur la morphologie osseuse mandibulaire était limité. Cette étude souligne la valeur de la radiographie panoramique pour évaluer la santé osseuse et souligne la nécessité de poursuivre les recherches dans diverses populations.

**Mots clés :** Os mandibulaire, Densité minérale osseuse, Préménopause, Postménopause, Radiographie panoramique dentaire

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# ABBREVIATIONS AND SYMBOLS

**AI** Antegonial Index

**BTMs** Bone Turnover Markers

**BTMs** Bone Turnover Markers

**CW** Cortical width

**DPR** Dental panoramic radiography

**DXA** Dual X-ray Absorption

**FRAX** Fracture risk assessment Tool (FRAX)

**GI** gonadal index

**IL** Interleukin

**MCI** Mandibular cortical index

**MI** Mental Index

**M/M** Mandibular ratio

**MRI** Magnetic Resonance Imaging

**pDXA** Peripheral dual-energy X-ray absorptiometry

**PMI** Panoramic Mandibular Index

**pOCT** Peripheral Quantitative Computed Tomography

**QCT** Quantitative Computed Tomography

**QUS** Quantitative Ultrasound

**SPA** Single-photon absorptiometry

**SSA** Sub-Saharan Africa

**WHO** World Health Organization

# INTRODUCTION

# INTRODUCTION

## BACKGROUND, PROBLEM AND JUSTIFICATION

Osteoporosis is a worldwide health issue that affects millions of people, especially postmenopausal women. This condition is characterized by decreased bone mass and an increase in the risk of fracture; this condition is often left undiagnosed until a fracture occurs[1].

Globally, osteoporosis is estimated to affect more than 200 million women worldwide and cause more than 8.9 million fractures annually[2, 3]. Hip fracture rates among South African women vary significantly by ethnicity, with white women having the highest incidence (176/100,000), followed by Indian (147.7) and black (43.5) women[4, 5]. In Cameroon, a study revealed low rates of fragility fractures in women. While 13.5% of women's fractures were at the hip, only 1.1% of women lived past 65 years, suggesting that shorter lifespans limit the occurrence of these age-related injuries.[6, 7] This pattern reflects wider disparities in fracture rates observed in other countries undergoing demographic shifts.[4] With rising life expectancy and shifting dietary habits, in sub-Saharan African (SSA) countries such as Cameroon, the prevalence of osteoporosis is expected to increase [4].

Osteoporosis can be identified through various methods, including the assessment of bone mineral density (BMD) using dual-energy X-ray absorptiometry (DXA), quantitative computed tomography (QCT), peripheral dual-energy X-ray absorptiometry (pDXA), peripheral quantitative computed tomography (pQCT), and quantitative ultrasound (QUS), as well as the quantification of bone turnover markers (BTMs) and the Fracture Risk Assessment Tool (FRAX).

According to the World Health Organization (WHO) classification, the gold standard for diagnosing osteoporosis is the evaluation of bone mineral density (BMD) through dual-energy X-ray absorptiometry (DXA), considered the gold standard[8]. However, BMD measurements via dual-energy X-ray absorptiometry (DXA) are not widely available or accessible to patients in many developing countries, including Cameroon, due to the high cost and limited accessibility of DXA, and because of the lack of reference data [7, 9].

Dental panoramic radiography (DPR) is an accessible and inexpensive imaging modality that is routinely used in dental practice and provides a two-dimensional view of teeth and the maxillofacial skeleton of patients [10, 11]. Panoramic radiography has been proposed as a potential tool for assessing osteoporosis, as it can reveal changes in the mandibular cortical bone that reflect the general skeletal status [12]. Several radiomorphometric indices, such as the mandibular cortical index (MCI), the panoramic mandibular index (PMI), the mental index (MI), the antegonial index (AI), and the gonial index (GI), have been developed to quantify the quality of mandibular bone mass [12]. These indices are based on measurements of the thickness, shape, and extent of erosion of the mandibular cortex on panoramic radiographs. Previous studies have shown that these indices

are correlated with bone mineral density (BMD) measured by dual-energy X-ray absorptiometry (DXA) or quantitative computed tomography (QCT) at various skeletal sites, such as the lumbar spine, the femoral neck, or the forearm; can discriminate between osteoporotic and nonosteoporotic individuals, with varying degrees of sensitivity and specificity; and can be used as screening tools for osteoporosis [12–14]. However, the prevalence and risk factors for osteoporosis in Cameroon are not well known, and the validity and reliability of the panoramic radiographic indices in this population have not been established. Hence, there is a pressing need for research to identify efficient methods for early osteoporosis screening in aging populations in developing countries [9]. Therefore, the aim of this thesis is to assess the applicability of panoramic radiographic indices for estimating mandibular BMD in a Cameroonian female population.

# CHAPTER I: GENERAL CONTEXT OF THE STUDY

## I. JUSTIFICATION

There is a lack of reliable and representative data on the prevalence, incidence, and burden of osteoporosis and fragility fractures in different countries, regions, and ethnic groups in Africa and Cameroon. There is a need to sensitize the public to the causes, consequences, and management of osteoporosis to develop affordable alternative methods for the early diagnosis of osteoporosis in Cameroon [6, 9].

### RESEARCH QUESTION

#### a) Principal Research Question

Is there a difference in mandibular bone mineral density between premenopausal and postmenopausal women in Cameroon, and if so, how is it associated with menopausal status?

### RESEARCH HYPOTHESIS

#### b) Primary Hypothesis

There will be a statistically significant difference in mandibular bone mineral density (BMD), as measured by panoramic radiographic morphometry, between premenopausal and postmenopausal Cameroonian women

### RESEARCH OBJECTIVES

#### c) General Objectives

To assess the applicability of panoramic radiographic indices for estimating mandibular BMD in a Cameroonian female population.

#### Specific Objectives

- To quantify and compare mandibular cortical bone mineral density (BMD) in premenopausal and postmenopausal Cameroonian women using panoramic radiographic measurements.
- To evaluate the association between menopausal status and radiographic indices of mandibular bone morphology in the study population.
- To determine the potential influence of age on mandibular cortical BMD and radiographic indices within each menopausal group.

# CHAPTER II: LITERATURE REVIEW

# LITREATURE REVIEW

## I.1 ANATOMY AND PYSHIOLOGY REVIEW OF THE BONE

## I.2 THE BONE

## I.3 DEFINITION

It is a rigid body tissue consisting of cells embedded in abundant hard intercellular material. The two principal components of this material, collagen and calcium phosphate, distinguish bone from other hard tissues, such as chitin, enamel, and shells Bone tissue comprises the individual bones of the human skeletal system and the skeletons of other vertebrates[15].

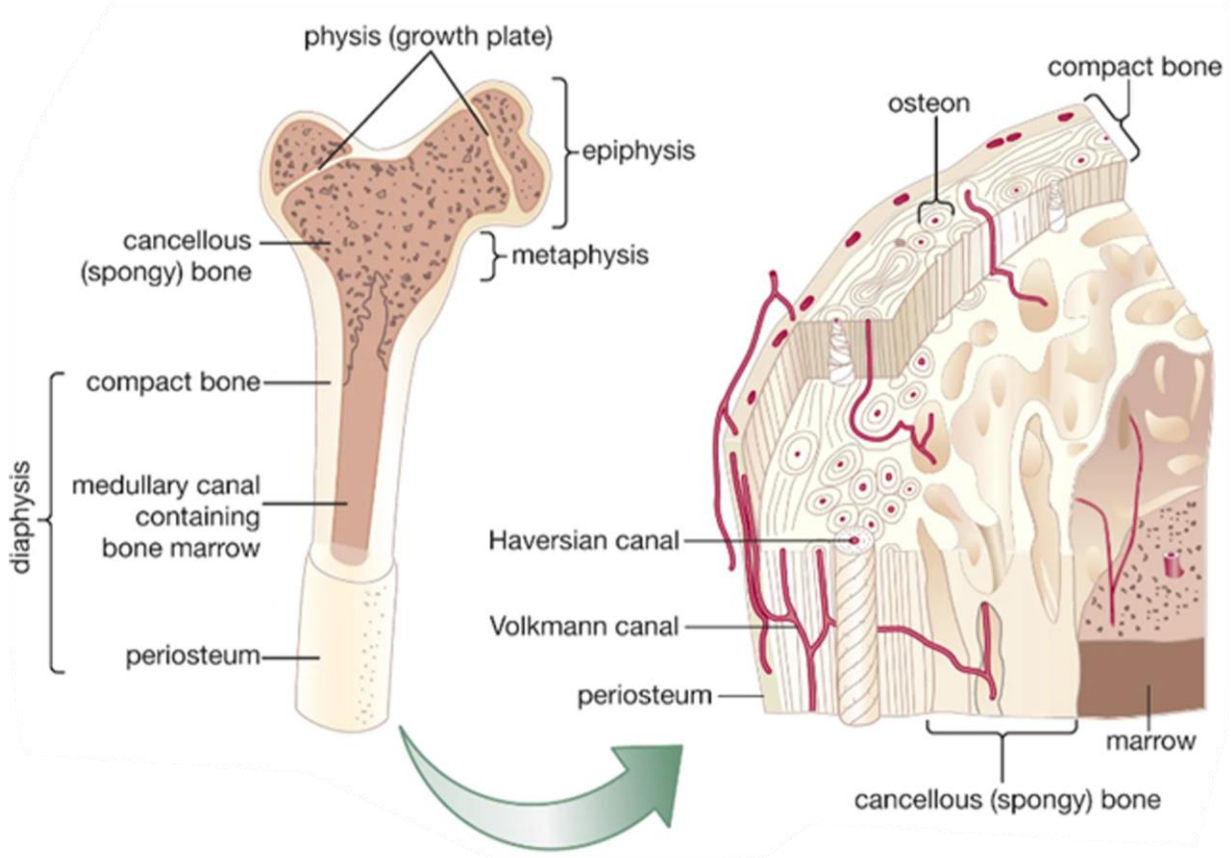



**Figure 1:** *A magnified view of the interior structure of a human long bone on a cross-section [15]*

The functions of bone include the following:

- Structural support for the mechanical action of soft tissues, such as the contraction of muscles and the expansion of lungs
- Protection of soft organs and tissues, as by the skull
- Provision of a protective site for specialized tissues such as the blood-forming system (bone marrow)

- A mineral reservoir, whereby the endocrine system regulates the level of calcium and phosphate in the circulating body fluids.

## STRUCTURAL CLASSFICATION OF BONE

Bone can be structurally classified into cortical bone and trabecular bone:

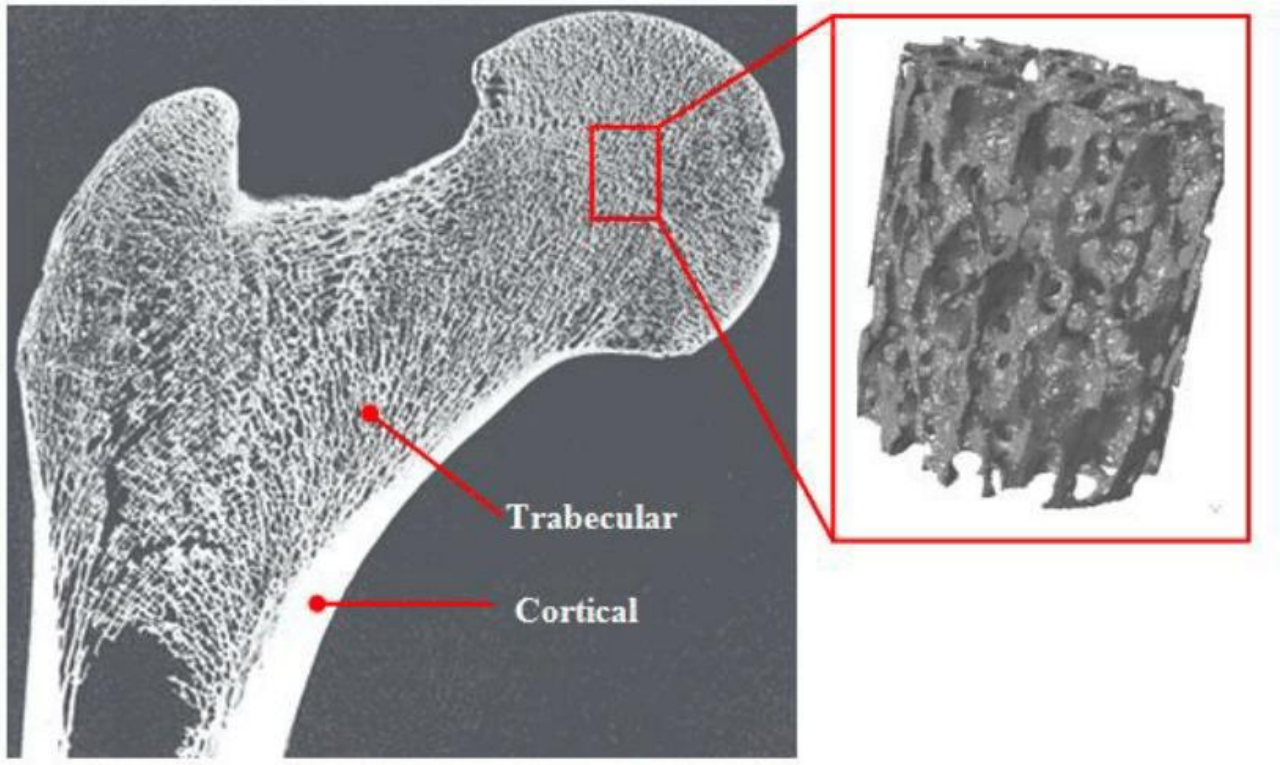



**Figure 2:** *Cross-section of a human femur showing the trabecula and cortex [16]*

- **Cortical Bone**

It is a dense and hard outer shell of bones, and forms the majority of our skeletal framework. Cortical bon is composed of dense, hard tissue, and forms the strong outer shell of bones like the femur.

This "compact" bone, aptly named for its density, surrounds the bone marrow cavity in long bones and constitutes approximately 80% of our skeletal mass. Its inner surface, known as the endosteal surface, and outer surface, the periosteal surface, provide attachment points for muscles and ligaments. Within the cortex lies the Haversian and Volkmann canals, tiny channels transporting blood vessels and nerves. Compared to its spongy counterpart, trabecular bone, cortical bone is less metabolically active [17–20].

However, as we age, resorption at the endosteal surface outpaces bone deposition, gradually widening the marrow space. This age-related process contributes to the gradual weakening of bones. Therefore, understanding the structure and activity of cortical bone is crucial for maintaining strong, healthy bones throughout life

**Age-Related Changes:**

Unfortunately, even the strongest materials take their toll on time. As we age, resorption at the endostea surface outpaces bone deposition, leading to gradual thinning of the cortical layer and widening of the marrow space. This process contributes to the weakening of bones and an increased risk of fractures, especially in later years.

**Maintaining Skeletal Health:**

Understanding the structure, function, and age-related changes in cortical bone is crucial for preserving skeletal health throughout life. By adopting healthy bone habits such as regular exercise, adequate calcium intake, and vitamin D supplementation, we can support the formation and maintenance of this vital tissue.[17, 18, 20]

- **Trabecular Bone**

  Additionally, spongy bones or cancellous bone forms a crucial part of our skeleton, despite making up only 20% of our skeletal mass. Its nickname, "spongy bone," reflects its honeycomb-like appearance due to the arrangement of thin bone plates called trabeculae. These plates form a meshwork, creating a large internal surface area that facilitates rapid bone turnover[21–23].

**Age-Related Changes:**

- **Sequential Loss:** As we age, trabecular bone loss follows a typical pattern. Non-weight bearing areas are affected first, followed by gradual thinning in weight-bearing regions. This can lead to the remaining thicker trabeculae appearing more prominent, but it is important to note that overall bone strength is declining.
- **Peak Bone Mass:** The bone mass naturally decreases with age. However, the rate and severity of this decline depend on the individual's peak bone mass achieved in early life. Men generally have a greater peak bone mass, decreasing susceptibility to age-related bone loss such as osteoporosis.

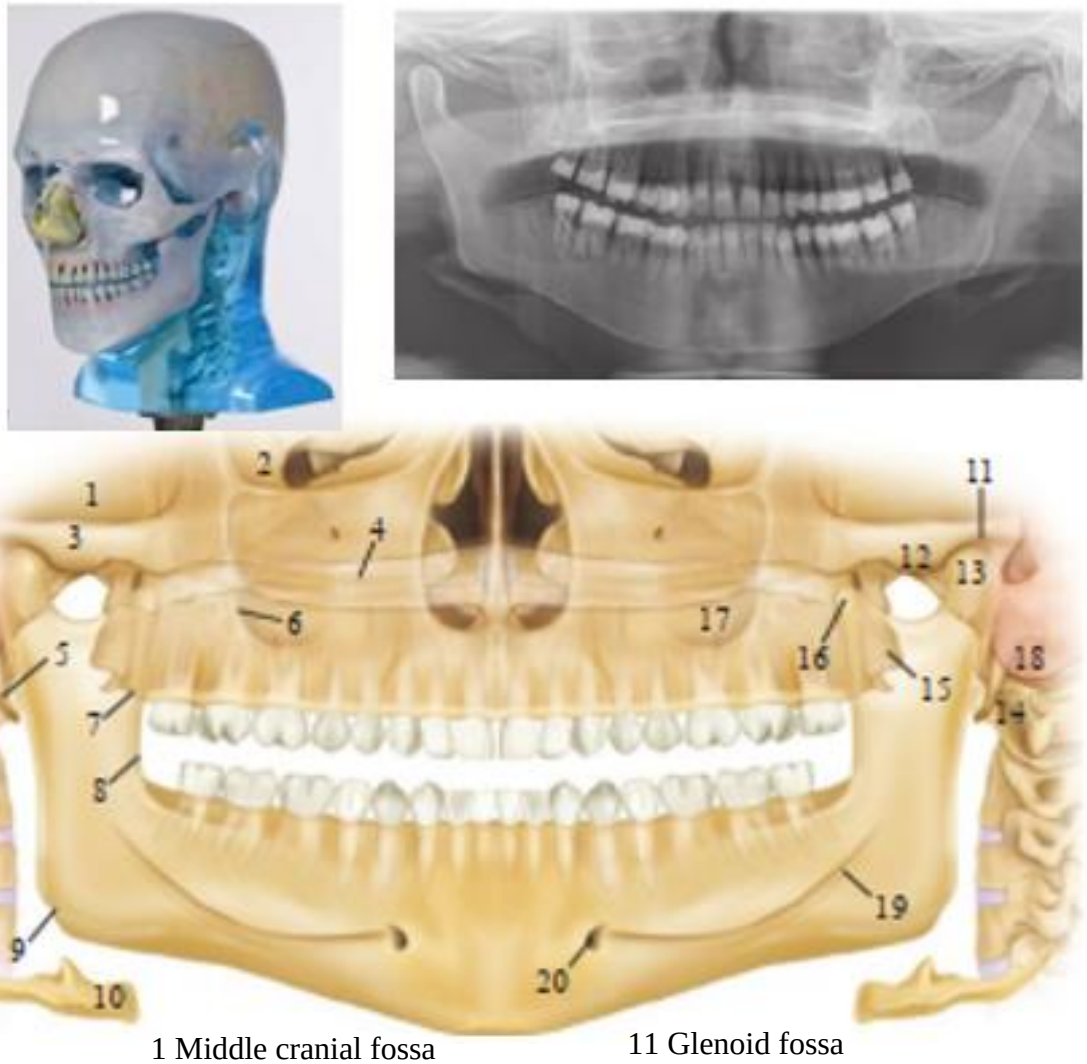
## II.4. PANORAMIC ANATOMY

Panoramic radiographs offer a view of the entire jaw and oral structures, providing a comprehensive dental map. Within this detailed landscape, varieties of anatomical features can reveal valuable information about dental health.

Bones, the sturdy foundation of your face, take center stage in a panoramic image. The prominent U-shaped mandible, or lower jaw, forms the base, while the maxilla, or upper jaw, sits above, and its intricate palatal bone is visible as the roof of your mouth. Interlaced throughout these bones are delicate blood vessels that supply nutrients and oxygen. The superior and inferior alveolar arteries snakes along the jawbones, nourishing the teeth and surrounding tissues. Veins, such as the angular and facial veins, drain deoxygenated blood, completing the circulatory loop.

These bony and vascular elements are intricately related. The alveolar arteries branch like tiny rivers, feeding individual teeth through minute channels at the root tips. Veins follow suit, draining away waste products. This intricate vascular network ensures healthy teeth by maintaining a constant supply of nutrients and removing metabolic byproducts. Additionally, the precise positioning of blood vessels within the jawbone contributes to its overall strength and resilience.

Understanding the interplay between these anatomical features on a panoramic radiograph empowers dentists to diagnose potential issues early on. Anomalies in bone density, such as cysts or tumors, can be identified, as can changes in vascular patterns that might indicate inflammation or infection. This comprehensive view allows for timely interventions and personalized treatment plans, ensuring a healthy and beautiful smile for years to come [24].




1 Middle cranial fossa
2 Orbit
3 Zygomatic arch
4 Palate
5 Styloid process
6 Floor of maxillae
7 Maxillary tuberosity
8 External oblique line
9 Angle of mandible
10 Hyoid bone
11 Glenoid fossa
12 Articular eminence
13 Mandibular condyle
14 Vertebra
15 Pterygoid plates
16 Coronoid process
17 Maxillary sinus
18 Ear lobe
19 Mandibular canal
20 Mental foramen

*Figure 3:A) The CIRS ATOM Max Dental and Diagnostic Head Phantom is a standard of reference for diagnostic radiology of the head. B, Panoramic image of a diagnostic head phantom. C, Panoramic anatomy. (A and B, Courtesy Fluke Biomedical, Cleveland, OH.) [24]*

## THE MANDIBUALR BONE

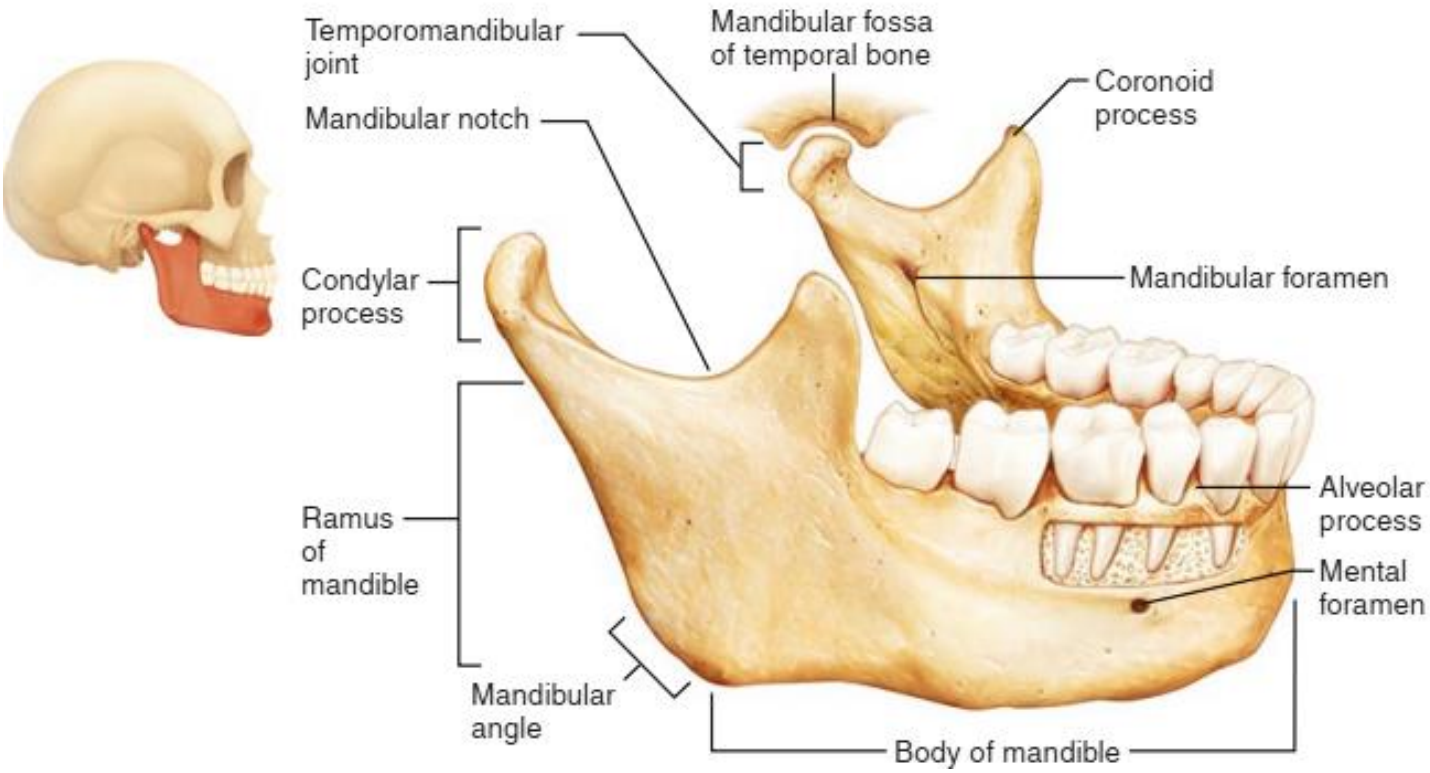



**Figure 4:** *Mandible, right lateral view[25]*

The mandible is the largest and strongest bone of the human skull. It is commonly known as the lower jaw and is located inferior to the maxilla. It is composed of a horseshoe-shaped body that lodges the teeth and a pair of rami that project upwards to form a temporomandibular joint.

The mandible is formed by a body and a pair of rami along with the condyloid and coronoid processes. The rami are vertical, wing-shaped structures that join the body at an angle.

Male mandibles are generally larger than female mandibles. They also have more pronounced muscle attachment points and are somewhat stronger than other people[25].

Below are the parts that make up the mandible:

**Body**

The body is the anterior portion of the mandible. The body has two surfaces, one on the outer and inner sides and two on the border: the upper and lower sides. The body ends and the rami begin on either side at the angle of the mandible, also known as the gonial angle.

1. The outer surface is also known as the external surface and has the following characteristics: mandibular symphysis/symphysis menti at midline, which joins the left and right halves of the bone and is detected as a subtle ridge in adults.

- The inferior portion of the ridge divides and encloses a midline depression called the mental protuberance, also known as the chin. The edges of the mental protuberance are elevated, forming the mental tubercle.
- A depression known as the incisive fossa occurs laterally to the ridge and below the incisive teeth.
- Below the second premolar is the mental foramen, in which the mental nerve and vessels exit.
- The oblique line courses posteriorly from the mental tubercle to the anterior border of the ramus.

2. The inner surface of the mandible has the following features:
    - The mylohyoid line is a prominent ridge that runs obliquely downwards and forwards from below the third molar tooth to the median area below the genial tubercles.
    - Below the mylohyoid line, the surface is slightly hollowed out to form the submandibular fossa, which lodges the submandibular gland.
    - Above the mylohyoid line, there is the sublingual fossa in which the sublingual gland lies.
    - The posterior surface of the symphysis menti is marked by four small elevations called the superior and inferior genial tubercles.
3. The upper border (alveolar border) consists of sockets for the teeth.
4. The lower border (inferior border) is also known as the base. A fossa known as the digastric fossa is present at the midline.

The upper border, also called the alveolar border, serves as a sturdy shelf for teeth, housing their individual sockets.

The lower border, known as the base, features a depression called the digastric fossa near the midline, providing attachment for another jaw muscle.

In essence, the mandible's body features a landscape of ridges, depressions, and foramina, each of which play a pivotal role in shaping, supporting, and animating the jaw.

**Campbell's lines**

These imaginary lines, traced like clues on the film, help doctors assess fractures and injuries in the jaw and facial bones[26].

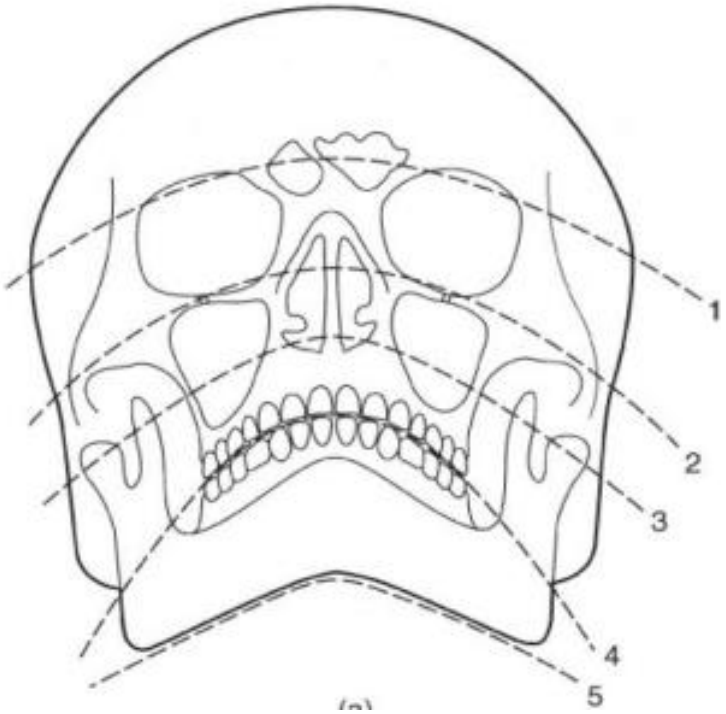



**Figure 5:** *McGrigor–Campbell lines, as modified by Trapnell, on a Waters view[26]*

**Line 1:** Think of it as a superhero stretching across your eyebrows, connecting the top points of your cheekbones.

**Line 2:** This one travels along your cheekbone and under your eye, dipping into your nose and then mirroring itself on the other side.

**Line 3:** Imagine a bridge starting at your jaw joint, climbing over your chin, crossing the space behind your nose, and then repeating on the other side.

**Line 4:** Picture of a ruler resting on your top and bottom teeth.

**Line 5:** Trace the bottom edge of your jaw, a sturdy line completing the set. Trapnell's contribution to Campbell's lines introduced a fifth line that follows the lower border of the mandible. This additional line provides further anatomical reference points for the systematic assessment of maxillofacial radiographs. The inclusion of this line enhances the comprehensive evaluation of the mandibular region and contributes to a more thorough analysis of the bony structures in the context of facial and cranial anatomy.

**Cranial base**

It comprises the frontal, ethmoid, sphenoid, and occipital bones, and this rigid platform inclines approximately 45° relative to the maxillary occlusal plane. Despite its strength, fractures in this region pose a diagnostic challenge. Conventional radiographs often fail to capture the cryptic

presence of the tumor, demanding superior resolution via computed tomography (CT) scans for definitive confirmation. Cranial base fractures can cause bleeding in the middle cranial fossa, sometimes visible as bruising behind the ear (Battle's sign). Additional complications that are serious include leakage of cerebrospinal fluid (CSF) through tears in the dura mater.

- CSF leakage can drain from the nose (rhinorrhea) or ear (otorrhea) if the eardrum is ruptured.
- If the eardrum remains intact, blood can build up behind it, turning it blue and bulging (hemotympanum).

These clinical signs help doctors diagnose cranial base fractures quickly and guide treatment

**Ramus**

The quadrilateral structure serves as the primary attachment site for the masticatory musculature. Its two surfaces (lateral and medial) and four borders (superior, inferior, anterior, and posterior) provide anchors for the temporalis, masseter, medial pterygoid, and lateral pterygoid muscles, orchestrating the powerful act of chewing. Key anatomical landmarks include the mandibular foramen, granting access to the inferior alveolar nerve and blood vessel bundle for tooth and gum innervation. The lingula, a triangular projection, serves as a crucial landmark for local anaesthetic injections. The coronoid process and condylar process project superiorly, offering further muscle attachment points.

The ramus exhibits variable thickness, with thinning occurring laterally behind the external oblique line and the temporal crest medially. These factors influence both mandibular ramus osteotomy and the incidence of mandibular angle fractures.

In essence, the mandibular ramus, with its intricate architecture and strategic connections, forms the backbone of masticatory function and plays a vital role in oral health and function.

## BONE REMODELLING

The restructuring of existing bone is characterized by constant resorption and formation. Approximately 5% of the cortical bone and 20% of the trabecular bone are renewed annually. In early adult life, the balance is positive; that is, there is more bone deposition [27]. This process is essential for maintaining bone health and strength. In healthy individuals, the rate of bone formation and breakdown is balanced, ensuring that bones remain strong and resilient. However, in individuals with osteoporosis, the balance between bone formation and breakdown is disrupted, leading to a net loss of bone mass and increased bone fragility.

### Anatomy of Bone Remodelling

Bone remodelling involves three main phases:

1. **Activation:** Osteocytes signal to osteoclasts to start breaking down bone tissue.
2. **Resorption:** Osteoclasts, specialized bone cells, breakdown old or damaged bone tissue. This process creates cavities in the bone matrix.
3. **Reversal:** Once resorption is complete, mononuclear cells, including macrophages and osteoblasts, appear on the bone surface. These cells prepare the surface for new bone formation.
4. **Formation:** Osteoblasts, bone-forming cells, lay down new bone tissue to fill the cavities created by resorption. The newly formed bone is then mineralized to become strong and hard.

### Physiology of Bone Remodelling

Bone remodelling is a highly regulated process that is influenced by a number of factors, including hormones, mechanical stress, and cytokines. These factors work together to maintain the balance between bone formation and breakdown. Hormones play a crucial role in regulating bone remodelling. Oestrogen, a sex hormone, is particularly important for bone health in women. Oestrogen helps to inhibit bone resorption and promote bone formation. As oestrogen levels decline after menopause, bone loss can accelerate.

Mechanical stress, such as weight-bearing exercise, also plays a role in bone remodelling. When bones are subjected to mechanical stress, they adapt by becoming stronger. This is why regular exercise is important for maintaining bone health. Cytokines are small signalling molecules that are involved in a variety of cellular processes, including bone remodelling. Some cytokines, such as interleukin-6 (IL-6), can promote bone resorption.

The three main types of cells involved in bone remodelling are as follows [28]:

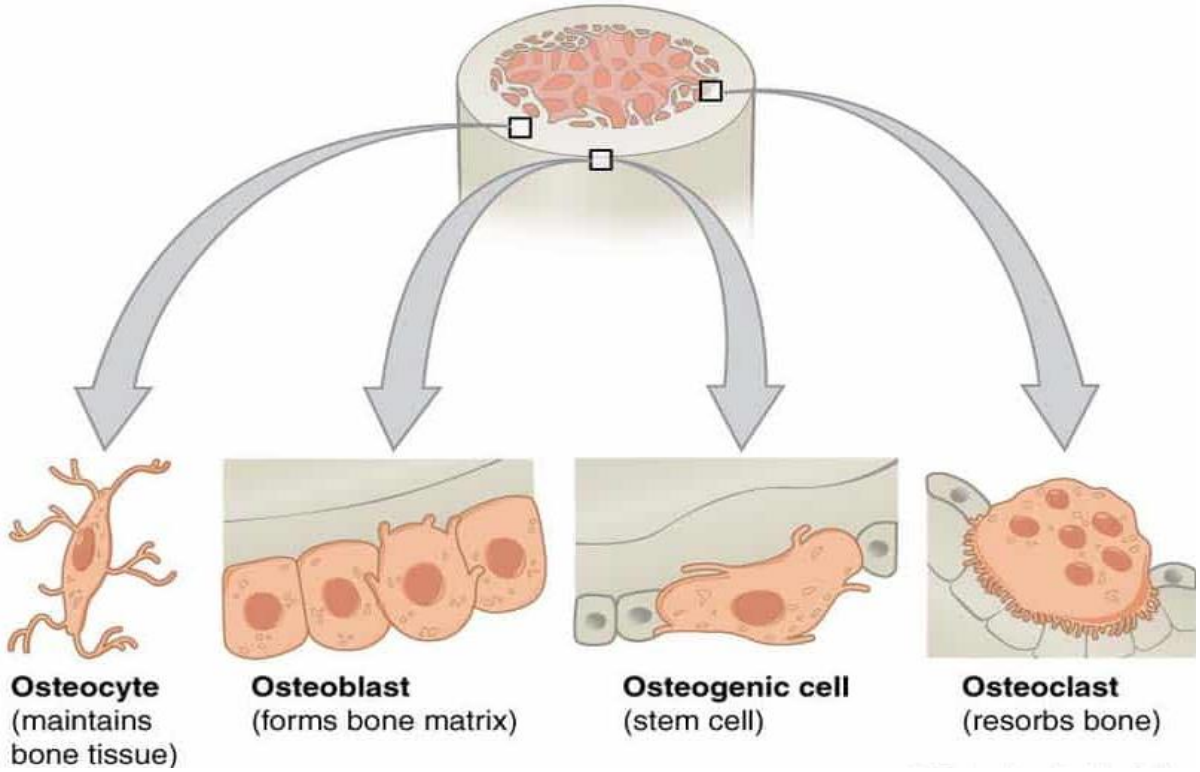



**Figure 6:** *Cellular components of bone and their functions[28]*

1. **Osteoclasts:** These cells are responsible for breaking down bone tissue. They are attracted to areas of damaged or weakened bone, where they secrete enzymes that dissolve the mineral matrix of bone.
2. **Osteoblasts:** These cells are responsible for forming new bone tissue. These cells lay down new bone matrix, which is then mineralized to form hard bone tissue.
3. **Osteocytes:** These cells are embedded within the bone matrix and help to regulate the activity of osteoclasts and osteoblasts. They also play a role in sensing and responding to mechanical stress on bones.

With aging, the amount of bone resorbed by osteoclasts is not fully restored, as bone deposited by osteoblasts leads to a loss of bone mass and strength (Almeida and O'Brien 2013) [29].

## I.4 OSTEOPOROSIS

### DEFINITION

Osteoporosis is a progressive systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture. (1) It is a silent disease that remains undetected until a fracture occurs. Bones are dynamic tissues that undergo continuous remodelling, but in osteoporosis, this remodelling process becomes unbalanced, leading to weakened and fragile bones. [31]. Trabecular bone and cortical bone are often thinner in people with osteoporosis. Moreover, they have a greater mineral content per area of tissue, larger crystals, more mature collagen, and greater carbonate content than people of the same age without osteoporosis[32]. Osteoporosis develops primarily through three mechanisms: insufficient development of peak bone mass (where the skeleton does not attain enough mass and strength during growth), excessive resorption of bone, and insufficient formation of new bone during the remodelling process. Osteoporosis affects the entire skeletal structure, with the spongy bone in the spine being particularly susceptible. As a result, individuals with osteoporosis frequently experience compression fractures in the vertebrae. Women are more likely to develop osteoporosis than men are. This is because women have less bone mass, and their estrogen levels decrease after menopause. Estrogen helps to keep bones strong, so when levels decline, bones become weaker. Additionally, women live longer than men do, which means that they have more time to lose bone mass.[33]

### II.5 EPIDEMIOLOGY

With the global increase in life expectancy in many parts of the country, women are now living more than one-third of their lives after menopause, and the number of postmenopausal women is increasing. In Europe, for example, the number of women older than 50 years is projected to increase by 30%–40% between 1990 and 2025 (6). Among men older than 50 years, the projected increase is expected to be even greater (50%). This trend is even more pronounced in other areas of the world. In North America, the proportion of the population older than 50 years is expected to nearly double. The proportionate increases will be greatest in Africa, Asia and Latin America, but Asia will have the highest absolute increase because it has the largest population. Osteoporosis is a neglected health concern in Africa, including in Cameroon, and lacks age-standardized reference data for precise screening and diagnosis[9]. Epidemiological studies on hip and vertebral fractures in Africa, particularly in Sub-Saharan Africa, are scarce[7]. These studies are often constrained by retrospective data, small sample sizes, and reliance on a single study site. Nevertheless, more recent research indicates a rising incidence of osteoporosis and fractures throughout the continent, marking a shift from earlier findings; this could be due to the increase in the population aged 60 years and older predicted over coming decades compared to less than 100% increase in Europe and North America [34]. The United Nations declaration of the Decade of Healthy Ageing 2021–2030 states

that there has never been a timelier opportunity to act to ensure the health of ageing adults, their families and communities. An estimated 1.3–1.7 million hip fractures occurred worldwide in 1990 [35, 36]By 2025, this number is expected to increase to almost 3 million. This is probably an underestimate since, in many regions, hip fracture rates increase even after age has been taken into consideration [36]. The WHO demographic shift over the next 50 years will lead to a large increase in the number of elderly people in Africa, Asia and South America. Consequently, the burden of the disease will shift from developed to developing countries. By 2050, 75% of the estimated 6.3 million hip fractures will occur in developing countries.

**Classification of Osteoporosis**

Osteoporosis can be divided into localized and generalized based on the number of bones involved[37].

Generalized osteoporosis was further classified as follows:

1. **Primary osteoporosis**

- Idiopathic juvenile osteoporosis
- Idiopathic osteoporosis in young adults
- Involutional osteoporosis
    (i) Type I (postmenopausal) osteoporosis
    (ii) Type II (age-related) osteoporosis

2. **Secondary osteoporosis** [38]

Primary osteoporosis is characterized by the absence of systemic disease. Idiopathic juvenile osteoporosis and idiopathic osteoporosis in young adults are self-limiting disorders. Postmenopausal osteoporosis affects women within 15–20 years after menopause. Age-related osteoporosis occurs in both men and women aged 70 years and older.

Secondary osteoporosis occurs as a result of a number of systemic diseases, such as hypogonadism, hyperthyroidism, malabsorption syndrome, chronic obstructive jaundice, anorexia nervosa, multiple myeloma, and osteogenesis imperfectus, and due to drug intake. Osteoporosis is frequently asymptomatic and often undetected until a fracture occurs. The common clinical features include back pain; loss of height; spinal deformity; and fractures of the vertebrae, hips, wrists, and other bones. Early diagnosis is very important for preventing pathological fractures, which have severe health and economic consequences.

## FACTORS INCREASING THE RISK OF OSTEOPOROSIS

The factors affecting the risk of osteoporosis can be classified into modifiable factors and nonmodifiable factors as follows:

**Non-Modifiable Risk Factors**

- **Gender**. Your chances of developing osteoporosis are greater if you are a woman. Women have less bone tissue available and lose bone faster than men because of the changes that occur during menopause.
- **Age**. The older you are, the greater your risk of osteoporosis. As you age, your bones become increasingly thinner.
- **Body size.** Small, thin-boned women are at greater risk.
- **Ethnicity**. Caucasian and Asian women are at highest risk. African American and Hispanic women had a lower but significant risk.
- **Family history.** Fracture risk may be due, in part, to heredity. People whose parents have a history of fractures also seem to have reduced bone mass and may be at risk for fractures.

**Modifiable Risk Factors:**

- **Sex hormones**. Abnormal absence of menstruation (amenorrhea), low estrogen levels (menopause), and low testosterone levels can lead to osteoporosis in men.
- **Anorexia nervosa.** Characterized by an irrational fear of weight gain, this eating disorder increases the risk of osteoporosis.
- **Calcium and vitamin D intake** A lifetime diet low in calcium and vitamin D makes you more prone to bone loss.
- **Medication use.** Long-term use of certain medications, such as glucocorticoids and some anticonvulsants, can lead to loss of bone density and fractures.
- **Lifestyle.** An inactive lifestyle or extended bed rest tends to weaken bones.
- **Cigarette smoking.** Smoking is harmful to bones as well as the heart and lungs.
- **Alcohol intake.** Excessive consumption of alcohol increases the risk of bone loss and fractures

## CLINICAL AND RADILOGICAL PRESENTATION OF

## A. CLINICAL PRESENTATION OF OSTEOPOROSIS

Osteoporosis is a condition that affects bones, making them weaker and more prone to fracture. It is more common in older people, especially women after menopause. Osteoporosis does not usually cause any symptoms until a bone break. However, some possible signs of osteoporosis include the following:

- Receding gums, which may indicate bone loss in the jaw
- Weak grip strength may reflect lower bone density in the wrist
- Neck or back pain, which may be due to a broken or collapsed bone in the spine
- Loss of height over time, which may result from multiple spinal fractures
- A stooped or hunched posture may also be caused by spinal fractures.
- A bone that breaks much more easily than expected, such as from a minor fall or injury.

If you suspect you have osteoporosis, you should talk to your health care provider. A bone density test can be used to measure the amount of bone mineral in the bones. This test can help diagnose osteoporosis and assess the risk of future fractures. The most common bone density test is called dual-energy X-ray absorptiometry (DXA), which involves the use of low-dose X-rays to scan the hip and spine. Other tests that may be used to evaluate osteoporosis include blood tests, urine tests, and vertebral fracture assessment (VFA).

## B. RADIOGRAPHIC PRESENTATION OF OSTEOPOROSIS

### I. GENRAL RADIOGRAPHY

The pathological changes observed in osteoporosis are due to resorption of cortical and trabecular bone. The main radiographic findings include changes in the trabecular pattern, cortical thinning, and decreased bone density, which are more prominent in the axial skeleton. Although the most common cause is primary osteoporosis, one has to be aware of the secondary causes as well. Conventional radiography helps in evaluating the secondary causes of osteoporosis, confirming or ruling out fractures and diagnosing concomitant or predisposing conditions. Although X-rays are not the gold standard for diagnosing osteoporosis [39], they can provide valuable insights when used alongside other clinical factors. Here, we look at in detail how hand and hip X-rays can reveal signs of this bone weakening [40].

**General X-ray Findings in Patients with Osteoporosis**

- **Decreased bone density:** This change in bone density appears as increased radiolucency (whiteness) on X-ray due to the decreased amount of bone mineral present.
- **Cortical thinning:** The outer layer of bones (cortex) appears thinner than usual.
- **Trabecular bone loss:** The internal network of thin bony plates (trabeculae) becomes less visible or disappears completely.

**a. Hand X-rays:**

- **Punctiform lucencies:** Tiny, round, clear areas within the carpal bones (wrist bones) are characteristic signs.
- **Thinning of the cortices:** This feature is notable in the metacarpal bones (long bones of the hand).

**Increased bone fragility:** Fractures, especially in the distal radius (forearm bone near the wrist), might be present. [41]

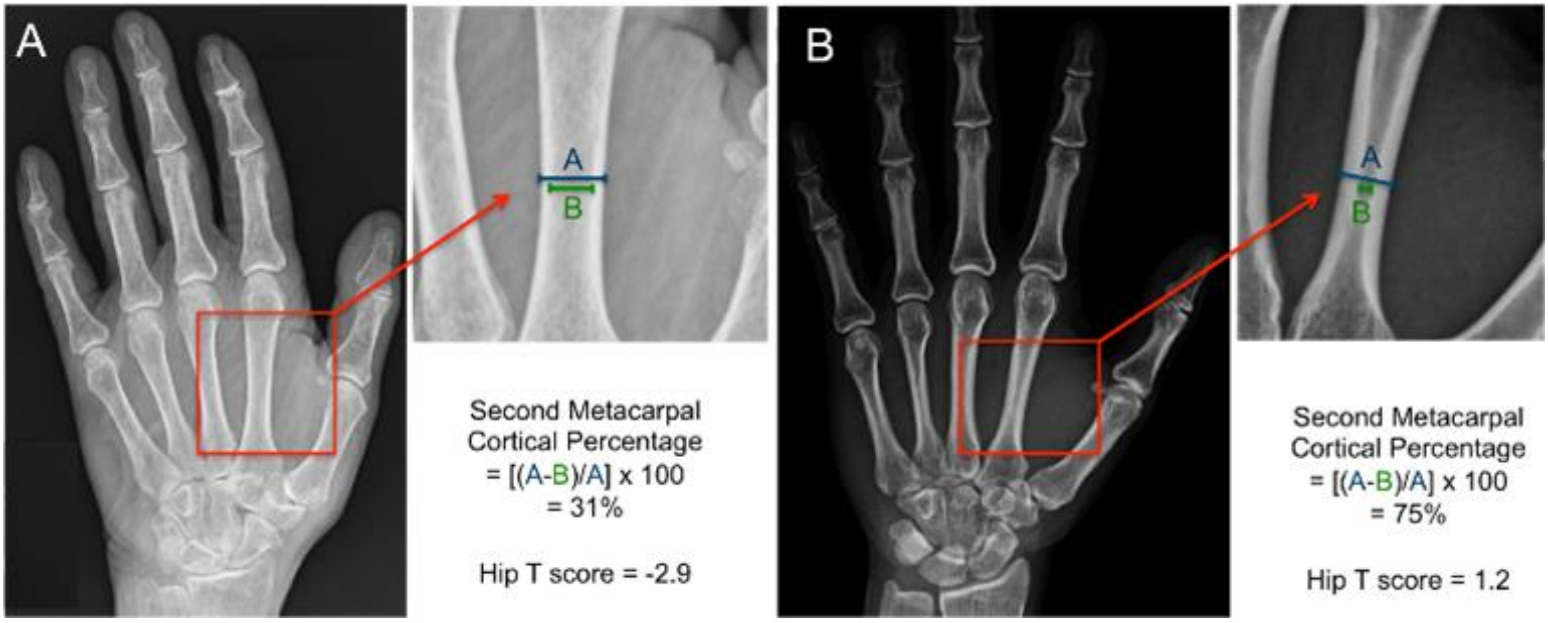



**Figure 7:** Hand X-ray (A shows signs of osteoporosis while B is normal) [41]

**b. Hip X-rays:**

- **Femoral neck thinning:** The narrow part of the thighbone (femur) is thinner.
- **Loss of trabecular bone in the femoral head:** The rounded upper end of the femur appears less dense.
- **Increased transparency of the acetabulum:** The hip socket appears more radiolucent due to bone loss.
- **Fractures:** Fragility fractures, hairline cracks, or complete breaks might be evident [42].

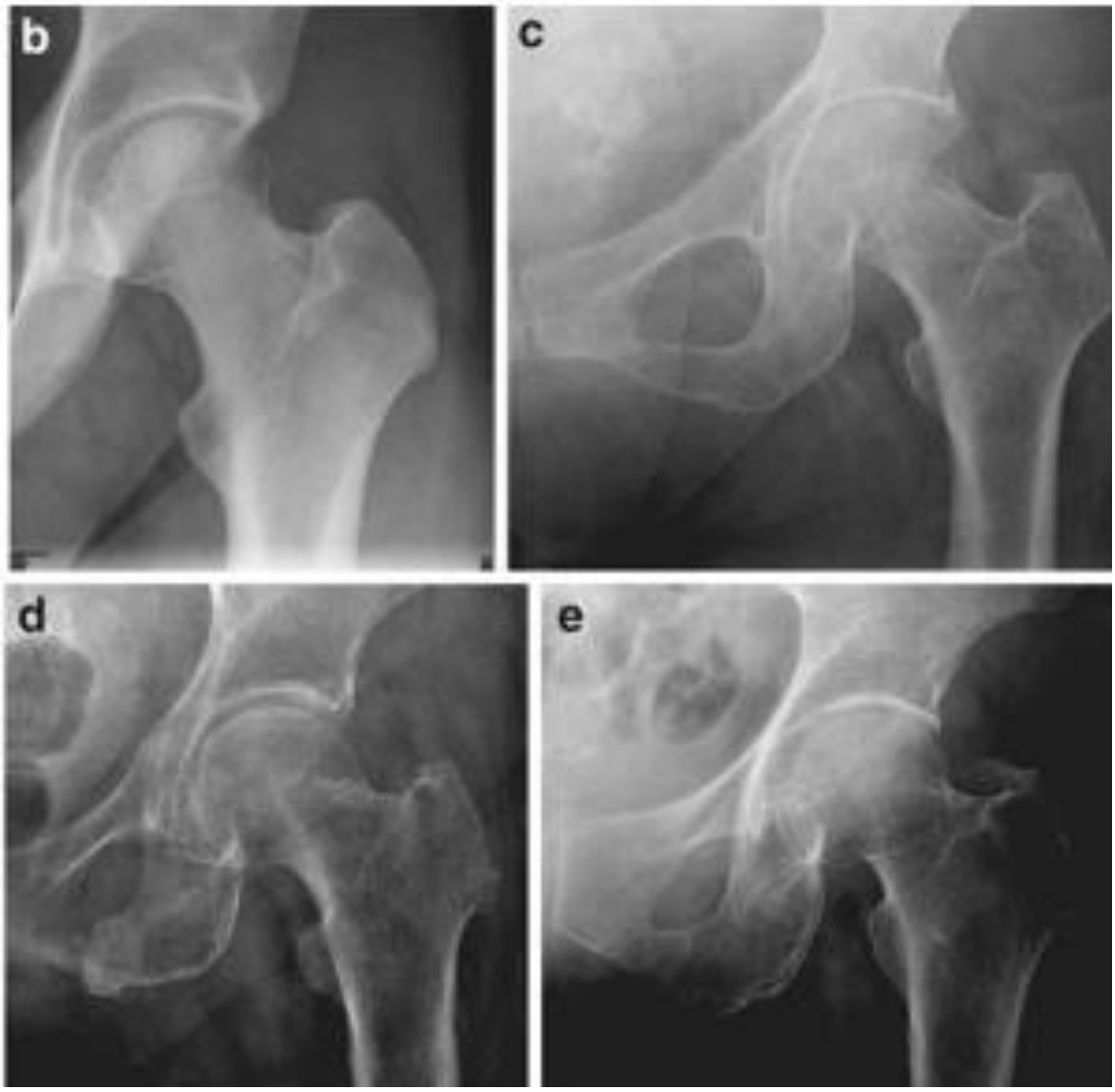



**Figure 8:** Hip radiography images with different trabecular patterns (b: Normal; c, d and e: signs of osteoporosis) [42]

Radiographs can be used to assess the gross morphology and presence of fractures but cannot accurately quantify the degree of osteoporosis. For formal diagnosis and evaluation of osteoporosis, a DXA scan is needed, which can measure the BMD at the femoral neck, lumbar spine, or other sites. DXA can also calculate the T score and Z score, which are indicators of the risk of fracture and the need for treatment, respectively. Other tests that may be used to evaluate osteoporosis include blood tests, urine tests, and vertebral fracture assessment (VFA).

**Limitations of X-rays in Osteoporosis Diagnosis:**

- X-rays can detect significant bone loss only, usually after 30-50% of bone loss has occurred.
- Moreover, these methods are less sensitive than dual-energy X-ray absorptiometry (DEXA), the gold standard for diagnosing osteoporosis.
- Other conditions, such as arthritis or Paget's disease, can mimic some X-ray findings.

Therefore, X-rays alone cannot **be used to** definitively diagnose osteoporosi**s.** They are often used:

- To confirm a diagnosis already suggested by DEXA or clinical factors.
- The purpose of this study was to assess fracture risk before or after an osteoporosis-related fracture.
- Disease progression was monitored in some patients.

**Practical Use of Hip and Hand X-rays in Osteoporosis Treatments**

The following section describes how hand and hip X-rays are used practically in the diagnosis and management of osteoporosis:

**Screening:**

- **Initial check:** If you are at high risk due to age, family history, or other factors, your doctor might order hand X-rays as a quick and accessible initial screening tool. Punciform lucencies or cortical thinning can alert patients to further investigation via DEXA.
- **Monitoring progression:** After diagnosis, periodic hand X-rays can be used to monitor the progression of bone loss and assess the effectiveness of treatment over time.

**Fracture assessment**

- **Confirming fragility fractures:** If a person has suffered a wrist or forearm fracture, especially a fracture of the colles, a hand X-ray can help determine if the patient has an osteoporosis-related fragility fracture.
- **Identifying fracture risk:** If a patient has not yet been fractured but has risk factors, hip X-rays can reveal subtle signs of bone loss, suggesting increased fracture risk and informing the need for preventive measures.

**Clinical Decision-Making:**

- **Treatment guidance:** Depending on the severity of bone loss and fracture risk observed via X-rays combined with DEXA and other factors, a doctor can tailor treatment plans based on medication, lifestyle modifications, or fall prevention strategies.

- **Surgical evaluation:** If hip X-rays reveal significant femoral neck thinning or existing fractures, they can help assess the potential for hip replacement surgery and guide surgical planning.

**ULTRA SONO GRAPHY**

Osteoporosis can present on ultrasonication when the bones appear on the image, which can indicate low bone mineral density (BMD) or an increased risk of fracture. Osteoporosis is a condition that affects bones, making them weaker and more prone to fracture. It is more common in older people, especially women after menopause.

Some of the features that can suggest osteoporosis on ultrasonication are as follows:

- Decreased bone density, which can be observed by decreased cortical thickness and loss of bony trabeculae in the mandible

- Increased bone translucency, which means that the bones appear darker than normal on the image due to less absorption of sound waves.

- Cortical changes, such as thinning, erosion, or endosteal scalloping, which reflect the loss of cortical bone mass

- Changes in the trabeculae, such as thinning, discontinuity, or disappearance, which reflect the loss of cancellous bone mass

- Fractures, especially at typical sites of osteoporotic fracture, such as the spine, hip, pelvis, wrist, humerus, or rib

However, these features are not very specific or accurate for diagnosing osteoporosis, as they may be affected by other factors, such as image quality, magnification, projection, and anatomical variation. Therefore, a more reliable method for assessing BMD and fracture risk is to perform a bone density test using dual-energy X-ray absorptiometry (DXA), which uses low-dose X-rays to scan the hip and spine. DXA can also calculate the T score and Z score, which are indicators of the risk of fracture and the need for treatment, respectively.

If you suspect you have osteoporosis, you should talk to your health care provider. They can perform a DXA scan or refer you to a specialist. They can also advise you on how to prevent or treat osteoporosis, such as by taking calcium and vitamin D supplements, doing regular weight-bearing exercise, quitting smoking, limiting alcohol intake, and taking medication if needed.

## DENTAL PANORAMIC RADIOGRAPHY

The presentation of osteoporosis on a dental panoramic radiograph is the appearance of bones on the image that can indicate low bone mineral density (BMD) or an increased risk of fracture. Some of the features that can suggest osteoporosis on a dental panoramic radiograph are as follows:

- Decreased bone density, which can be observed by decreased cortical thickness and loss of bony trabeculae in the mandible
- Increased bone translucency, which means that the bones appear darker than normal on the image due to less absorption of X-rays.
- Cortical changes, such as thinning, erosion, or endosteal scalloping, which reflect the loss of cortical bone mass
- Changes in the trabeculae, such as thinning, discontinuity, or disappearance, which reflect the loss of cancellous bone mass
- Fractures, especially at typical sites of osteoporotic fracture, such as the spine, hip, pelvis, wrist, humerus, or rib [43].F

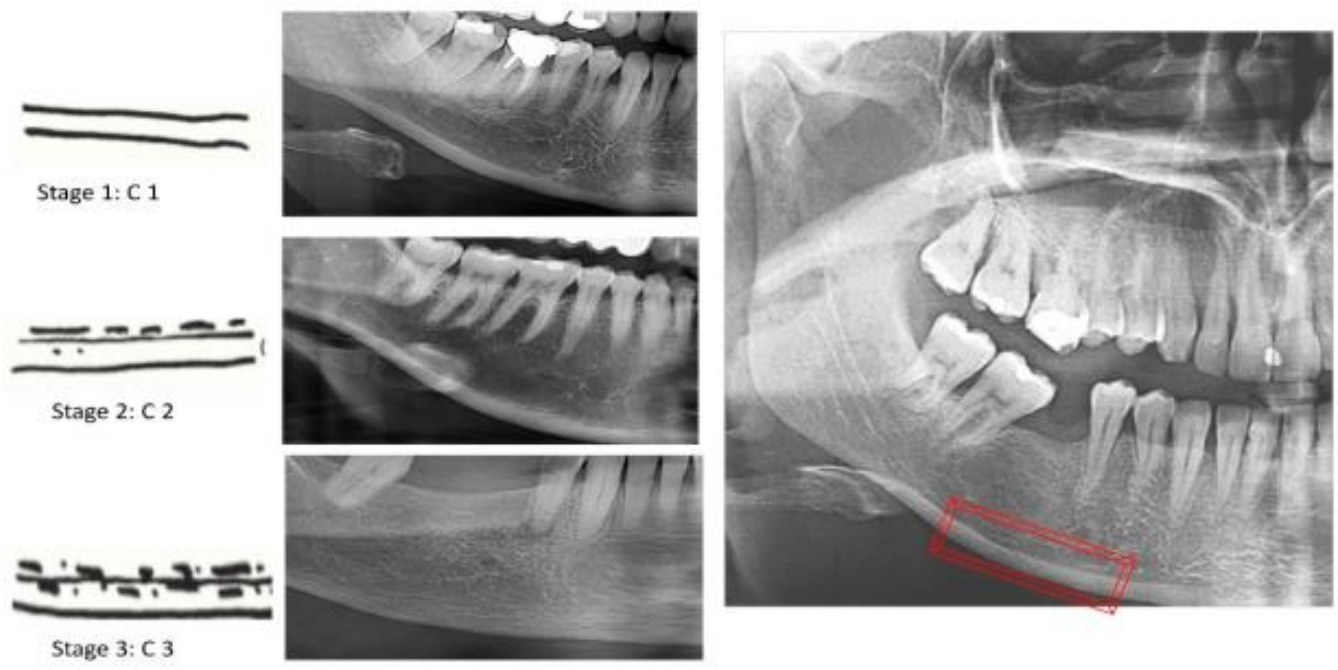



**Figure 9:** *Classification of mandibular cortical bone[43]*

Panoramic radiomorphometric indices, such as the MCI, are considered an auxiliary method for diagnosing osteoporosis on panoramic radiographs. However, evaluating these indices during routine checkups in younger women can aid in the early detection of osteoporosis. [44].

## DIAGNOSIS

The diagnosis of osteoporosis usually relies on a combination of methods that measure different aspects of bone health, and the main methods used are as follows:

1. **Medical history and physical examination**: Doctors ask about your symptoms, medical conditions, medications, family history, and lifestyle habits. They also checked your height, weight, blood pressure, pulse, and vision. They may look for signs of osteoporosis in their spine and hips by feeling bony ridges or deformities.
2. **Bone mineral density (BMD) test:** This is the most common and accurate test for measuring bone density. A machine that uses low levels of X-rays is used to determine the proportion of minerals in bones. During this painless test, you lie on a padded table as a scanner passes over your body. In most cases, only certain bones are checked, usually in the hip and spine. The results are expressed as a number called the T score, which compares bone density to that of a healthy young adult of the same sex. A T score less than -2.5 indicated osteopenia (low bone density), while a T score less than -1 indicated osteoporosis (very low bone density).

**Methods of Measuring Bone Mineral Density**

1. **Dual-energy X-ray absorptiometry (DXA)** is a medical imaging technique that measures bone mineral density (BMD) using spectral imaging. Two X-ray beams, with different energy levels, are aimed at the patient's bones. When soft tissue absorption is subtracted, the bone mineral density (BMD) can be determined from the absorption of each beam by bone [45]. DXA is the most widely used and most thoroughly studied bone density measurement technology. Low-dose X-rays are used to measure the amount of calcium and other minerals in a specific area of bone[46].
2. **Quantitative computed tomography (QCT)** is a medical technique that measures bone mineral density (BMD) using a standard X-ray computed tomography (CT) scanner with a calibration standard to convert Hounsfield units (HUs) from CT images to bone mineral density values [47]. The QCT is often used to measure BMD in the spine.[48]
3. **Single-photon absorptiometry (SPA)** is a scanning technique that uses photons of a single energy source to measure the density of a material, especially bone[49]. SPA is a noninvasive method in which a small amount of radioactive material is used to measure bone mineral density (BMD) in the wrist. The method operates when a certain amount of gamma rays emitted by isotopes pass through human tissues. There is an exponential relationship between the number of gamma rays absorbed and the thickness of tissues, and the absorption characteristics of different tissues are different; however, the effects of soft tissues and water on gamma rays are the same. Therefore, the influence of soft tissues can be eliminated by a water bath, after which the number of gamma rays absorbed by bone tissues can be measured and subsequently calculated.

4. **Peripheral quantitative computed tomography (pQCT)** is a type of quantitative computed tomography (QCT) that measures bone mineral density (BMD) in a peripheral part of the body, such as the forearms or legs. It is a noninvasive, relatively safe imaging modality that can be used to diagnose osteoporosis [50].
5. **Quantitative ultrasound (QUS)** is a medical imaging technique that measures bone mineral density (BMD) using sound waves. QUS detects subresolution acoustic properties to provide information on tissue microstructure. RF refers to radiofrequency data; I/Q refers to in-phase and quadrature data, whereas compression and shear waves refer to elastic waves used in ultrasound imaging[51]. QUS is a low-cost and readily available alternative to DXA for bone mineral density (BMD) measurements for osteoporotic fracture risk assessment. It is performed at a variety of skeletal sites, among which the most widely investigated are the calcaneus, phalanges, and radius.[52]

**3. Laboratory tests** (bone turnover markers): These tests can help rule out other causes of low bone density or monitor the effects of treatment on bones.

**Bone turnover markers (BTMs)** are laboratory tests that measure enzymes synthesized by osteoblasts or osteoclasts or products generated during the formation or degradation of the bone matrix and released into the circulation [53]. BTMs are widely used in both research and clinical practice. In the last 20 years, much experience has been gained in the measurement and interpretation of these markers, which include commonly used bone formation markers (bone alkaline phosphatase, osteocalcin, and procollagen I N-propeptide) and commonly used resorption markers (serum C-telopeptides of type I collagen, urinary N-telopeptides of type I collagen, and tartrate-resistant acid phosphatase type 5b). BTMs can be useful in the diagnosis and management of several diseases, such as osteoporosis, osteomalacia, Paget's disease, fibrous dysplasia, hypophosphatasia, primary hyperparathyroidism, and chronic kidney disease-mineral bone disorder. [54]

**4. Blood tests**: These tests can assess conditions that affect bone health, such as thyroid problems, anaemia, vitamin D deficiency, calcium imbalance, or infection.

- **Thyroid problems**: Thyroid hormones play an important role in bone metabolism. An overactive or underactive thyroid gland can lead to bone loss and increase the risk of fractures.
- Anaemia: Anaemia is a condition in which the body does not produce enough red blood cells. Red blood cells are responsible for transporting oxygen to body tissues, including bones. Without enough oxygen, bones may become weak and brittle.
- **Vitamin D deficiency**: Vitamin D is essential for bone health. It helps the body absorb calcium, which is necessary for strong bones. A deficiency in vitamin D can lead to weak and brittle bones.

- **Calcium imbalance**: Calcium is a mineral that is essential for strong bones. Too much or too little calcium in the blood can lead to bone loss and increase the risk of fractures.
- **Infection**: Certain infections, such as osteomyelitis, can affect bone health. Blood tests can help detect the presence of infection in the body.

5. **Fracture risk assessment Tool (FRAX)**: Fracture risk assessment Tool (FRAX) is a free online tool that estimates the risk of having a hip or other major fracture in the next 10 years, especially in patients with osteoporosis. The tool is administered by a health care provider and can be used for individuals who meet certain conditions. Patients with low bone density (osteopenia) are not currently taking osteoporosis medication, and they are postmenopausal women or men older than age 50. To calculate your FRAX scores, you will have to answer several questions about habits such as alcohol intake and other disorders you may have that are linked to osteoporosis, such as type 1 diabetes. Knowing your 10-year risk for fractures will allow you and your doctor to make decisions about treatment. If you're FRAX score is 3% or more for hip fracture or 20% or more for other major osteoporosis fractures, you may be at increased risk of fracture. Treatment may be recommended to reduce the risk of fracture. This can estimate your risk of breaking a bone in the next 10 years based on your age, sex, BMD score, and other factors. This can help decide whether you need treatment or not.
6. **Magnetic resonance imaging (MRI)**: a non-invasive medical test that produces images of soft tissues, such as organs and muscles, within the body. It uses magnets, radio waves, and a computer to create 3D images without radiation. To obtain an MRI image, a patient is placed inside a large magnet and must remain there during the imaging process to avoid blurring the image. Contrast agents (often containing the element Gadolinium) may be given to a patient intravenously before or during the MRI to increase the speed at which protons realign with the magnetic field. MRI is a safe choice for imaging, especially for people who need frequent imaging tests for chronic health concerns. This approach can provide detailed images of bones and soft tissues without using radiation. It can help detect fractures or other abnormalities in the bones.

The diagnosis of osteoporosis is based on the combination of these methods and their results. However, no single test can diagnose osteoporosis by itself. Therefore, doctors usually use clinical judgement along with objective measurements to make a diagnosis.

**TREATMENT**

The treatment plan for osteoporosis depends on several factors, such as age, sex, bone density, fracture risk, and medical history. Some of the common treatment options are as follows:

- **Medications:** There are different types of medications that can help prevent bone loss and reduce the chance of breaking a bone. Some of the most widely prescribed medications are bisphosphonates, such as alendronate, risedronate, ibandronate, and zoledronic acid[1]. These drugs

slow the breakdown of bone and can improve bone density. These agents are usually taken orally, but some can be given intravenously. Other medications that can treat osteoporosis include denosumab, which is a shot under the skin every six months[1]; hormone-related therapy, such as estrogen or raloxifene, which can mimic estrogen's effects on bone density in postmenopausal women[1]; and testosterone, which can help men with low testosterone levels and osteoporosis[2].

- **Calcium and vitamin D:** Calcium and vitamin D are essential nutrients for bone health. Calcium helps build and maintain bone, while vitamin D helps the body absorb calcium and regulate bone growth. Individuals can obtain calcium and vitamin D from their diet, such as through dairy products, green leafy vegetables, fish, and fortified foods[3]. Individuals can also take supplements if their intake is insufficient. The recommended daily intake of calcium for adults is 1,000 to 1,200 milligrams, and the recommended daily intake of vitamin D for adults is 10 micrograms.

- **Exercise:** Exercise can help strengthen one’s bones and muscles, improve one’s balance and posture, and prevent falls. Weight-bearing exercises, such as walking, jogging, and climbing

## I.5 CURRENT SATET OF LITERATRUE ON THE RESEARCH QUESTION

The current standard for diagnosing osteoporosis is dual-energy X-ray absorptiometry (DXA) or bone mineral density (BMD) measurements. However, these methods are expensive and not widely available, especially in low income countries.

### Asia

### In India

A recent study in India proposed that assessing mandibular cortical width (MCW) and the mandibular cortical index (MCI) via panoramic radiographs, in addition to the new factor of age at menarche, may serve as an effective method for osteoporosis screening in women[12].

In conclusion, although the application of panoramic radiographs for osteoporosis screening is in its early phases, the findings from these studies indicate that these images could serve as an economical and noninvasive substitute for DXA scans or BMD measurements. Nevertheless, additional research is needed to verify the diagnostic accuracy of these indicators and to create a standardized protocol for their integration into general dental practice.(8, 33)

As early identification of osteoporosis is crucial, the creation of an effective and cost-efficient screening model would be highly advantageous. This study aimed to assess the diagnostic precision of MCW and MCI indices derived from dental panoramic radiographs, along with a new variable, age at menarche, for osteoporosis detection. The research included 150 Caucasian women (aged 45 to 86) who met the eligibility criteria, who underwent DXA scans of the left hip and lumbar spine (L2 to L4), and who were categorized as osteoporotic, osteopenic, or normal based on their T scores. Two observers assessed the MCW and MCI on panoramic radiographs. A statistically significant correlation existed between the T score and MCI and MCW. Additionally, age at menarche was significantly correlated with the T score ($p = 0.006$). In conclusion, within this study, the MCW, especially when combined with age at menarche, demonstrated greater effectiveness in detecting osteoporosis. Individuals with an MCW less than 3.0 mm and age at menarche later than 14 years should be referred for DXA scans due to their elevated risk of osteoporosis.[43]

#### In Korea

According to a study carried out by (Kim et al in 2016), digital panoramic radiographs could be used for the diagnosis of osteoporosis in postmenopausal women. The mental index (MI), mandibular cortical index (MCI), and simple visual estimation (SVE) were positively correlated with bone mineral density (BMD). The optimal cut-off value of the MI for the diagnosis of spinal osteoporosis was 2.22 mm. These results suggest that the MI, MCI, and SVE may be useful indices for the diagnosis of osteoporosis in a Korean population.

The study also revealed that BMD at the lumbar spine and total hip was significantly lower in participants with a reduction in mandibular width, thinning, or resorption of the mandibular cortex.

These findings suggest that changes in the mandibular cortex may be an early indicator of osteoporosis [56].

In conclusion, the present study suggested that digital panoramic radiographs may be useful tools for diagnosing osteoporosis in postmenopausal women. However, further research is needed to confirm these findings and to establish the optimal cut-off values for MI, MCI, and SVE for the diagnosis of osteoporosis in different populations.

**In Africa**

Currently, there is limited research on the use of dental panoramic radiography (DPR) for early osteoporosis diagnosis in African populations, and little or no research has evaluated the use of alternative diagnostic methods for the early detection of osteoporosis.

**In Morocco**

According to a study by Ghazi et al. (2007), the Osteoporosis Self-Assessment Tool (OST), which assesses age and weight, is designed to identify women with a greater likelihood of having low BMD, warranting BMD testing. This study aimed to evaluate the effectiveness of OST in identifying osteoporotic white men in Morocco. An epidemiological cross-sectional study was conducted, analysing the records of 229 white Moroccan men attending an outpatient rheumatology centre. OST scores were compared to bone density T scores to assess OST's ability to identify men with osteoporosis (T scores < -2.5). With an OST score < 2 indicating DXA referral, the sensitivity ranged from 63% at the lumbar spine to 87% at the total hip for detecting BMD T scores of -2.5, while the specificity ranged from 58 to 59%. The negative predictive value of the OST was high across all skeletal sites (87-98%), demonstrating its usefulness in identifying patients with normal BMD who may not require DXA testing. The performance of OSTs among Moroccan men was comparable to that reported for Asian and US populations.

In conclusion, the OST is an effective and efficient tool for identifying high-risk men for DXA measurements, particularly in settings with limited BMD technology availability or cost constraints. Its ability to accurately identify men with osteoporosis and rule out those with normal BMD can optimize resource utilization and patient care.[57]

**In Nigeria**

A study was conducted in 2017 by Ezeonu et al. The prevalence of osteoporosis was investigated among pregnant women attending an antenatal clinic in a rural Southeast Nigerian hospital. The study participants were randomly selected, and their bone mineral density (BMD) was measured using OsteoPro, a quantitative ultrasound scan. The findings revealed that 36.4% of the participants had osteoporosis, while 17.1% had osteopenia. The study concluded that the high incidence of osteoporosis among pregnant women in Southeast Nigeria could be attributed to the predominant poor adherence to calcium supplementation and low doses of calcium supplements among pregnant women in this region.[58]

**In Cameroon**

A 2008 study was performed to determine the bone mineral density (BMD) of Cameroonian women and the importance of primary osteoporosis in menopausal women. This 10-month cross-sectional and observational study was carried out on voluntary clinically healthy women aged at least 20 years. A complete clinical examination and measurement of the BMD by quantitative ultrasound measurement of the calcaneus were carried out. The BMD was calculated automatically by an apparatus with values in g/cm2 and a T score. According to the results, the average bone mineral density was 0.513 g/cm2 (± 0.141). The decrease in bone mineral density progressed with age, with a sharp slope after 70 years. A statistically significant reduction in BMD was associated with menopause, lower or moderate physical activity, and weekly consumption of milk products less than the equivalent of a cup of yogurt or cigarette smoke. Alcohol consumption and obesity had no significant influence on the distribution of BMD. Considering the T score, 13.6% had osteoporosis, 46.6% had osteopenia, and 53.4% had a normal T score. Among women aged 50 years and older, 17.9% had osteoporosis, while among women aged younger than 50 years and older, 17.6% had osteoporosis, and 55.8% had osteoporosis. In conclusion, the BMD of urban Cameroonian women is comparable to that of other women worldwide. Osteoporosis is also present in the Western world, but it is associated with relatively fewer fractures. These results need to be confirmed by studies with larger population sizes [6]. Osteoporosis is a serious and growing health problem in Africa and Cameroon that requires urgent attention and action from all stakeholders. By addressing the gaps and challenges in the early diagnosis of this condition, the state of knowledge and care of osteoporosis can be improved.

# CHAPTER III : MATERIALS AND METHODS

# MATERIALS AND METHODS

## 1.1 TYPE OF STUDY

We carried out An Analytical Cross-Sectional study

## 1.2 STUDY SETTING

We carried out our study at the Laboratory of Implantology and Periodontology at the Faculty of Medicine and Biomedical Science of the University of Yaoundé I.

- **Laboratory of Implantology and Periodontology**

The Laboratory of Implantology and Periodontology at the Faculty of Medicine and Biomedical Science of the University of Yaoundé I consists of five units and a waiting room.

We have:

- Three rooms equipped with a functioning dental chair, dental equipment for implant dentistry and more
- A Sterilization room containing an autoclave, a dustbin or more
- The radiographic room was equipped with a desktop computer and a Rayscan alpha version 24.2.10.784 dental panoramic radiograph.


**Figure 10:** RayScan alpha version 24.2.10.784 and Desktop unit (at the Laboratory of Implantology and Periodontology of FMBS/UY1)

### 1.3 STUDY PERIOD AND DURATION

We carried out our study from November 2021 to June 2024, lasting 7 months. The data was collected from January 10 2024 to April 16, 2024.

### STUDY POPULATION

### SOURCE POPULATION

Patients referred for a dental panoramic radiograph at the Implantology and Periodontology Laboratory of the Faculty of Medicine and Biomedical Science of the University of Yaoundé I (FMBS UYI).

### TARGET POPULATION

Files of aged women fulfilling all the inclusion criteria were cited in our studies. Patients aged above 25 years referred to the Implantology and Periodontology Laboratory of the Faculty of Medicine and Biomedical Science of the University of Yaoundé I (FMBS UYI) for panoramic radiography.

## INCLUSION AND EXCLUSION CRITERIA

### A. INCLUSION CRITERIA

- Files of women between the ages of 25 and older at the time of radiographic examination to ensure full mandibular development
- The inferior mandibular cortex and one or both mental foramina should be appreciable on the radiograph.
- The underlying systemic pathology that may affect skeletal metabolism is unknown

### B. NON-INCLUSION CRITERIA

- Files of women aged less than 25 years at the time of radiographic examination
- All the files of male patients were not included.

### C. EXCLUSION CRITERIA

- History of metabolic bone disease, cancer with bone metastasis, significant renal impairment, or medication that affects bone metabolism
- Patient positioning errors
- Intrinsic errors on the radiographs
- Patient history of maxillofacial trauma and reconstruction

## SAMPLE-SIZE DETERMINATION

Sampling will be no probabilistic and controlled quota sampling.
We calculated our minimum sample size using Cochran's formula below:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

where

- n is the sample size
- Z is the Z value (e.g., 1.96 for a 95% confidence level).
- p The estimated incidence of osteoporosis in aged women in Cameroon ranges from **13.6%** to 55.8%.[6]
- e is the acceptable margin of error 0.5

Our sample size is **187**

## 1.4 STUDY PROCREDURE

## Ethical and Administrative Procedure

After validation of our research protocol by our supervisor and co-supervisors, we submitted a request for ethical clearance to the Institutional Review Board (IRB) of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. Thereafter, we submitted research

authorization forms to the Laboratory of Implantology and Periodontology at the Faculty of Medicine and Biomedical Science of the University of Yaoundé I for administrative approval.

## Recruitment

During the initial phase of our study, we meticulously reviewed radiographic registries of patients referred to the Laboratory of Implant Dentistry and Periodontology for Dental Panoramic Radiographs (DPR). We carefully selected patients who met our pre-defined inclusion criteria for enrollment in the study.

Next, we refined this group of patients by applying our exclusion criteria in a sequential, two-step process. First, we categorized patients based on their age into pre-menopausal, peri-menopausal, and post-menopausal groups. We then contacted all women in the peri-menopausal age range to verify their last menstrual period date, allowing us to accurately determine if they were pre- or post-menopausal at the time of their radiograph.

Following this, a team of dentists at the Implant Dentistry and Periodontology Laboratory meticulously examined and evaluated the dental panoramic radiographs of the remaining patients who met our inclusion criteria. We recorded radiographic measurements and relevant radiomorphic indices as specified in our study protocols.

To ensure accuracy and reliability, each dentist independently interpreted the radiographs at least three times. Before proceeding to the next radiograph, each dentist reviewed their previous two interpretations to identify and correct any potential errors or inconsistencies. This rigorous process helped to minimize the risk of misinterpretations and incorrect diagnoses.

**Data Collection**

We will collect data through a written questionnaire (appendix V, VI) comprising four (04) sections.

Section 1: Sociodemographic data

Section 2: Panoramic Radiography Evaluation

Section 3: Radiomorphometric indices

**Panoramic Radiometric Indices**

These indices are measured on panoramic radiographs and can be used to evaluate bone loss, which can predict a possible loss of bone mineral density[59].

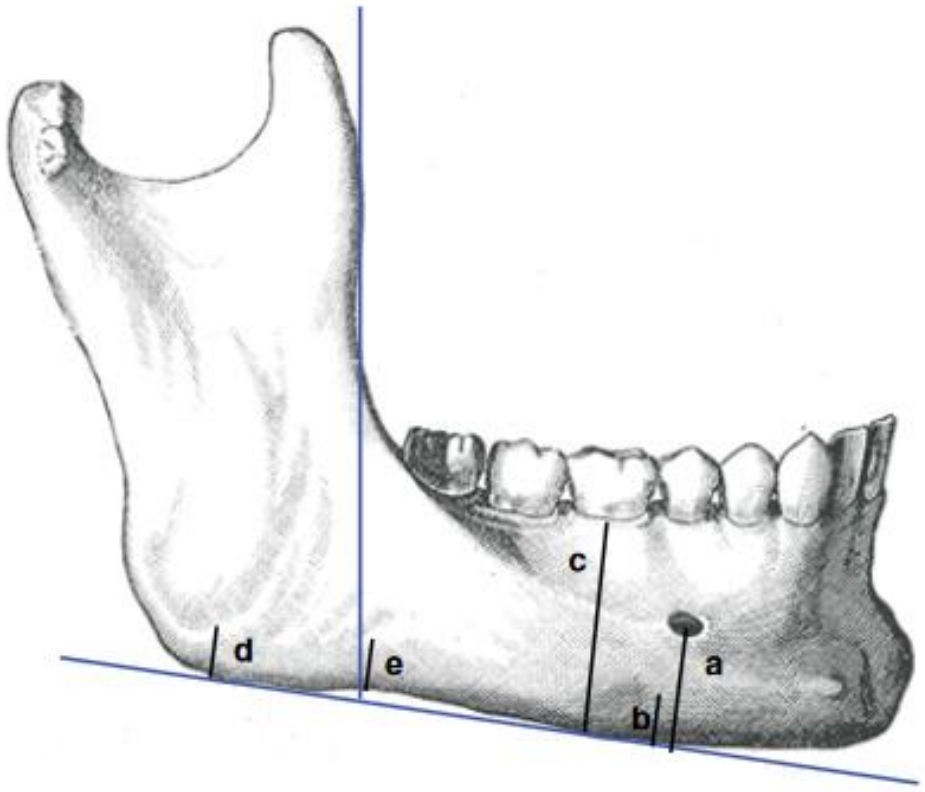



**Figure 11:** *Linear panoramic indices: mandibular cortical width (or mental index or mandibular cortical thickness) = b; panoramic mandibular index (PMI) = b/a; gonial index (GI) = d; antegonial index (AI) = e; mandibular ratio (M/M) = c/a***[59]**

### a) Mandibular Cortical Index

The mandibular condylar index (MCI) is a three-level classification system that assesses the porosity of the mandible and is related to bone mineral density. This index was developed by Klemetti and is known as the Klemetti Index. It is used to identify individuals with low bone mineral density or those at risk of osteoporosis. The MCI was determined by examining the inferior cortex of the mandible on panoramic radiographs. The cortex is categorized into one of three groups [60].

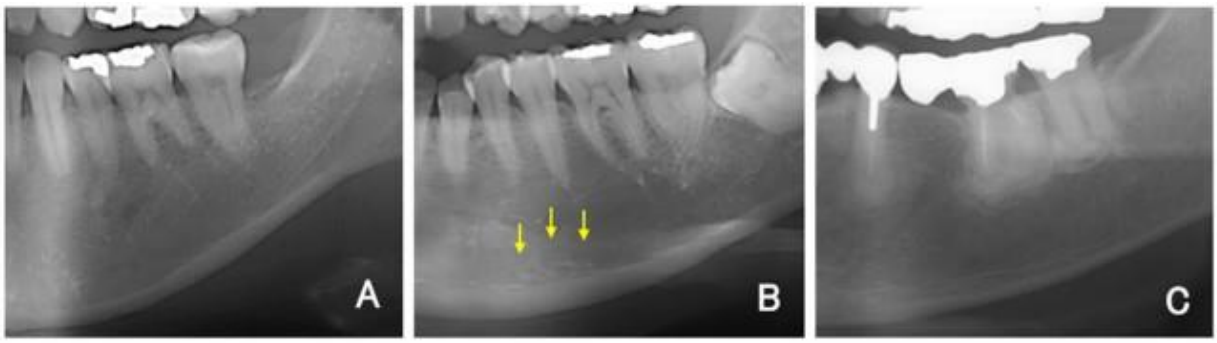



**Figure 12:** *Klemetti Classification of the Mandibular Cortical Bone. (A) Representative image of C1,*

*(B) representative image of C2, (C) representative image of C3***[60]**

- **C1**: The endosteal margin of the cortex is smooth, regular, and sharp on both sides of the mandible.
- **C2**: The endosteal margin shows semilunar defects or resorption cavities with cortical endosteal residues one to three layers thick on one or both sides.
- **C3**: The endosteal margin has numerous (>3) thick cortical endosteal residues and is clearly porous.

A C1 score indicates normal bone mineral density, while a C2 or C3 score suggests low bone mineral density or an increased risk of osteoporosis. The MCI is a simple and non-invasive method for identifying individuals at risk of osteoporosis.

**b)** The mandibular cortical width (MCW)/mental index (MI) is a measure of the thickness of the mandibular cortex at the level of the mental foramen. This measurement technique was developed by Ledgerton et al. and is used to assess bone density in the mandible. According to Ledgerton et al., the procedure for measuring the MFI is as follows [61]:

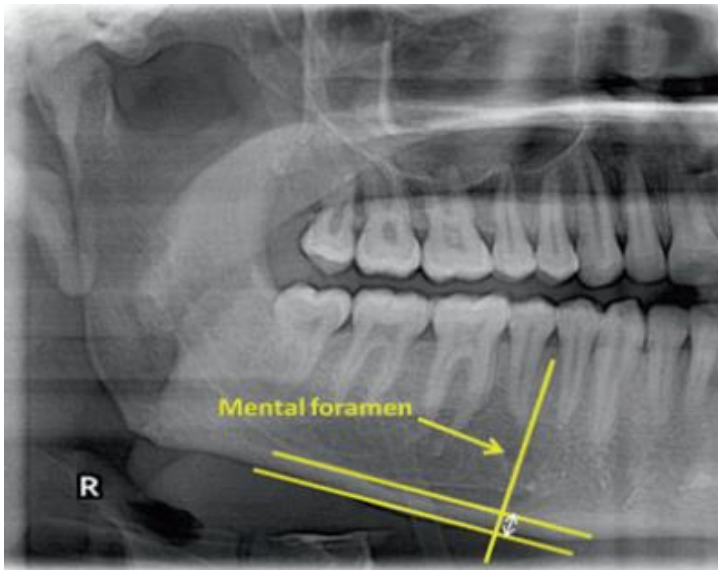



**Figure 13:** *Mental index/Mandibular cortical Width***[61]**

1. A line perpendicular to the tangent of the lower border of the mandible and through the center of the mental foramen was drawn.
2. The cortical thickness in the region of interest on both the right and left sides of the mandible was measured. Measuring both sides is important because different sides of the mandible may be influenced by different occlusal forces and may exhibit asymmetric bone density.
3. The mean cortical thickness was calculated for both sides of the mandible.

The MFI is a simple and noninvasive method for assessing bone density in the mandible. It can be used to identify individuals who may be at risk for osteoporosis or other bone-related disorders.

**c) Panoramic Mandibular Index (PMI)**

The Panoramic Mandibular Index (PMI) was measured according to the following criteria:

1. A line is drawn perpendicular to the tangent to the lower border of the mandible and through the center of the mental foramen.
2. Measurements were made along this line of cortical width, the distance between the lower border of the mandible and the inferior and superior margins of the mental foramen [61].

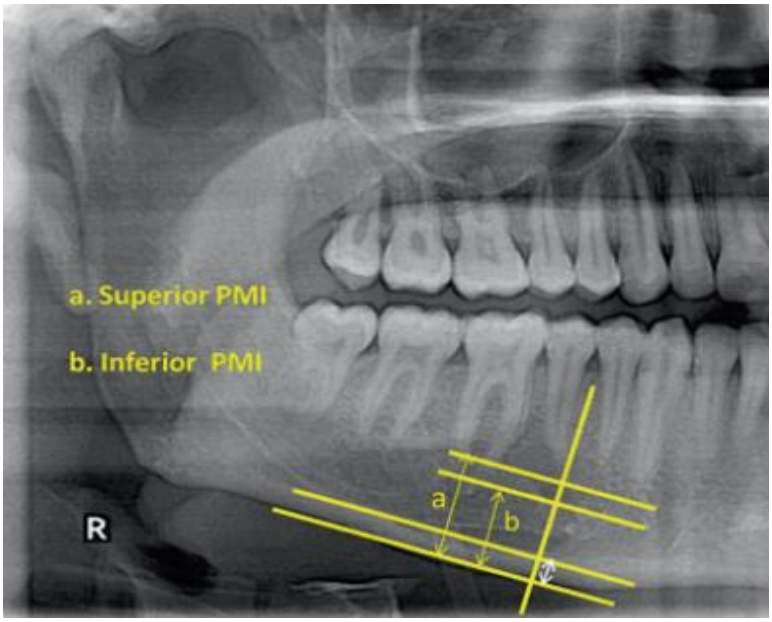



**Figure 14:** *Panoramic Mandibular Index***[61]**

Step 1 was described by Ledgerton et al., while step 2 was introduced by Benson et al.

The superior and inferior PMIs were calculated as follows:

- **Superior PMI**: cortex thickness/distance from the superior margin of the mental foramen to the inferior border of the mandible
- **Inferior PMI:** cortex thickness/distance from the inferior margin of the mental foramen to the inferior border of the mandible.

Several studies have shown that MCI and the PMI are significantly correlated with mandibular BMD and have moderate sensitivity and specificity for diagnosing mandibular BMD (Horner and Devlin 1998). In summary, the PMI is a simple and noninvasive method for assessing bone density in the mandible. It can be used to identify individuals who may be at risk for osteoporosis or other bone-related disorders.

**d) Antegonial Index (AI)**

The linear radiomorphometric index measures the thickness of the mandibular cortex at the intersection of a line perpendicular to the mandibular cortex and the tangent line to the anterior border of the ramus. This index was developed by Ledgerton et al. (1999) and is considered normal if the cortical thickness is greater than 3.2 mm [61].

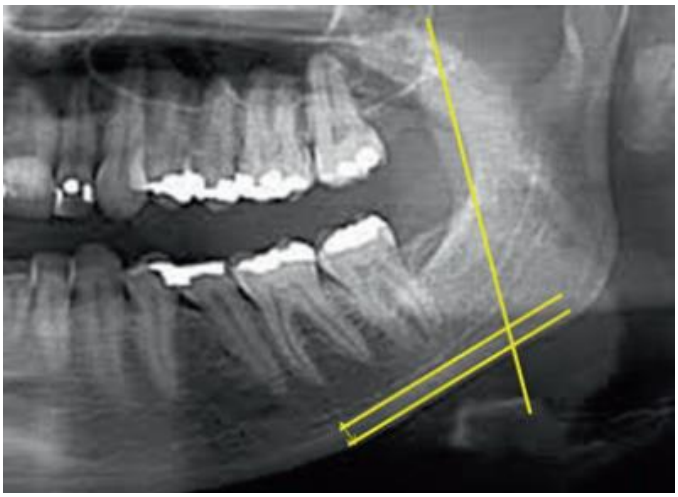


**Figure 15:** ***Antegonial index*****[61]**

Research on the antegonial index has revealed that the changes measured are inversely proportional to sex and dental status.

**e) Gonial Index (GI)** The mandibular angular cortex index (MCI) is a measure of the thickness of the mandibular cortex at the gonial angle. The normal value for the MCI is greater than 1.2 mm [61].

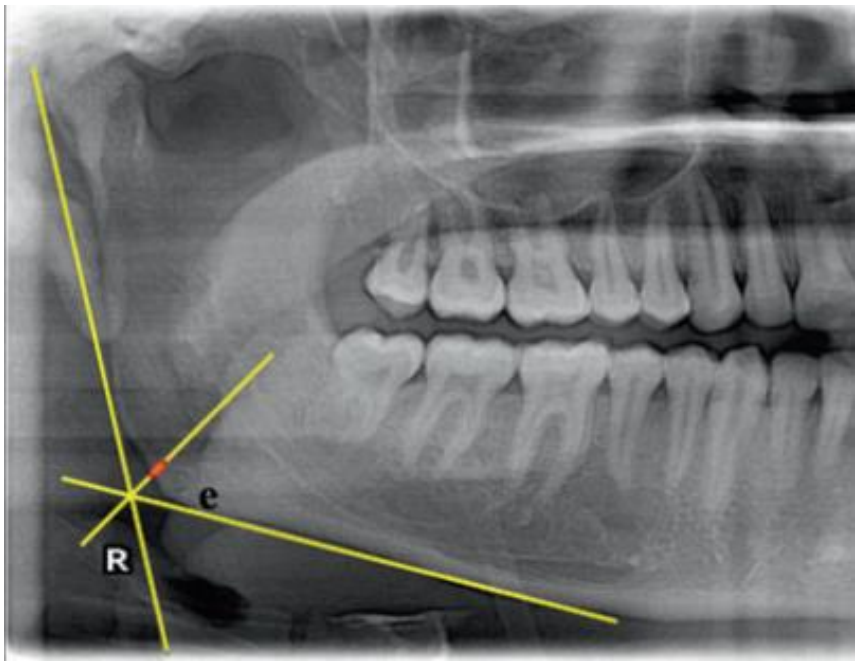



**Figure 16:** *Gonial index***[61]**

The MCI was developed by Bras et al. in 1982 and has been shown to be negatively correlated with age. Studies have shown that the incidence of MCI is not significantly affected by sex or dental status. However, the precision of MCI measurements can be poor due to the small size of the cortical width in the gonial region [61].

## 1.5 MATERIALS AND RESAORUCES

### Human resources

- Principal investigator
- Supervising team
- Health personnel of the Laboratory of Implantology and Periodontology
- Study participants
- Statistician

### Materials

- Collection materials: Data sheets.
- Office equipment: A4 paper reams, pens, pencils, erasers, printer.
- The data analysis materials used were as follows: software (CS-PRO, SPSS, Microsoft Office Excel), laptop, and USB (Universal Serial Bus) key.

## 1.6. DATA MANAGEMENT AND ANALYSIS

The database was constructed and coded using Microsoft Excel 2016 and analysed with SPSS (Statistical Package for Social Sciences) version 27.0 software for statistical analysis. Charts will be generated using Microsoft® Office Excel 2016 and S.P.S.S. version 27.0 Quantitative variables were summarized using appropriate measures based on their distribution. Normally distributed data were presented as mean and standard deviation, while skewed data were represented by median and interquartile range.

To assess associations between categorical variables, Chi-square tests were employed where applicable. One-way ANOVA was used to compare means between groups for normally distributed data, while Student's T-test was used for non-normally distributed data.

Finally, Pearson correlation analysis was performed to evaluate the relationships between continuous variables measured in our studies

## 1.7. ETHICAL CONSIDERATION

### Ethical Clearance

The study was conducted in accordance with guidelines governing human research as stated in the Nuremberg code of 1947 and the Helsinki declaration of 1964 revised in October 2013. Research authorizations were obtained from the Directors of the Laboratory of Implantology of the Faculty of Medicine and Biomedical Science. Ethical clearance was obtained from the Institutional Review Board of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I N0 0112. Participants were informed of the purpose, benefits and risks of the study.

# CHAPTER IV: RESULTS

## RESULTS

We found 1,660 records of female patients referred for or prescribed a dental panoramic radiograph from 2021 and April 16, 2024. But this number was reduced to 400 after performing random sample of 400 radiographs was then taken and further reduced to 188 after applying exclusion criteria based on image quality, patient history, and the presence of specific dental conditions.

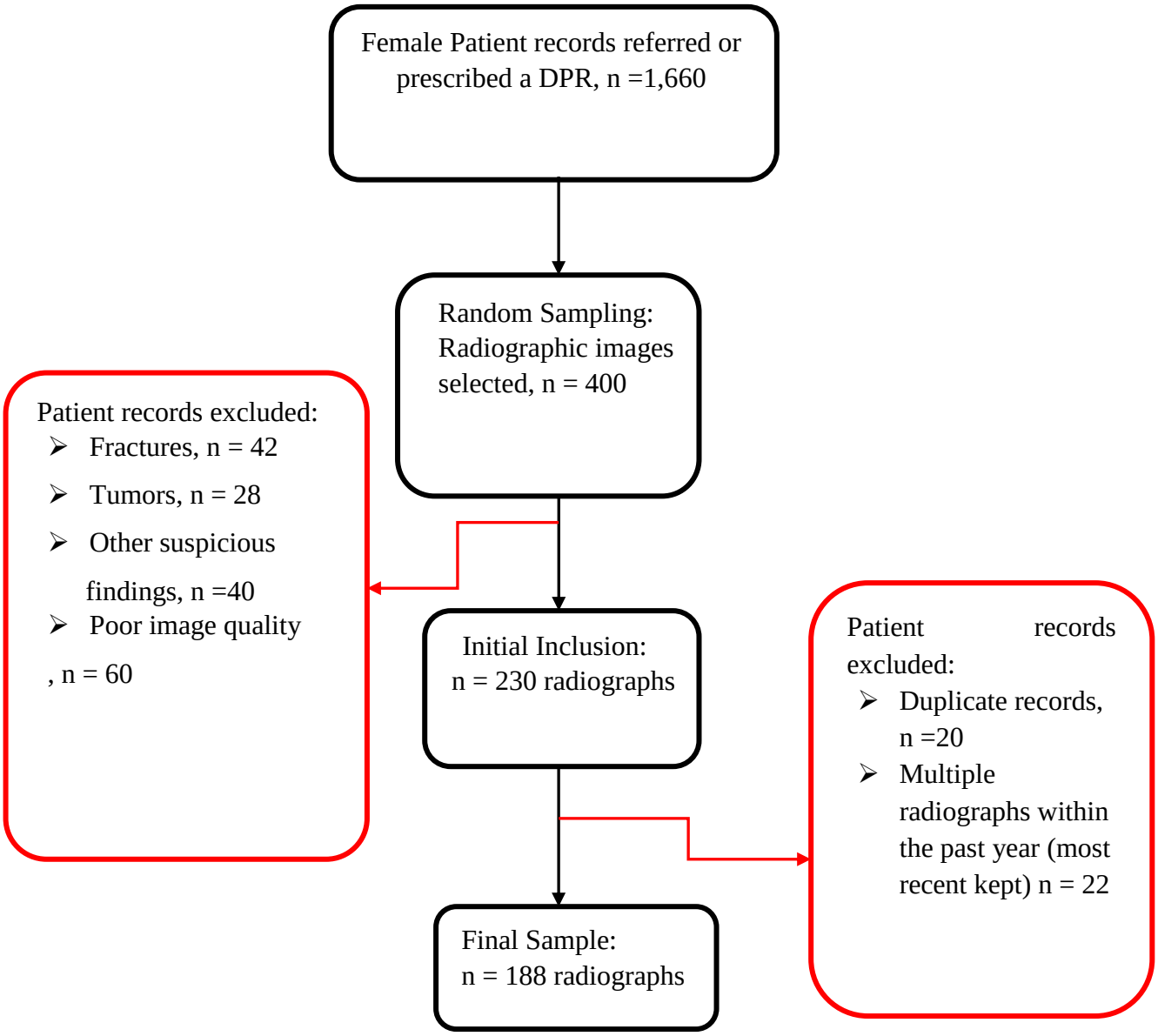



**Figure 17:** Flow chart of patient data

# 4.1 GENERAL CHARACTERISTICS OF THE STUDY POPULATION

## 4.1.1 SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

The median age of our study population (n=188) was 39.5 [30.0 – 52.5] years with a minimum age of 24 years and a maximum age of 86 years. All participants were female with 68.6% (n=129) being pre-menopausal. The median age for premenopausal women was 34.0 [27.0 – 40.0] years while that for post-menopausal women was 61.0[54.0 – 68.5] years.

Table I: Sociodemographic Characteristics (n=188)

| Variable | Frequency(n) | Percentage (%) |
|---|---|---|
| **Menopause status** | | |
| Pre-menopausal | 129 | 68.6 |
| Post menopausal | 59 | 31.4 |

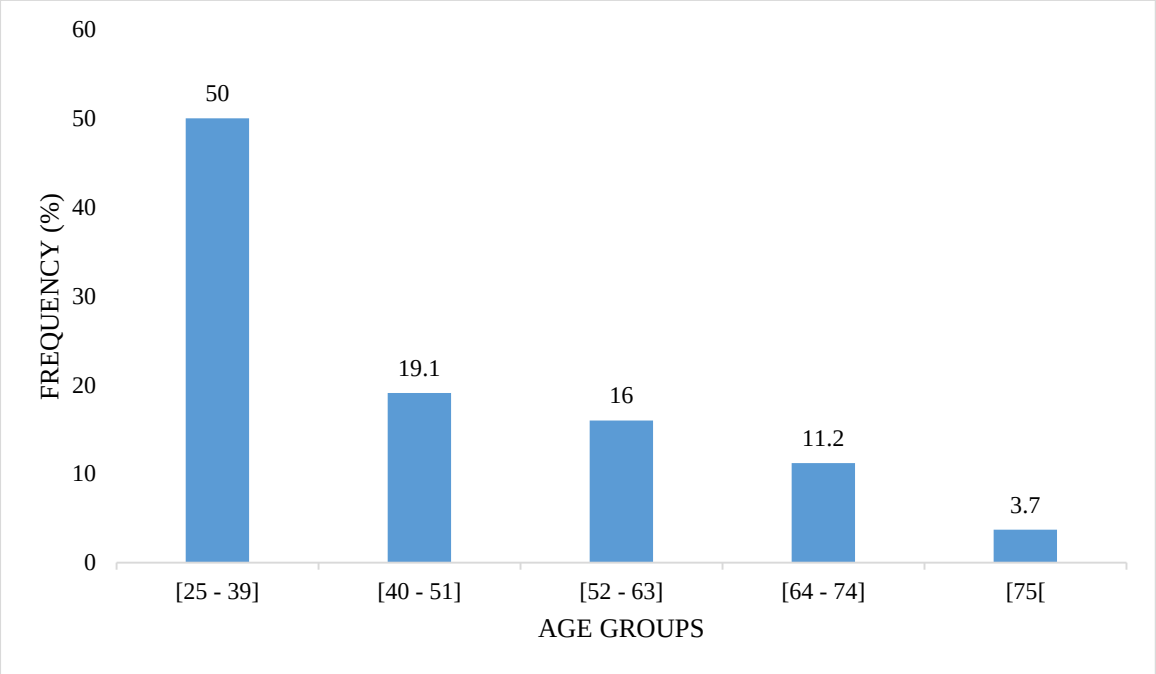



Figure 18: age groups(n=188)

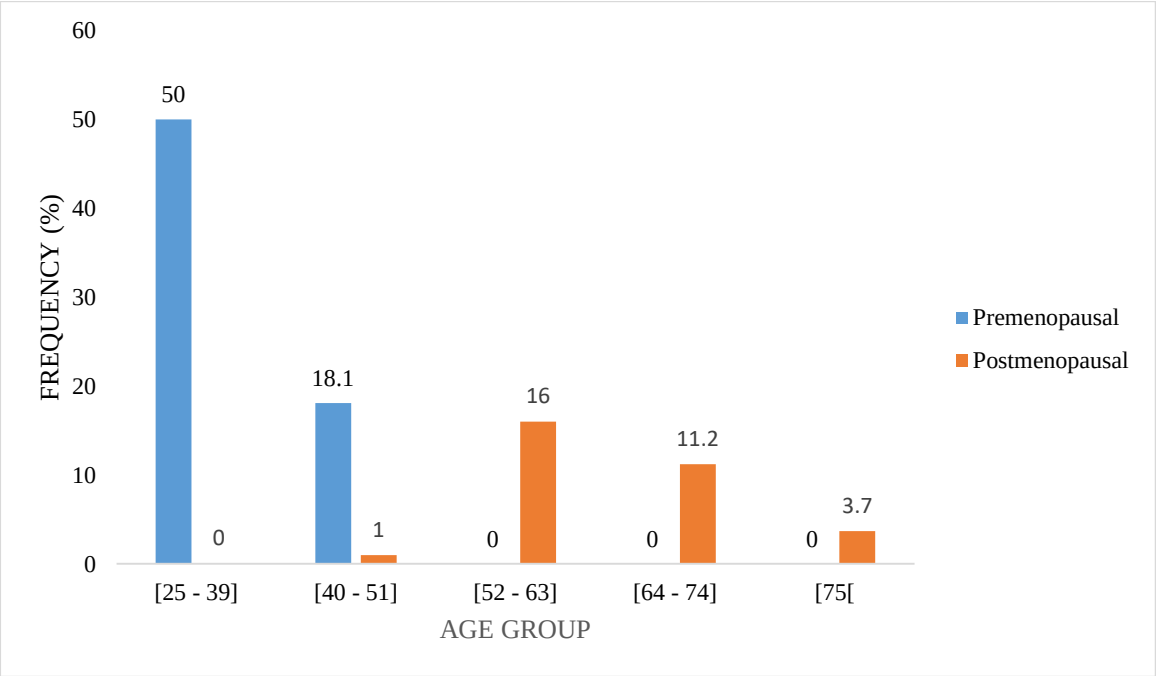



Figure 19: Age per menopausal group (n=188)

5.1.2 RADIOGRAPHIC FINDINGS IN STUDY POPULATION

Table II: General radiographic findings (n=188)

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Dentation status** | | |
| Partial edentulism | **143** | **76.1** |
| No edentulism | 45 | 23.9 |
| **Left furcation defects** | | |
| No bone loss | **144** | **60.6** |
| Mild | 49 | 26.1 |
| Moderate | 08 | 4.3 |
| Severe | 09 | 4.8 |
| No value (no molar) | 08 | 4.3 |
| **Right furcation defects** | | |
| No bone loss | **124** | **66.0** |
| Mild | 41 | 21.8 |
| Moderate | 05 | 2.7 |
| Severe | 11 | 5.9 |
| No value (no molar) | 07 | 3.7 |
| **(Bone loss) VBL-Left** | | |
| None | 01 | 0.5 |
| Mild | 13 | 6.9 |
| Moderate | **98** | **52.1** |
| Severe | 76 | 40.5 |
| **(Bone loss) VBL-Right** | | |
| None | 01 | 0.5 |
| Mild | 09 | 4.8 |
| Moderate | **94** | **50.0** |
| Severe | 84 | 44.7 |
| **Periapical radiolucency** | | |
| Present | **114** | **60.6** |
| Absent | 74 | 60.6 |

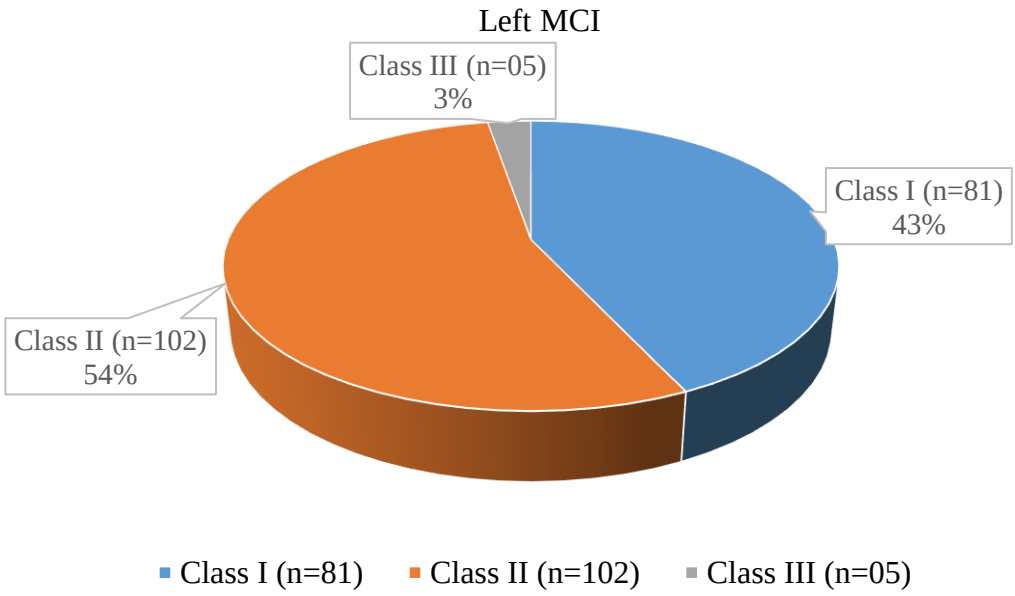



Figure 20: left MCI(n=188)

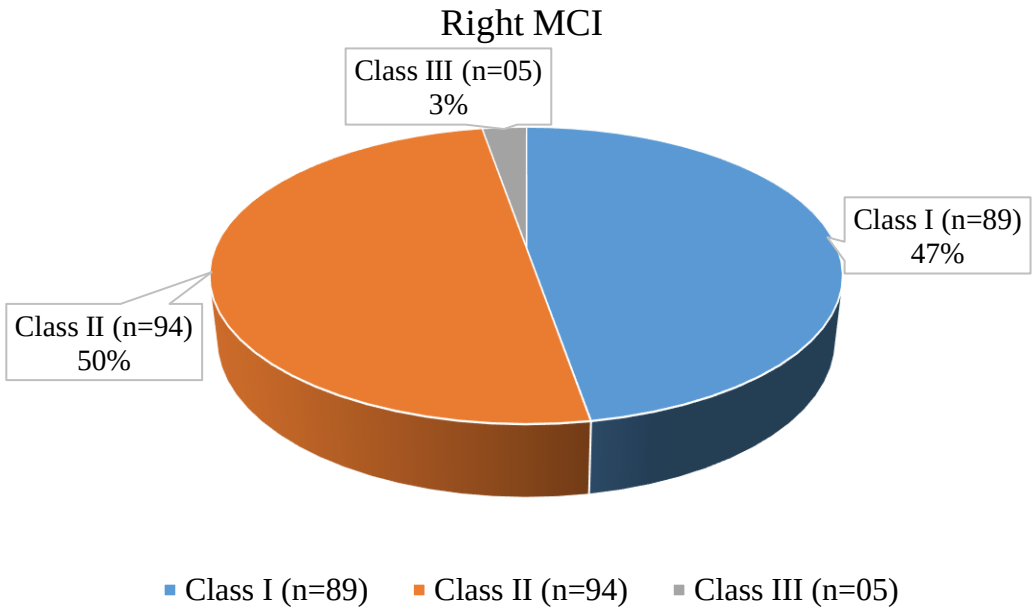



Figure 21: right MCI(n=188)

Table III: Radiographic Indices (n=188)

| Variable | Mean±SD |
|---|---|
| Right GI | 1.4±0.3 |
| Left GI | 1.3±0.3 |
| Right AI | 3.6±0.7 |
| Left AI | 3.6±0.7 |
| Right MCW/MI | 3.8±0.7 |
| Left MCW/MI | 3.8±0.7 |
| Right superior PMI | 13.2±1.5 |
| Left superior PMI | 13.0±1.5 |
| Right inferior PMI | 11.6±1.5 |
| Left inferior PMI | 11.3±1.6 |

### 5.1.3 RADIOGRAPHIC COMPARISON OF PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN

Table IV: Radiographic findings per menopausal group(n=188)

| Variable | Menopausal status | | p Value |
|---|---|---|---|
| | Premenopausal (%) | Postmenopausal (%) | |
| **Dentation status** | | | 0.144 |
| Partial edentulism | **94(50.0)** | **49(26.1)** | |
| No edentulism | 35(18.6) | 10(5.3) | |
| **Left furcation defects** | | | 0.892 |
| No bone loss | **82(43.6)** | **32(17.0)** | |
| Mild | 29(15.4) | 20(10.6) | |
| Moderate | 05(2.7) | 03(1.6) | |
| Severe | 05(2.7) | 04(2.1) | |
| No value (no molar) | 08(4.3) | 00(0.0) | |
| **Right furcation defects** | | | 0.754 |
| No bone loss | **87(46.3)** | **37(19.7)** | |
| Mild | 26(13.8) | 15(7.9) | |
| Moderate | 03(1.6) | 02(1.1) | |
| Severe | 07(3.7) | 04(2.1) | |
| No value (no molar) | 06(3.2) | 01(0.5) | |
| **(Bone loss) VBL-Left** | | | 0.451 |
| None | 01(0.5) | 00(0.0) | |
| Mild | 11(5.9) | 02(1.1) | |
| Moderate | **68(36.2)** | **30(15.9)** | |
| Severe | 49(26.1) | 27(14.4) | |
| **(Bone loss) VBL-Right** | | | 0.809 |
| None | 01(0.5) | 00(0.0) | |
| Mild | 07(3.7) | 02(1.1) | |
| Moderate | **65(34.6)** | **79(42.0)** | |
| Severe | 56(29.8) | 28(14.9) | |
| **Periapical radiolucency** | | | 0.522 |

| | | |
|---|---|---|
| Present | **76(40.4)** | **38(20.2)** |
| Absent | 53(28.2) | 21(11.2) |

Table V: MCI per menopausal group(n=188)

| Variable | Menopausal status | | p Value |
|---|---|---|---|
| | Premenopausal (%) | Postmenopausal (%) | |
| **Left MCI** | | | 0.535 |
| Class I | 59(31.4) | 22(11.7) | |
| Class II | 67(35.6) | 35(18.6) | |
| Class III | 03(1.6) | 02(1.1) | |
| **Right MCI** | | | 0.629 |
| Class I | 64(34.0) | 25(13.3) | |
| Class II | 62(32.9) | 32(17.0) | |
| Class III | 03(1.6) | 02(1.1) | |

The table presents the distribution of Mandibular Cortical Index (MCI) classes among premenopausal and postmenopausal women, with a total sample size of 188. There were three classes of MCI (I, II, and III) assessed for both left and right sides.

For left MCI, the majority of premenopausal women were classified as Class II (67, 35.6%), followed by Class I (59, 31.4%). A small percentage was classified as Class III (3, 1.6%). Among postmenopausal women, Class II was again the most common (35, 18.6%), followed by Class I (22, 11.7%). The proportion of Class III remained low (2, 1.1%). The p-value for the comparison between premenopausal and postmenopausal women was 0.535, indicating no statistically significant difference.

For right MCI, the distribution was similar. Class II was the most frequent in both premenopausal (62, 32.9%) and postmenopausal (32, 17.0%) women, followed by Class I. Class III remained the least common. The p-value for the comparison between groups was 0.629, again indicating no statistically significant difference.

## 5.2 COMPARISM OF THE DENTAL PANORAMIC MANDIBULAR INDICES IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN IN OUR STUDY POPULATION

Table VI: Indices per menopausal group (n=188)

| Variable | Menopausal status (Mean±SD) | | p Value |
|---|---|---|---|
| | Premenopausal | Postmenopausal | |
| Right GI | 1.4±0.3 | 1.3±0.3 | 0.647 |
| Left GI | 1.4±0.3 | 1.3±0.3 | 0.744 |
| Right AI | 3.7±0.8 | 3.5±0.6 | 0.219 |
| Left AI | 3.6±0.7 | 3.5±0.7 | 0.713 |
| Right MCW/MI | 3.9±0.7 | 3.6±0.7 | 0.757 |
| Left MCW/MI | 3.8±0.7 | 3.6±0.7 | 0.953 |
| Right superior PMI | 13.1±1.5 | 13.4±1.5 | 0.927 |
| Left superior PMI | 12.9±1.7 | 13.1±2.1 | 0.378 |
| Right inferior PMI | 11.5±1.6 | 11.8±1.4 | 0.443 |
| Left inferior PMI | 11.4±1.6 | 11.7±1.5 | 0.363 |

This Table shows no significant differences in mean values of radio morphometric Indices between Pre and Postmenopausal women in our studies.

## 5.3 CORRELATION BETWEEN AGE AND INDICES IN EACH GROUP

### 5.3.1 GENERAL STUDY POPULATION

Table VII: Correlations Between Age and Radiomorphometirc Indices (n=188)

| Variable | Correlation coefficient (r) | p value |
|---|---|---|
| Right GI | **- 0.156** | **0.023** |
| Left GI | - 0.080 | 0.275 |
| Right AI | -0.088 | 0.227 |
| Left AI | **- 0.151** | **0.039** |
| Right MCW/MI | **- 0.156** | **0.032** |
| Left MCW/MI | - 0.071 | 0.332 |
| Right superior PMI | 0.075 | 0.305 |
| Left superior PMI | 0.004 | 0.957 |
| Right inferior PMI | 0.105 | 0.152 |
| Left inferior PMI | 0.052 | 0.482 |

Table VIII: Age groups and indices (n=188)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] | [40 – 51] | [52 – 63] | {64 - 74} | [75[ | |
| Right GI | 1.4±0.3 | 1.3±0.4 | 1.4±0.3 | 1.3±0.3 | 1.1±0.3 | **0.032** |
| Left GI | 1.4±0.3 | 1.4±0.4 | 1.5±0.4 | 1.3±0.6 | 1.5±0.7 | 0.325 |
| Right AI | 3.7±0.7 | 3.6±0.8 | 3.6±0.5 | 3.7±0.9 | 3.6±0.8 | 0.532 |
| Left AI | 3.7±0.7 | 3.6±0.8 | 3.7±0.6 | 3.8±0.7 | 3.8±0.5 | 0.073 |
| Right MCW/MI | 3.9±0.8 | 3.8±0.7 | 3.8±0.8 | 3.8±0.6 | 3.9±0.7 | 0.202 |
| Left MCW/MI | 3.8±0.8 | 3.9±0.7 | 3.9±0.8 | 3.8±0.6 | 3.8±0.9 | 0.644 |
| Right superior PMI | 13.1±1.4 | 13.2±1.6 | 13.2±1.5 | 13.2±1.4 | 13.1±1.3 | 0.769 |
| Left superior PMI | 12.9±1.6 | 12.9±1.7 | 13.0±1.7 | 13.1±1.6 | 12.9±1.7 | 0.972 |
| Right inferior PMI | 11.2±1.2 | 11.2±1.4 | 11.1±1.3 | 11.3±1.2 | 11.3±1.3 | 0.540 |
| Left inferior PMI | 11.1±1.6 | 11.1±1.4 | 11.2±1.8 | 11.2±1.7 | 11.2±1.6 | 0.664 |

There’s a significant difference in Right GI values within age groups (p = 0.032)

Table IX: MCI and age groups (n=188)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] | [40 – 51] | [52 – 63] | {64 - 74} | [75[ | |
| Left MCI | | | | | | 0.065 |
| Class I | 45(23.9) | 15(7.9) | 12(6.4) | 07(3.7) | 02(1.1) | |
| Class II | 48(25.5) | 20(10.6) | 18(9.6) | 11(5.9) | 05(2.7) | |
| Class III | **01(0.5)** | **01(0.5)** | **00** | **03(1.6)** | **00** | |
| Right MCI | | | | | | 0.086 |
| Class I | 49(26.1) | 16(8.5) | 13(6.9) | 08(4.3) | 03(1.6) | |
| Class II | 44(23.4) | 19(10.1) | 17(9.0) | 10(5.3) | 04(2.1) | |
| Class III | **01(0.5)** | **01(0.5)** | **00** | **03(1.6)** | **00** | |

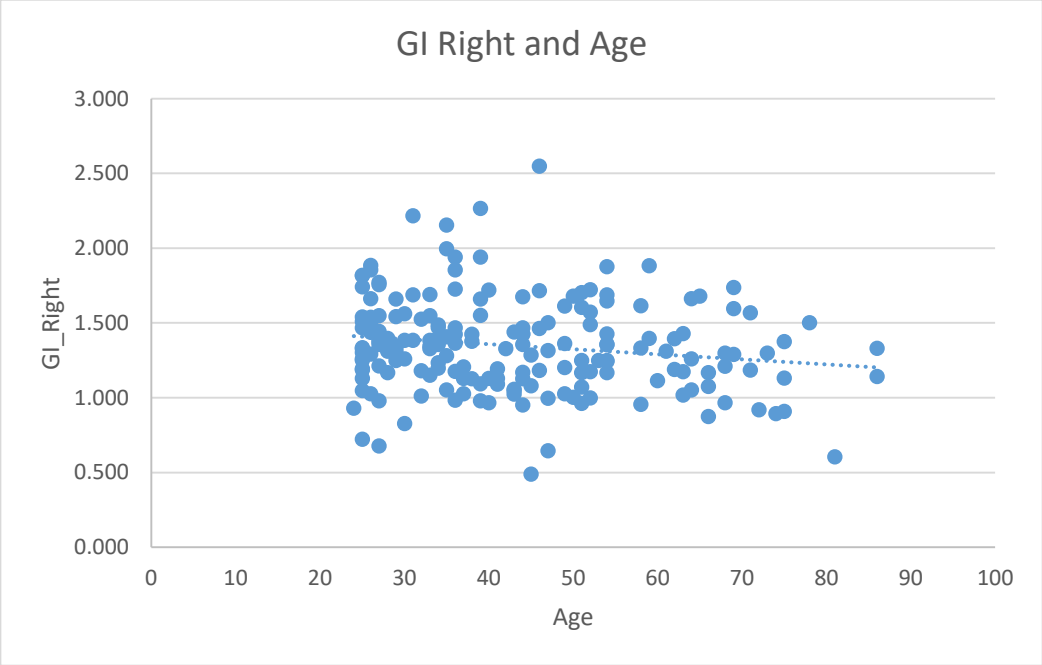



*Figure 22: Relationship between Right Gonial Index and Age*

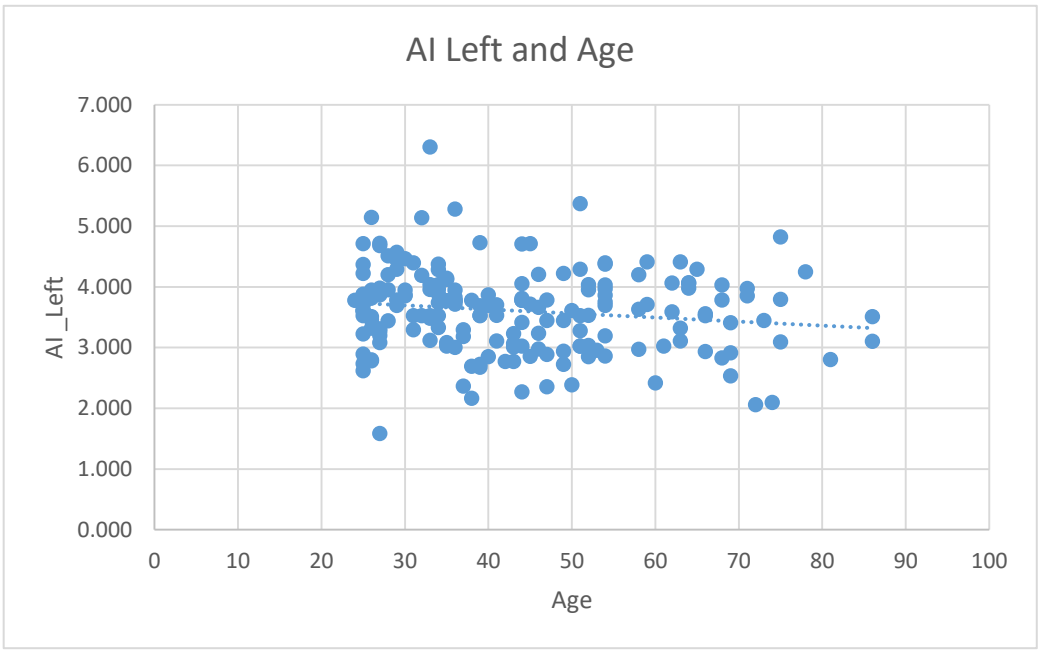



**Figure 23:** Relationship between Left Antegonial Index and Age

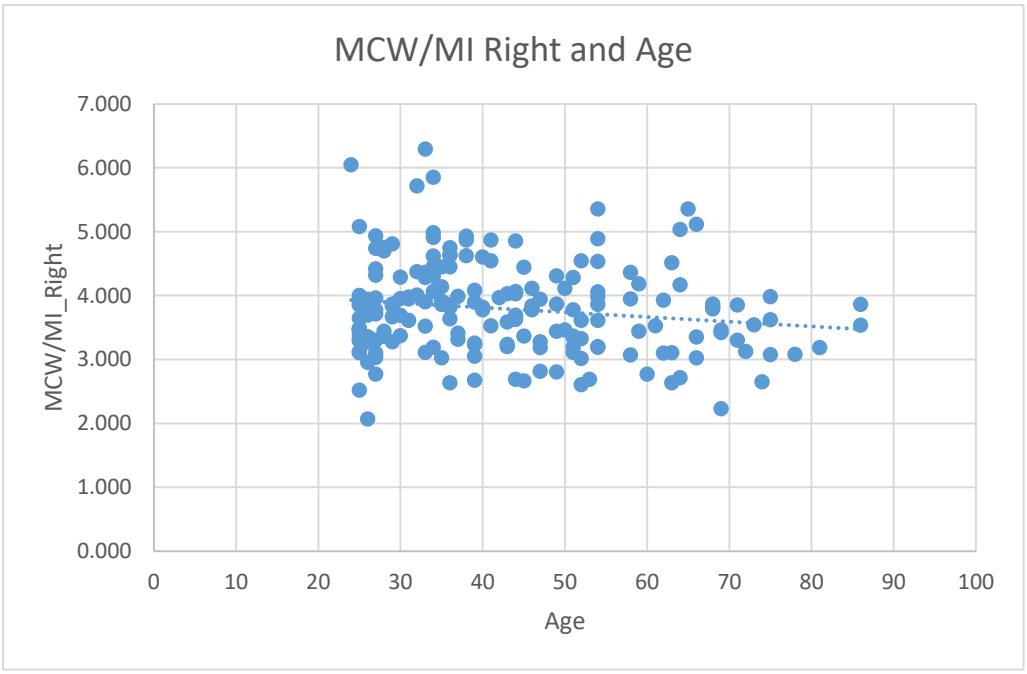



**Figure 24:** Relationship between Right Mandibular Cortical Width/Mandibular Index (MCW/MI) and Age

### 5.3.2 **PREMENOPAUSAL GROUP**

Table X: Correlations of Radiomorphometric Indices with Age in the Premenopausal group (n=129)

| Variable | Correlation coefficient (r) | p value |
|---|---|---|
| Right GI | - 0.120 | 0.167 |
| Left GI | - 0.120 | 0.179 |
| Right AI | - 0.015 | 0.868 |
| Left AI | **- 0.179** | **0.042** |
| Right MCW/MI | 0.031 | 0.726 |
| Left MCW/MI | 0.070 | 0.433 |
| Right superior PMI | 0.098 | 0.268 |
| Left superior PMI | - 0.032 | 0.715 |
| Right inferior PMI | 0.151 | 0.088 |
| Left inferior PMI | - 0.025 | 0.779 |

Table XI: Correlation of Radiomorphometric Indices Age groups in Premenopausal group (n=129)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] | [40 – 51] | [52 – 63] | {64 - 74} | [75[ | |
| Right GI | 1.4±0.3 | 1.3±0.4 | 00 | 00 | 00 | 0.067 |
| Left GI | 1.4±0.3 | 1.2±0.3 | 00 | 00 | 00 | 0.081 |
| Right AI | 3.7±0.7 | 3.5±0.7 | 00 | 00 | 00 | 0.130 |
| Left AI | **3.7±0.7** | **3.4±0.6** | 00 | 00 | 00 | **0.048** |
| Right MCW/MI | 3.9±0.8 | 3.7±0.6 | 00 | 00 | 00 | 0.152 |
| Left MCW/MI | 3.8±0.8 | 3.7±0.7 | 00 | 00 | 00 | 0.471 |
| Right superior PMI | 13.1±1.4 | 13.3±1.7 | 00 | 00 | 00 | 0.655 |
| Left superior PMI | 12.9±1.6 | 13.0±1.8 | 00 | 00 | 00 | 0.457 |
| Right inferior PMI | 11.5±1.4 | 11.8±1.9 | 00 | 00 | 00 | 0.368 |
| Left inferior PMI | 11.4±1.6 | 11.4±1.7 | 00 | 00 | 00 | 0.504 |

Table XII: MCI Correlation with Age Group with in the premenopausal group (n=129)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] | [40 – 51] | [52 – 63] | {64 - 74} | [75[ | |
| Left MCI | | | | | | **0.000** |
| Class I | 45(34.9) | 14(10.9) | 00 | 00 | 00 | |
| Class II | 48(37.2) | 19(14.7) | 00 | 00 | 00 | |
| Class III | 01(0.8) | 01(0.8) | 01(0.8) | 00 | 00 | |
| Right MCI | | | | | | **0.000** |
| Class I | 49(37.9) | 15(11.6) | 00 | 00 | 00 | |
| Class II | 44(34.1) | 18(13.9) | 00 | 00 | 00 | |
| Class III | 01(0.8) | 01(0.8) | 01(0.8) | 00 | 00 | |

5.3.2 POSTMENOPAUSAL GROUP

Table XIII: Correlations of Radiomorphometric Indice With Age in Postmenopausal group (n=59)

| Variable | Correlation coefficient (r) | p value |
|---|---|---|
| Right GI | **- 0.273** | **0.036** |
| Left GI | - 0.064 | 0.630 |
| Right AI | - 0.101 | 0.447 |
| Left AI | - 0.130 | 0.328 |
| Right MCW/MI | - 0.129 | 0.328 |
| Left MCW/MI | - 0.015 | 0.912 |
| Right superior PMI | - 0.146 | 0.269 |
| Left superior PMI | - 0.085 | 0.523 |
| Right inferior PMI | - 0.102 | 0.441 |
| Left inferior PMI | - 0.102 | 0.441 |

Table XIV: Correlation of Radiomorphometric Indices Age groups in Postmenopausal group(n=59)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] | [40 – 51] | [52 – 63] | {64 - 74} | [75[ | |
| Right GI | 00 | 1.3±0.5 | 1.4±0.3 | 1,3±0.3 | 1.1±0.3 | 0.208 |
| Left GI | 00 | 1.4±0.4 | 1.3±0.3 | 1.1±0.4 | 1.0±0.4 | 0.875 |
| Right AI | 00 | 3.7±0.1 | 3.5±0.6 | 3.3±0.7 | 3.4±0.7 | 0.898 |
| Left AI | 00 | 2.9±0,9 | 3.6±0.6 | 3.4±0.7 | 3.6±0.7 | 0.436 |
| Right MCW/MI | 00 | 3.8±0.5 | 3.7±0.7 | 3.6±0.8 | 3.5±0.4 | 0.871 |
| Left MCW/MI | 00 | 3.4±0.9 | 3.7±0.8 | 3.6±0.8 | 3.6±0.3 | 0.969 |
| Right superior PMI | 00 | 15.5±0.4 | 13.4±1.4 | 13.3±1.3 | 12.9±2.2 | 0.227 |
| Left superior PMI | 00 | 12.3±0.7 | 13.2±2.4 | 13.1±1.7 | 12.9±2.4 | 0.937 |
| Right inferior PMI | 00 | 12.8±0.4 | 11.8±1.4 | 11.9±1.3 | 11.2±1.9 | 0.523 |
| Left inferior PMI | 00 | 10.7±0.9 | 11.9±1.3 | 11.7±1.7 | 11.4±1.9 | 0.657 |

Table XV: MCI Correlation with Age Group with in the Postmenopausal group (n=59)

| Variable | Age groups | | | | | p value |
|---|---|---|---|---|---|---|
| | [35 - 39] (%) | [40 – 51] (%) | [52 – 63] (%) | [64 – 74] (%) | [75[(%) | |
| Left MCI | | | | | | 0.611 |
| Class I | 00 | 01(1.7) | 12(20.3) | 07(11.9) | 02(3.4) | |
| Class II | 00 | 01(1.7) | 18(30.5) | 11(18.6) | 05(8.5) | |
| Class III | **00** | **00** | **00** | **02(3.4)** | **00** | |
| Right MCI | | | | | | 0.666 |
| Class I | 00 | 01(1.7) | 13(22.0) | 08(13.6) | 03(5.1) | |
| Class II | 00 | 01(1.7) | 17(28.8) | 10(16.9) | 04(6.8) | |
| Class III | **00** | **00** | **00** | **02(3.4)** | **00** | |

# CHAPTER V: DISCUSSION

# DISCUSSION

We carried out an Analytical comparative study for a duration of 8 months from November 2023 to June 2024 and was on patients radiological files aged from 25-year-old and above that had done a Dental Panoramic Radiography scan in Laboratory of Implantology of the Faculty of Medicine and Biomedical Science from January 2021 to April 2024. We retained 188 participants in our study. Our general objective was to assess the applicability of panoramic radiographic indices for estimating mandibular BMD in a Cameroonian female population.

## 5.1 Limits of the study

1. Since our Study focus on Cameroonian Women our findings may not be applicable to women of other ethnicities or nationalities due to potential differences in bone density and menopausal experiences.
2. Since Panoramic Radiographs offer a two -dimensional view of a three-dimensional structure, this limitation may not fully capture all the complexity of mandibular bone morphology and could potentially affect the accuracy of radiographic indices.
3. We could not obtain more information from the patient's files like region of origin, dietary habits and physical activities which could have helped us evaluate more sociodemographic aspects of our study.

## I. SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

The mean age of patients (n=188) at the time of their radiography was 43.15 ± 15.2 years, ranging from 25 to 86 years, with the most represented age group being 25-39 years (50%). This is consistent with the national demographic data where the majority of women of reproductive age are under 39 years[62]. This younger age distribution in our study contrasts notably with previous studies by Taguchi et al in 2006,Singwe-Ngandeu and Nko'o Amvene, 2008 and Leite et al., 2010 where the mean ages were significantly higher (52 year, 63.5 ± 4.7 years and 55.6 ± 4.7 years, respectively) [63–65]. The discrepancy in age compared to these studies could be attributed to differences in study design, population selection, or geographic location, but may also reflect the overall younger population demographic in Cameroon [66, 67]. The postmenopausal group had the highest percentage (16.0%) in the 52-63 age range followed by the 64 – 74 age group (11.2%) in our study population. This distribution pattern aligns with the expected physiological changes associated with menopause, indicating that the study population reflects a typical menopausal transition across age groups.

## II. CLINICAL AND RADIOGRAPHIC FINDINGS IN STUDY POPULATION

In our study we used only the panoramic radiographs similar to Jacob et al in India as well as Passos et al in Brazil. The reasoning behind this is that BMD, of which there has been a reported significant reduction in post-menopausal women can be visualized at the level of the maxilla and mandible as they are part of the skeletal system [68, 69]. However the World Health Organization (WHO) has accepted Dual energy X ray absorptiometry (DXA) as the gold standard method to measure BMD.[70, 71] but these DXA facilities are scarce and expensive.[72, 73]. Hence explaining why, we used only panoramic radiographs in our study.

Panoramic radiographs of the study population (n=188) revealed a high prevalence of partial edentulism (76.1%), indicating a substantial proportion of participants had experienced tooth loss. This finding is consistent with the well-documented association between increasing age and tooth loss[74–76]. And could reflect the general oral health status in our local settings.

Regarding furcation defects, the majority of participants exhibited no bone loss in both left (60.6%) and right (66.0%) molar region. However, a considerable proportion presented with mild to severe bone loss, with the left side showing a slightly higher prevalence across all categories. Notably, vertical bone loss (VBL) was predominantly moderate to severe on both the left (92.6%) and right (94.7%) sides, suggesting a significant degree of periodontal disease progression in our population. These results are similar to that of Deepa et al in India who saw that females after are at higher risk of developing periodontal disease[77]

Periapical radiolucency, indicative of inflammatory changes at the root apex, was present in 60.6% of the participants. This finding underscores the importance of assessing and managing periodontal

health in this population, as untreated periodontal disease can lead to various oral and systemic complications.

Periodontal infection in itself has been shown to possibly trigger the activation of RANKL resulting in the subsequent osteoclastic activation and activity which in turn can induce osteoporosis in individuals with periodontitis and hence a periodontal infection can hasten the onset of osteoporosis. [68, 78]

Overall, the panoramic radiographic findings highlight a high prevalence of dental and periodontal diseases in the study population. This may be attributed to factors such as oral hygiene practices, and access to dental care[79, 80]. Further investigation into these potential contributing factors is warranted to develop targeted interventions aimed at improving oral health outcomes in this population.

The Gonial Index (GI) assesses the morphology of the gonial angle, with mean values of 1.4±0.3 on the right and 1.3±0.3 on the left. The Antegonial Index (AI) evaluates the antegonial notch depth, showing mean values of 3.6±0.7 on both sides. The Mandibular Cortical Width/Mental Index (MCW/MI) measures cortical bone thickness at the mental foramen, with consistent means of 3.8±0.7 bilaterally. Lastly, the Panoramic Mandibular Index (PMI) provides information on overall mandibular morphology and cortical bone thickness at different locations, with both superior and inferior measurements exhibiting slight variations between the right and left sides.

Overall, the data suggests relatively symmetrical mandibular morphology and cortical bone thickness between the right and left sides, with subtle differences observed in some indices.

Several authors have used just one side either left or right for measurement (Gassama et al in Senegal). The similar values between left and right measurements in our study shows the possible reliability of both sides for measurements[81].

**Radiographic Comparison Of Premenopausal And Postmenopausal Women**

Our study compared the dental and periodontal health of premenopausal (n = 157) and postmenopausal (n = 31) women using various radiographic findings. The prevalence of partial edentulism was higher in premenopausal women (60.0%) compared to postmenopausal women (26.1%), but this difference was not statistically significant (p = .144).

Osteoporosis more frequent in post-menopausal women, can adversely affect oral health. Systemic osteoporotic changes can manifest in the jaw bones resulting in resorption of the alveolar crest.[11] Other oral changes include a reduction in the jawbone density, temporomandibular joint disorder, periodontal disease, and eventually leading to tooth loss. [68, 82]. Moreover as we observed in our study there was a high prevalence of partial edentulism (76.1%,n=188), reflecting the general oral health status in our local setting and this could explain the relative comparability of partial edentulism observed between the 2 groups in our study.

For left furcation defects, 43.6% of premenopausal women had no bone loss versus 17.0% of postmenopausal women, with no significant difference (p = .892). Right furcation defects showed 46.3% of premenopausal women with no bone loss compared to 19.7% of postmenopausal women (p = .754). Vertical bone loss (VBL) was predominantly moderate to severe in both groups, with no significant differences (left: p = .451; right: p = .809). Periapical radiolucency was observed in 28.2% of premenopausal women and 11.2% of postmenopausal women, without significant difference (p = .522). Overall, there were no significant differences in dental and periodontal health indicators between premenopausal and postmenopausal women, indicating that menopausal status may not be a major determinant of these conditions in this population. Several factors may explain the lack of significant differences between the two groups. Hormonal changes due to menopause can affect oral health, but their impact may be outweighed by other variables such as genetics, overall health, oral hygiene practices, diet, and access to dental care[83]. These factors are crucial in maintaining oral health regardless of menopausal status. The smaller sample size of postmenopausal women (n = 59) compared to premenopausal women (n = 129) might limit the ability to detect significant differences. A larger sample size could provide more robust data and possibly reveal subtle differences. Additionally, the influence of menopause on oral health is complex and multifactorial, potentially requiring a more comprehensive study design to uncover significant impacts. The good health and proactive dental care of the study population may also mitigate the expected differences in oral health outcomes, reducing the impact of menopause on these conditions.

## III. MANDIBULAR CORTICAL INDEX (MCI) IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN IN OUR STUDY POPULATION

Our study's findings indicate that the most frequently detected categories of mandibular cortical index (MCI) on radiographic examination were Class I and Class II, with notable differences between premenopausal and postmenopausal groups (Table V).

Specifically, in the premenopausal group, the distribution was as follows: Class I was observed in 59 cases (31.4%) on the left and 64 cases (34.0%) on the right; Class II in 67 cases (35.6%) on the left and 62 cases (32.9%) on the right; and Class III in 3 cases (1.6%) on both sides. In the postmenopausal group, the distribution was: Class I in 22 cases (11.7%) on the left and 25 cases (13.3%) on the right; Class II in 35 cases (18.6%) on the left and 32 cases (17.0%) on the right; and Class III in 2 cases (1.1%) on both sides.

The p-values for the left and right MCI were 0.535 and 0.629, respectively, indicating no significant differences between the premenopausal and postmenopausal groups.

These results align with those reported by Govindraju and Chandra in India, who found that Class I was the most detected category, followed by Class II, with Class III being the least prevalent [61]. This discrepancy could be attributed to the small sample size of our study population, which may have limited the statistical power to detect differences between groups. Future studies with larger sample sizes are needed to confirm these findings and to explore potential differences in the mandibular cortical index classifications between premenopausal and postmenopausal women more robustly.

# IV. COMPARISM OF THE DENTAL PANORAMIC MANDIBULAR INDICES IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN IN OUR STUDY POPULATION

Our study investigated the mandibular indices of premenopausal and postmenopausal women. We observed no statistically significant difference in the mean right and left Gonial Index (GI) (1.4 ± 0.3) between the two groups. Similarly, the mean Antegonial Index (AI) displayed minimal variation, with premenopausal women showing values of 3.7 ± 0.8 (right) and 3.6 ± 0.7 (left), and postmenopausal women showing 3.5 ± 0.6 (right) and 3.5 ± 0.7 (left). The Mandibular Cortical Width/Mental Index (MCW/MI) ratio also exhibited no significant difference, with premenopausal women having a mean of 3.9 ± 0.7 (right) and 3.8 ± 0.7 (left) compared to 3.6 ± 0.7 (both sides) in postmenopausal women. Finally, the mean Superior and Inferior Panoramic Mandibular Indices (PMI) remained comparable between the groups, ranging from 11.4 to 13.4 with slight variations between right and left sides (Table VI).

Overall, the data suggests relatively symmetrical mandibular morphology and cortical bone thickness between the right and left measurements, with subtle differences observed in some indices. Several authors, such as Gassama et al. in Senegal[81], have used just one side, either left or right, for measurement. The similar values between left and right measurements in our study indicate the reliability of both sides for such measurements.

However, these findings diverge from those reported by Mudda et al. in India [84].Their study identified a statistically significant difference ($p < 0.05$) in the mean MCW/MI values between premenopausal (4.99 ± 0.75) and postmenopausal women (4.46 ± 1.09).

This discrepancy warrants further investigation. Potential explanations for the difference in results could include variations in sample population demographics, measurement techniques, or methodological approaches.

## V. CORRELATION BETWEEN AGE AND INDICES IN EACH GROUP

### a) Correlation Between Indices and Age Group

We examined the relationship between the Gonial Index (GI), Antergonial Index (AI), mandibular cortical width (MCW), panoramic mandibular index (PMI), and age. Our findings revealed that the GI had negative correlations with age on both the left ($r = -0.156$, $p = 0.023$) and right ($r = -0.080$) sides. However, only the left side showed a statistically significant decrease in GI with age, indicating that the GI tends to decline on the left side as people age in our sample.

Similarly, both AIs also showed negative correlations with age, but neither was statistically significant (left AI: $r = -0.088$, $p = 0.275$; right AI: $r = -0.071$, $p = 0.227$). This aligns with Jacob et al.'s findings, which indicated higher AI values in a normal group compared to an osteoporotic group, suggesting that while AI may decrease with age and menopausal status, these changes were not statistically significant in our study. Therefore, AI may not be a sensitive indicator of age-related changes in bone mineral density (BMD) or menopausal status in our population[68].

In contrast, Mudda et al. reported higher mean GI values, which they attributed to the unique ethnic background of their sample. They also found significant differences in GI values between premenopausal and postmenopausal women, with postmenopausal women exhibiting higher erosion. Our results differ, showing that in our Indian sample, GI does not significantly vary with menopausal status, although there is an evident age-related decline.[84].

The mandibular cortical width relative to the first molar (MCW/MI) also displayed a negative correlation with age ($r = -0.156$, $p = 0.032$), suggesting that mandibular cortical width may decrease with increasing age in this population group.

These indices showed a negative correlation with age amongst all our study participants and this implies a decrease in BMD with age and also especially with the post-menopausal group. These results are similar to Jacob et al in India who found the antegonial index was found to be higher in the normal group than the osteoporotic group.[68]

Devlin and Horner in India found similar trends, where indices like MI correlated with skeletal status determined by BMD. This alignment suggests that MCW/MI could serve as a reliable marker for evaluating mandibular cortical health and potential BMD decline with age, in Indian demographic[85].

Concerning the panoramic Mandibular Indices, the right superior PMI showed a positive but non-significant correlation with age ($r = 0.075$, $p = 0.305$), while both left superior PMI and inferior PMI did not show significant correlations (left PMI: $r = 0.004$, $p = 0.957$; inferior PMI: $r = 0.052$, $p = 0.482$).

Bhatnagar et al. concluded that panoramic radiographs are effective for early detection of osseous changes in postmenopausal women, emphasizing the importance of PMI as a diagnostic tool. However, our findings suggest that PMI may not be significantly impacted by menopausal status or age, indicating that while PMI can be a useful screening tool, its sensitivity might be lower compared to other indices in detecting early osseous changes in our study population[86].

### b) Correlation Between Age Group and MCI

The analysis of the correlation between age groups and Mandibular Cortical Index (MCI) presented in Table IX reveals notable trends across different age cohorts. The MCI, divided into left and right classifications, and further categorized into three classes, shows a general pattern where the prevalence of Class I MCI (indicative of healthier mandibular cortices) decreases with advancing age.

Conversely, the frequencies of Class II and Class III MCI (indicative of poorer mandibular cortices) tend to increase among older age groups. Specifically, for the left MCI, the youngest age group (35-39 years) has the highest percentage in Class I (23.9%) and the lowest in Class III (0.5%), while the oldest age group (75+ years) shows a marked decrease in Class I (1.1%) and no representation in Class III. A similar trend is observed in the right MCI data. However, the p-values for both left ($p = 0.065$) and right MCI ($p = 0.086$) suggest that these observed differences are not statistically significant at the conventional alpha level of 0.05. Therefore, while the data indicate a potential age-related decline in mandibular cortical health, the lack of statistical significance implies that further research with a larger sample size might be necessary to confirm these trends definitively. Mudda et al. reported similar findings where postmenopausal women showed higher C3 prevalence. Although our results align with these observations, the lack of statistical significance in our study suggests a need for larger sample sizes to conclusively determine the impact of age and menopausal status on MCI in our population[84].

### c) Correlation Between Age Group and Menopusal Status (In Permenopusal Women)

The presented tables analyze the correlation between age and various radiomorphometric indices, including the Gonial Index (GI), Antegonial Index (AI), Mandibular Cortical Width (MCW), Panoramic Mandibular Index (PMI), and Mandibular Cortical Index (MCI) in premenopausal patients (n=129).

Table X details the correlation coefficients (r) and p-values for these indices. Notably, the left AI exhibits a statistically significant negative correlation with age ($r = -0.179$, $p = 0.042$), suggesting a decrease in AI as age increases. Other indices such as right GI ($r = -0.120$, $p = 0.167$), left GI ($r = -0.120$, $p = 0.179$), right AI ($r = -0.015$, $p = 0.868$), and the various MCW and PMI measurements do not show statistically significant correlations with age, indicating that these indices may remain relatively stable in the premenopausal group.

Table XI examines the mean values of these indices across different age groups within the premenopausal cohort, showing that there are no significant variations in GI, AI, MCW, or PMI with age. This lack of significant change is reflected in the p-values, all of which exceed 0.05, indicating no substantial age-related differences in these indices among premenopausal women.

Table XII presents the distribution of MCI classifications across age groups within the premenopausal cohort. The data reveals a statistically significant correlation ($p = 0.000$) for both left and right MCI. The youngest age group (35-39 years) has the highest representation in Class I (34.9% left MCI, 37.9% right MCI) and Class II (37.2% left MCI, 34.1% right MCI), with minimal representation in Class III (0.8% for both). As age increases to the 40-51 group, there is a notable decrease in Class I (10.9% left MCI, 11.6% right MCI) and an increase in Class II (14.7% left MCI, 13.9% right MCI). No individuals aged 52 and above are present in this dataset.

In conclusion, while most radiomorphometric indices remain stable across different age groups in premenopausal women, the significant negative correlation of left AI with age and the significant differences in MCI classifications suggest age-related changes in mandibular cortical health. These findings highlight the importance of considering age when evaluating mandibular health in premenopausal patients. Further studies are recommended to validate these trends and explore their clinical implications

### d) Correlation Between Age Group and Menopusal Status (In Postmenopusal Women)

The analysis of radiomorphometric indices among postmenopausal patients reveals significant variations in the Gonial Index (GI), Antergonial Index (AI), Mandibular Cortical Width (MCW), and Panoramic Mandibular Index (PMI) across different age groups. Table XIII indicates a significant negative correlation between the right GI and age ($r = -0.273$, $p = 0.036$), suggesting that as age increases, the right GI tends to decrease. However, no significant correlations were observed for the left GI, right and left AI, right and left MCW/MI, and the right and left superior and inferior PMI, indicating that these indices do not show a significant association with age in this sample.

Table XIV presents the mean values of these indices across different age groups. Notably, the right GI shows a decreasing trend with advancing age, particularly evident from the age group of 52-63 years to 75+ years, though the p-value (0.208) does not indicate statistical significance. Similarly, the left GI and AI indices did not demonstrate significant changes across age groups ($p = 0.643$ and 0.807, respectively). The right and left MCW/MI and the right and left superior and inferior PMI also show no significant differences across age groups, with p-values well above 0.05, indicating a lack of significant age-related changes in these indices.

Additionally, Table XV explores the Mandibular Cortical Index (MCI) across age groups, showing the distribution of Class I, Class II, and Class III MCI. The majority of the sample falls into Class I and II across all age groups, with no significant differences noted ($p = 0.611$ and 0.666 for right MCI). This further underscores the absence of significant age-related variations in mandibular cortical integrity among postmenopausal women.

In conclusion, while the right GI shows a notable negative correlation with age, most other radiomorphometric indices do not exhibit significant age-related differences among postmenopausal women. These findings suggest that except for the right GI, the studied indices remain relatively stable across different age groups in postmenopausal patients, indicating that age may not be a major influencing factor for these indices in this population. Further research with larger sample sizes and additional variables may provide deeper insights into the relationship between age and mandibular indices in postmenopausal women.

# CONCLUSION AND RECOMMENDATIONS

# CONCLUSION

In conclusion, our study investigated the utility of panoramic radiographic indices in assessing mandibular bone mineral density (BMD) and morphology in Cameroonian women. The findings indicate that mandibular cortical BMD, as measured by panoramic radiographs, does not significantly differ between premenopausal and postmenopausal women.Indices such as the Gonial Index (GI), Antegonial Index (AI), and Mandibular Cortical Width/Mental Index (MCW/MI) were comparable across both groups, suggesting that menopausal status does not significantly impact mandibular bone density or morphology in this population.

Age-related changes were observed in specific indices, notably a statistically significant negative correlation between age and the left Gonial Index (GI) in both groups, and a decline in the Mandibular Cortical Index (MCI) in premenopausal women. However, most other indices remained largely unaffected by age, indicating a limited overall impact on mandibular bone morphology.

Despite the inherent limitations of panoramic radiographs, such as their two-dimensional nature, the study affirms the applicability of these indices for estimating mandibular BMD in Cameroonian women. The indices demonstrated consistent measurements and reflected expected age-related changes in bone density and morphology.

# RECOMMENDATIONS

We humbly recommend the following:

**To Dentistry Student and Dental Clinicals**

To Recognize the potential of panoramic radiographs as a tool for assessing mandibular bone health, particularly in identifying early signs of osteoporosis.

To Develop skills in interpreting panoramic radiographs and utilizing indices like GI, AI, MCW/MI, and PMI, students can enhance their comprehensive oral health assessments

To Consider incorporating panoramic radiographic analysis into routine dental examinations, especially for patients with risk factors for osteoporosis, such as postmenopausal women or individuals with a history of periodontal disease.

**To Researchers**

To conduct further studies on a larger sample size investigating the potential clinical applications of panoramic radiography in identifying individuals at risk of osteoporosis or other bone-related conditions.

**To the Faculty of Medicine and Biomedical Sciences**

To Educate dental medicine students on radiographic interpretation, including the utilization of radiographic indices, to enhance their diagnostic skills and understanding of bone health.

To Integrate the knowledge gained from this study into medical and dental curricula can enhance the understanding of mandibular bone health among future healthcare professionals.

**To the Ministry of Public Health**

To Promote collaboration between medical and dental specialties to foster interdisciplinary research initiatives, leading to improved diagnostic tools and treatment strategies for bone-related disorders.

## REFRENCES


1. Taguchi A (2009) Panoramic radiographs for identifying individuals with undetected osteoporosis. Jpn Dent Sci Rev 45:109–120

2. for the International Osteoporosis Foundation, Borgström F, Karlsson L, et al (2020) Fragility fractures in Europe: burden, management and opportunities. Arch Osteoporos 15:59

3. Lorentzon M, Johansson H, Harvey NC, Liu E, Vandenput L, McCloskey EV, Kanis JA (2022) Osteoporosis and fractures in women: the burden of disease. Climacteric 25:4–10

4. Ward KA, Pearse CM, Madanhire T, Wade AN, Fabian J, Micklesfield LK, Gregson CL (2023) Disparities in the Prevalence of Osteoporosis and Osteopenia in Men and Women Living in Sub-Saharan Africa, the UK, and the USA. Curr Osteoporos Rep 21:360–371

5. Dela SS, Paruk F, Brown SL, Lukhele M, Kalla AA, Jordaan JD, Conradie M, Mohamed O, Chutterpaul P, Cassim B (2020) Ethnic and gender-specific incidence rates for hip fractures in South Africa: A multi-centre study. Bone 133:115253

6. Singwe-Ngandeu M, Nko'o Amvene S (2008) [Bone mineral density in Cameroon women in Yaounde: an echographic study]. Mali Med 23:21–26

7. Zebaze RMD, Seeman E (2003) Epidemiology of hip and wrist fractures in Cameroon, Africa. Osteoporos Int 14:301–305

8. (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group. World Health Organ Tech Rep Ser 843:1–129

9. Paruk F, Tsabasvi M, Kalla AA (2021) Osteoporosis in Africa—where are we now. Clin Rheumatol 40:3419–3428

10. Różyło-Kalinowska I (2021) Panoramic radiography in dentistry. Clin Dent Rev 5:26

11. Supriyanti R, Setiadi AS, Ramadhani Y, Widodo HB (2016) Point Processing Method for Improving Dental Radiology Image Quality. Int J Electr Comput Eng IJECE 6:1587

12. Bajoria AA, Ml A, Kamath G, Babshet M, Patil P, Sukhija P (2015) Evaluation of Radiomorphometric Indices in Panoramic Radiograph – A Screening Tool. Open Dent J 9:303–310

13. Balto KA, Gomaa MM, Feteih RM, AlAmoudi NM, Elsamanoudy AZ, Hassanien MA, Ardawi M-SM (2018) Dental Panoramic Radiographic Indices as a Predictor of Osteoporosis in Postmenopausal Saudi Women. J Bone Metab 25:165

14. Abdinian M, Milaei M, Soltani P (2023) Digital panoramic radiography and CBCT as auxiliary tools for detection of low bone mineral density in post-menopausal women: a cross-sectional study. BMC Med Imaging 23:78

15. (2023) Cancellous bone | Structure, Function, Composition | Britannica. https://www.britannica.com/science/cancellous-bone. Accessed 20 Jan 2024

16. Hambli R, Hattab N (2013) Application of Neural Network and Finite Element Method for Multiscale Prediction of Bone Fatigue Crack Growth in Cancellous Bone. In: Gefen A (ed) Multiscale Comput. Model. Biomech. Biomed. Eng. Springer Berlin Heidelberg, Berlin, Heidelberg, pp 3–30

17. Clarke B (2008) Normal bone anatomy and physiology. Clin J Am Soc Nephrol CJASN 3 Suppl 3:S131-139

18. Branch NSC and O (2023) Bone Health and Osteoporosis. In: Natl. Inst. Arthritis Musculoskelet. Skin Dis. https://www.niams.nih.gov/health-topics/bone-health-and-osteoporosis. Accessed 20 Jan 2024

19. Mayhew P Cortical bone | Radiology Reference Article | Radiopaedia.org. Radiopaedia. https://doi.org/10.53347/rID-50742

20. Bonewald LF (2013) Osteocytes. In: Rosen CJ (ed) Primer Metab. Bone Dis. Disord. Miner. Metab., 1st ed. Wiley, pp 34–41

21. Eriksen EF, Axelrod DW, Melsen F (1994) Bone histomorphometry. Raven Press New York, New York

22. Bailey DA, Martin AD, McKay HA, Whiting S, Mirwald R (2000) Calcium Accretion in Girls and Boys During Puberty: A Longitudinal Analysis. J Bone Miner Res 15:2245–2250

23. Grampp S, Steiner E, Imhof H (1997) Radiological diagnosis of osteoporosis. Eur Radiol 7 Suppl 2:S11-19

24. 8 Panoramic radiograph 2 - Panoramic radiograph It is often difficult to obtain adequate diagnostic - Studocu. https://www.studocu.com/row/document/jamaa%D8%A9-msr-llaalom-oaltknolojya/oral-diagnosis-i/8-panoramic-radiograph-2/48655234. Accessed 24 Jan 2024

25. Elaine M, Katja H © 2016 Pearson Education, Inc. - ppt download. https://slideplayer.com/slide/12573332/. Accessed 24 Jan 2024

26. Atheer T (2023) Maxillofacial Imaging.

27. Fernández-Tresguerres-Hernández-Gil I, Alobera-Gracia MA, del-Canto-Pingarrón M, Blanco-Jerez L (2006) Physiological bases of bone regeneration II. The remodeling process. Med Oral Patol Oral Cirugia Bucal 11:E151-157

28. Behzadi S, Luther GA, Harris MB, Farokhzad OC, Mahmoudi M (2017) Nanomedicine for safe healing of bone trauma: Opportunities and challenges. Biomaterials 146:168–182

29. Almeida M, O'Brien CA (2013) Basic Biology of Skeletal Aging: Role of Stress Response Pathways. J Gerontol A Biol Sci Med Sci 68:1197–1208

30. Bartl R, Bartl C (2019) Definition of Osteoporosis. In: Osteoporos. Man. Springer International Publishing, Cham, pp 93–95

31. Kanis JA, Kanis JA (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: Synopsis of a WHO report. Osteoporos Int 4:368–381

32. Boskey AL, Coleman R (2010) Aging and Bone. J Dent Res 89:1333–1348

33. United Nations (1994) The Sex and Age Distribution of the World Populations: The 1994 Revision.

34. Aboderin IAG, Beard JR (2015) Older people's health in sub-Saharan Africa. The Lancet 385:e9–e11

35. Cooper C, Campion G, Melton LJ (1992) Hip fractures in the elderly: A world-wide projection. Osteoporos Int 2:285–289

36. Gullberg B, Johnell O, Kanis JA (1997) World-wide Projections for Hip Fracture: Osteoporos Int 7:407–413

37. Tarvade (Daokar) SM, Daokar SG (2014) Osteoporosis and Orthodontics: A Review. Sci J Dent 1:26–29

38. Riggs BL (1991) Overview of osteoporosis. West J Med 154:63–77

39. Themes UFO (2017) in Osteoporosis. Radiol. Key

40. Radswiki T Transient osteoporosis of the hip | Radiology Case | Radiopaedia.org. Radiopaedia. https://doi.org/10.53347/rID-12031

41. Joseph J. Schreiber, MD, Robin N Kamal, MD, Jeffrey Yao, MD Simple Assessment of Global Bone Density and Osteoporosis Screening Utilizing Standard Radiographs of the Hand. https://meeting.handsurgery.org/abstracts/2017/AAHS1.cgi.

42. Guglielmi G (ed) (2013) Osteoporosis and Bone Densitometry Measurements. https://doi.org/10.1007/978-3-642-27884-6

43. Triantafyllopoulos G, Mitsea A, Rontogianni A, Korres D (2023) Osteoporosis Screening Using Dental Panoramic Radiographs and Age at Menarche. Diagnostics 13:881

44. Lopez-Lopez J, Estrugo-Devesa A, Jane-Salas E, Ayuso-Montero R, Gomez-Vaquero C (2011) Early diagnosis of osteoporosis by means of orthopantomograms and oral x-rays: A systematic review. Med Oral Patol Oral Cirugia Bucal e905–e913

45. (2022) Bone Density Scan (DEXA or DXA). In: Radiol. Patients. https://www.radiologyinfo.org/en/info/dexa. Accessed 30 Nov 2023

46. NIH (2023) Bone Mineral Density Tests: What the Numbers Mean. In: NIH Natl. Institue Arthritis Musculoskelet. Skin Dis. https://www.niams.nih.gov/health-topics/bone-mineral-density-tests-what-numbers-mean. Accessed 30 Nov 2023

47. University of California, San Francisco Quantitative Computed Tomography (QCT). In: UCSF Dep. Radiol. Biomed. Imaging. https://radiology.ucsf.edu/patient-care/services/QCT. Accessed 30 Nov 2023

48. Emer MÖ, İnce S, Arslan N (2016) Bone Mineral Densitometry: Measurement and Evaluation Methods. In: Korkusuz F (ed) Musculoskelet. Res. Basic Sci. Springer International Publishing, Cham, pp 197–212

49. Merriam-Webster Single photon absorptiometry. In: Merriam-Webstercom Med. Dict. https://www.merriam-webster.com/medical/single%20photon%20absorptiometry. Accessed 29 Nov 2023

50. Peripheral Quantitative Computed Tomography (pQCT, HR-pQCT). In: SCIRE Prof. https://scireproject.com/evidence/bone-health/bone-outcome-measures/imaging-modalities/peripheral-quantitative-computed-tomography-pqct-hr-pqct/.

51. Cloutier G, Destrempes F, Yu F, Tang A (2021) Quantitative ultrasound imaging of soft biological tissues: a primer for radiologists and medical physicists. Insights Imaging 12:127

52. Hans D, Métrailler A, Gonzalez Rodriguez E, Lamy O, Shevroja E (2022) Quantitative Ultrasound (QUS) in the Management of Osteoporosis and Assessment of Fracture Risk: An Update. In: Laugier P, Grimal Q (eds) Bone Quant. Ultrasound. Springer International Publishing, Cham, pp 7–34

53. Harold N Rosen, MD (2023) Use of biochemical markers of bone turnover in osteoporosis. In: UptoDate. https://www.uptodate.com/contents/use-of-biochemical-markers-of-bone-turnover-in-osteoporosis.

54. Schini M, Vilaca T, Gossiel F, Salam S, Eastell R (2023) Bone Turnover Markers: Basic Biology to Clinical Applications. Endocr Rev 44:417–473

55. Çakur B, Şahin A, Dagistan S, Altun O, Çaglayan F, Miloglu Ö, Harorli A (2008) Dental Panoramic Radiography in the Diagnosis of Osteoporosis. J Int Med Res 36:792–799

56. Kim O, Shin M, Song I, Lim I, Yoon S, Kim O, Lee Y, Kim Y, Chung H (2016) Digital panoramic radiographs are useful for diagnosis of osteoporosis in Korean postmenopausal women. Gerodontology 33:185–192

57. Ghazi M, Mounach A, Nouijai A, Ghozlani I, Bennani L, Achemlal L, Bezza A, El Maghraoui A (2007) Performance of the osteoporosis risk assessment tool in Moroccan men. Clin Rheumatol 26:2037–2041

58. Ezeonu P, Agwu U, Ajah L, O Dimejesi I, Ogbonnaya L, J Umeora O, Onoh R (2017) The prevalence of osteoporosis among antenatal clinic attendees in a rural mission hospital in South-East Nigeria. Niger J Clin Pract 20:1522

59. Calciolari E, Donos N, Park JC, Petrie A, Mardas N (2015) Panoramic Measures for Oral Bone Mass in Detecting Osteoporosis: A Systematic Review and Meta-Analysis. J Dent Res 94:17S-27S

60. Seki K, Yoshino T, Ogisawa S, Arai Y, Tonogi M, Iinuma T (2023) Diagnostic Study of Mandibular Cortical Index Classification Using Dental Cone-Beam Computed Tomography Findings: A Preliminary Cross-Sectional Study. Y Rep 6:48

61. Govindraju P, Mahesh Kumar TS, Chandra P, Balaji P, Sowbhagya MB (2015) Panoramic Radiomorphometric Indices of Mandible: Biomarker for Osteoporosis. In: Preedy VR (ed) Biomark. Bone Dis. Springer Netherlands, Dordrecht, pp 1–23

62. Reproductive health in Cameroon. https://www.gfmer.ch/Endo/Reprod_health/Cameroon/Net_Reproduction_Cameroun.htm. Accessed 31 May 2024

63. Taguchi A, Tsuda M, Ohtsuka M, et al (2006) Use of dental panoramic radiographs in identifying younger postmenopausal women with osteoporosis. Osteoporos Int 17:387–394

64. Singwe-Ngandeu M, Nko'o Amvene S (2008) [Bone mineral density in Cameroon women in Yaounde: an echographic study]. Mali Med 23:21–26

65. Leite AF, Figueiredo PTDS, Guia CM, Melo NS, De Paula AP (2010) Correlations between seven panoramic radiomorphometric indices and bone mineral density in postmenopausal women. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontology 109:449–456

66. Fomulu JN, Bechem E, Nkwabong E, Nana PN (2013) MENOPAUSE: A NEGLECTED REPRODUCTIVE HEALTH CONCERN IN CAMEROON. Health Sci Dis. https://doi.org/10.5281/hsd.v10i2.77

67. Ako S, Fokoua S, Sinou M, Leke R (2024)https://www.gfmer.ch/Endo/Reprod_health/Cameroon/Net_Reproduction_Cameroun.htm. Accessed 1 Jan 2024

68. Jacob L, Subramanian K, Srinivasan S, Krishnan M, Krishnan A, Mathew A (2022) Assessment of the efficacy of digital panoramic radiographs in analyzing changes in bone mineral density in postmenopausal women. J Fam Med Prim Care 11:4342

69. Finkelstein JS, Brockwell SE, Mehta V, et al (2008) Bone Mineral Density Changes during the Menopause Transition in a Multiethnic Cohort of Women. J Clin Endocrinol Metab 93:861–868

70. Khadilkar A, Mandlik R (2015) Epidemiology and treatment of osteoporosis in women: an Indian perspective. Int J Womens Health 841

71. Mounach A, Rezqi A, Ghozlani I, Achemlal L, Bezza A, El Maghraoui A (2012) Prevalence and Risk Factors of Discordance between Left- and Right-Hip Bone Mineral Density Using DXA. ISRN Rheumatol 2012:1–6

72. Melescanu-Imre M, Preoteasa E (2009) Mandibular Panoramic Indexes Predictors of Skeletal Osteoporosis for Implant Therapy. 35:

73. Nih Consensus Development Panel On Osteoporosis Prevention, Diagnosis, And Therapy (2001) Osteoporosis Prevention, Diagnosis, and Therapy. JAMA J Am Med Assoc 285:785–795

74. Parker ML, Thornton-Evans G, Wei L, Griffin SO (2020) Prevalence of and Changes in Tooth Loss Among Adults Aged ≥50 Years with Selected Chronic Conditions — United States, 1999–2004 and 2011–2016. MMWR Morb Mortal Wkly Rep 69:641–646

75. Xu K, Li L, Jia S, et al (2023) Association of Tooth Loss and Diet Quality with Acceleration of Aging: Evidence from NHANES. Am J Med 136:773-779.e4

76. Barman J, Kalita C, Baruah R, Choudhury K (2022) Tooth loss and its risk factors among the young adults in the Kamrup (Metro) district of Assam: An epidemiological study. J Indian Assoc Public Health Dent 20:159

77. Deepa D, Jain G (2016) Assessment of periodontal health status in postmenopausal women visiting dental hospital from in and around Meerut city: Cross-sectional observational study. J -Life Health 7:175

78. Kim J, Amar S (2006) Periodontal disease and systemic conditions: a bidirectional relationship. Odontology 94:10–21

79. Almeida FT, Gianoni-Capenakas S, Rabie H, Figueiredo R, Pacheco-Pereira C (2024) The use of panoramic radiographs to address the oral health needs of vulnerable Canadian populations. Can J Dent Hyg CJDH J Can Hyg Dent JCHD 58:19–25

80. Al-Abdaly MMAA, Alasmari AH, Alqahtani SJ, Alzahrani AA, AlAhmari JMA, Al-Abdaly GMM, Alqaysi IHI, Al-Shamrani MDM (2022) Extra-Oral Digital Panoramic Radiographic Interpretation and Clinical Findings of Stage IV Periodontitis among Some Samples Concerning Saudi/Non-Saudi Nationality. Open J Stomatol 12:42–61

81. Gassama BC, Ndiaye ML, Lecor PA, Diop S, Toure B (2021) Mandibular bone changes and dental status: A radiomorphometric study by the mandibular cortical index on a Senegalese female population aged 40 years and over. Adv Oral Maxillofac Surg 4:100200

82. Wang C-W, McCauley LK (2016) Osteoporosis and Periodontitis. Curr Osteoporos Rep 14:284–291

83. Dutt P, Chaudhary S, Kumar P (2013) Oral Health and menopause: A comprehensive review on current knowledge and associated dental management. Ann Med Health Sci Res 3:320

84. Mudda JA, Bajaj M, Patil VA (2010) A Radiographic comparison of mandibular bone quality in pre- and post-menopausal women in Indian population. J Indian Soc Periodontol 14:121–125

85. Horner K, Allen P, Graham J, et al (2010) The relationship between the OSTEODENT index and hip fracture risk assessment using FRAX. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontology 110:243–249

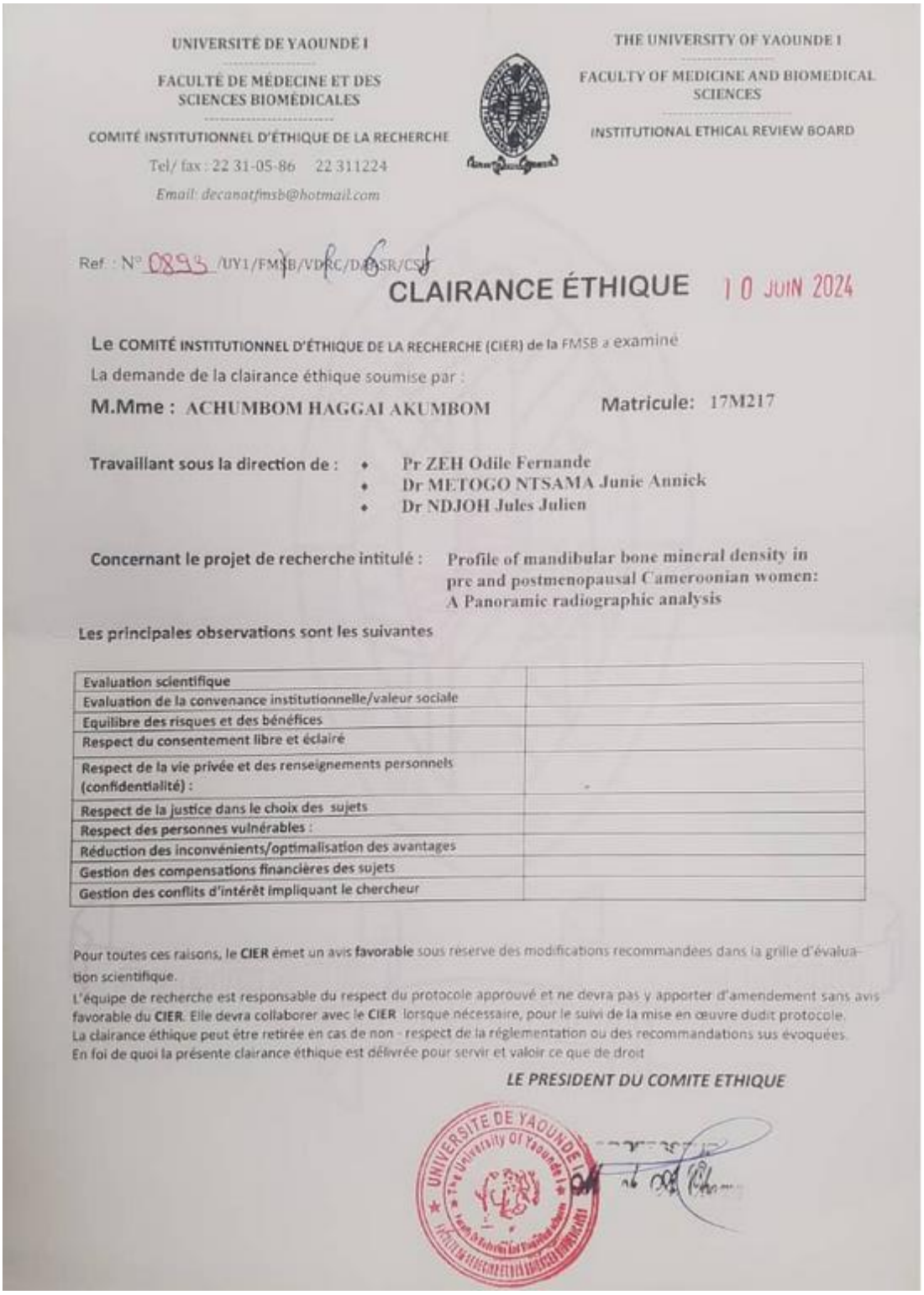
86. Bhatnagar S, Krishnamurthy V, Pagare SS (2013) Diagnostic Efficacy of Panoramic Radiography in Detection of Osteoporosis in Post-Menopausal Women with Low Bone Mineral Density. J Clin Imaging Sci 3:23

87. Salari N, Ghasemi H, Mohammadi L, Behzadi MH, Rabieenia E, Shohaimi S, Mohammadi M (2021) The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. J Orthop Surg 16:609

# ANNEXES

# APPENDIX

## APPENDIX I: Ethical Clearance



UNIVERSITE DE YAOUNDE I

FACULTE DE MEDECINE ET DES SCIENCES BIOMEDICALES

COMITE INSTITUTIONNEL D'ETHIQUE DE LA RECHERCHE

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Email: decanatfmsb@hotmail.com

THE UNIVERSITY OF YAOUNDE I

FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES

INSTITUTIONAL ETHICAL REVIEW BOARD

Ref : N° 0893 /UY1/FMSB/VDRC/DASR/CSD

CLAIRANCE ÉTHIQUE 10 JUIN 2024

Le COMITÉ INSTITUTIONNEL D'ÉTHIQUE DE LA RECHERCHE (CIER) de la FMSB a examiné

La demande de la clairance éthique soumise par :

M.Mme : ACHUMBOM HAGGAI AKUMBOM Matricule: 17M217

Travaillant sous la direction de :
- Pr ZEH Odile Fernande
- Dr METOGO NTSAMA Junie Annick
- Dr NDJOH Jules Julien

Concernant le projet de recherche intitulé : Profile of mandibular bone mineral density in pre and postmenopausal Cameroonian women: A Panoramic radiographic analysis

Les principales observations sont les suivantes

| | |
|---|---|
| Evaluation scientifique | |
| Evaluation de la convenance institutionnelle/valeur sociale | |
| Equilibre des risques et des bénéfices | |
| Respect du consentement libre et éclairé | |
| Respect de la vie privée et des renseignements personnels (confidentialité) : | |
| Respect de la justice dans le choix des sujets | |
| Respect des personnes vulnérables : | |
| Réduction des inconvénients/optimalisation des avantages | |
| Gestion des compensations financières des sujets | |
| Gestion des conflits d'intérêt impliquant le chercheur | |

Pour toutes ces raisons, le **CIER** émet un avis **favorable** sous réserve des modifications recommandées dans la grille d'évaluation scientifique.

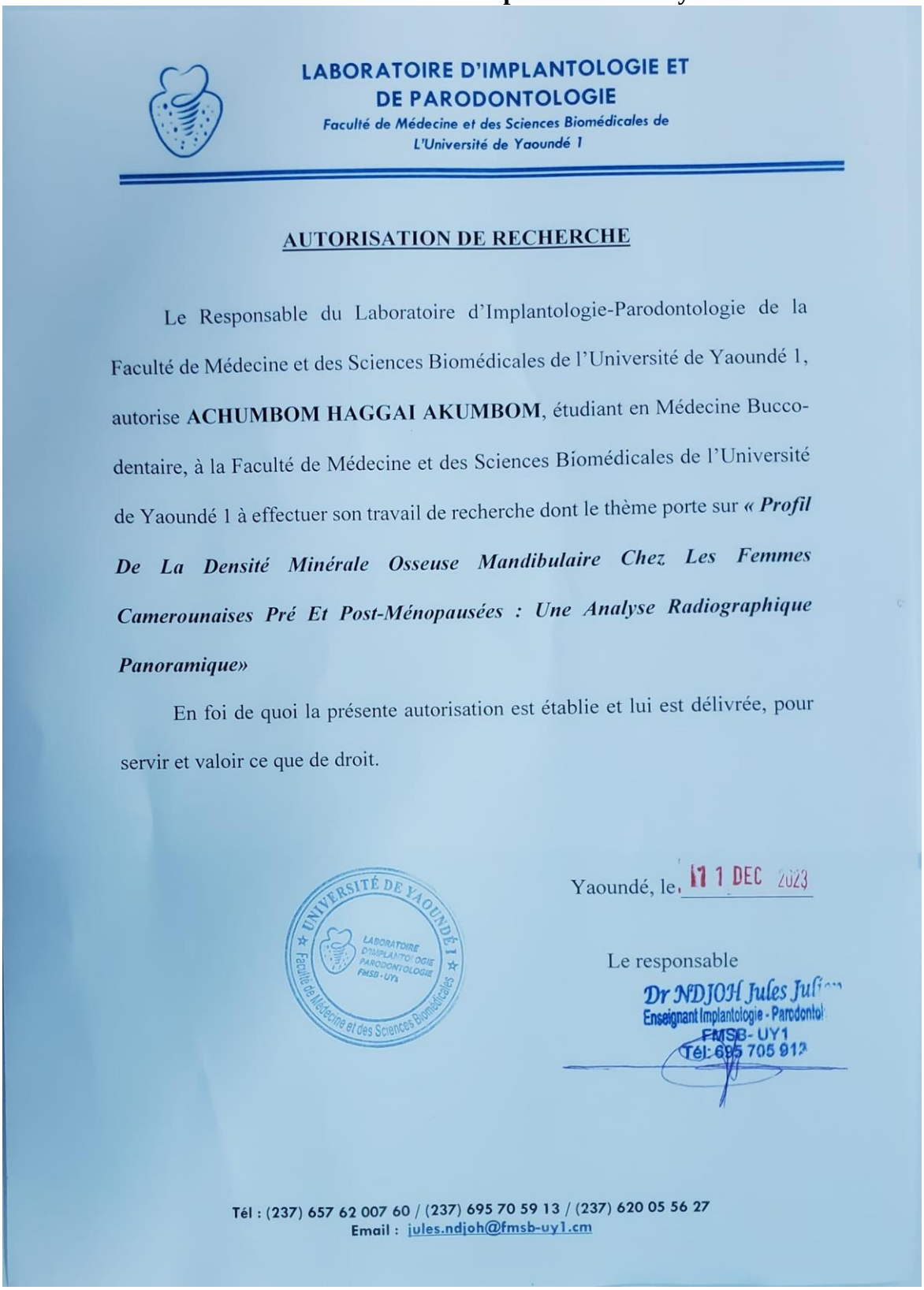
L'équipe de recherche est responsable du respect du protocole approuvé et ne devra pas y apporter d'amendement sans avis favorable du **CIER**. Elle devra collaborer avec le **CIER** lorsque nécessaire, pour le suivi de la mise en œuvre dudit protocole.

La clairance éthique peut être retirée en cas de non - respect de la réglementation ou des recommandations sus évoquées.

En foi de quoi la présente clairance éthique est délivrée pour servir et valoir ce que de droit

*LE PRESIDENT DU COMITE ETHIQUE*

## APPENDIX II: Research authorization of Dental Implant Laboratory of FMBS



LABORATOIRE D'IMPLANTOLOGIE ET DE PARODONTOLOGIE
Faculté de Médecine et des Sciences Biomédicales de L'Université de Yaoundé 1

**AUTORISATION DE RECHERCHE**

Le Responsable du Laboratoire d'Implantologie-Parodontologie de la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé 1, autorise **ACHUMBOM HAGGAI AKUMBOM**, étudiant en Médecine Bucco-dentaire, à la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé 1 à effectuer son travail de recherche dont le thème porte sur ***« Profil De La Densité Minérale Osseuse Mandibulaire Chez Les Femmes Camerounaises Pré Et Post-Ménopausées : Une Analyse Radiographique Panoramique»***

En foi de quoi la présente autorisation est établie et lui est délivrée, pour servir et valoir ce que de droit.

UNIVERSITÉ DE YAOUNDÉ I ★ Faculté de Médecine et des Sciences Biomédicales ★ LABORATOIRE D'IMPLANTOLOGIE PARODONTOLOGIE FMSB - UY1

Yaoundé, le, 11 DEC 2023

Le responsable

Dr NDJOH Jules Julien
Enseignant Implantologie - Parodontol
FMSB- UY1
Tél: 695 705 913

Tél : (237) 657 62 007 60 / (237) 695 70 59 13 / (237) 620 05 56 27
Email : jules.ndjoh@fmsb-uy1.cm

## APPENDIX III: Anti Plagiarism Report

Duplichecker

# Dupli Checker Plagiarism Report

Originality Report

| 8.36% | 91.64% | 8155 | 56652 |
|---|---|---|---|
| Plagiarized Content | Unique Content | Words | Characters |

## Primary Sources

| | | |
|---|---|---|
| 1 | https://www.academia.edu/94906... ... Introduction Osteoporosis is a systemic skeletal disorder characterized by low bone mass and deterioration of the bone microstructure, resulting in ... | 0.17% |
| 2 | https://pubmed.ncbi.nlm.nih.gov/3... by AC Mendoza - 2020 - Cited by 4 — Materials and methods: We carried out a retrospective cross-sectional study of all patients who underwent EUS-guided drainage- | 0.17% |
| 3 | https://eacim-ceramic-implantolo... Jan 25, 2024 — Ambassador for Africa. - Lecturer in Implantology and Periodontology at the Faculty of Medicine and Biomedical Sciences, University of ... | 0.17% |
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| 5 | https://www.researchgate.net/publ... Matériels et méthodes Nous avons réalisé une étude transversale pendant 5 jours consécutifs en mars 2020, au sein d'un hôpital centre de référence, du ... | 0.17% |
| 6 | http://www.houstonspinesurgeon.c... Often called "the silent disease," osteoporosis is a bone condition characterized by decreased bone mass and the subsequent deterioration of bone tissue. | 0.17% |
| 7 | https://pubmed.ncbi.nlm.nih.gov/2... Areal bone mineral density (BMD) measured by dual-energy X-ray absorptiometry (DXA) is an established criterion in the diagnosis of osteoporosis. This measure,... | 0.17% |

Report was generated on Fri, Jun 14, 2024

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## APPENDIX IV: Information leaflet

**Title:** Profile Of Mandibular Bone Mineral Density In Pre And Postmenopausal Cameroonian Women: A Panoramic Radiographic Analysis

**Investigator:** I am ACHUMBOM HAGGAI AKUMBOM, a final-year dental medical student at the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I, Cameroon.

**Supervisor:** Professor ZEH ODILE FERNANDE, full professor of Radiology and Medical Imaging

**Cosupervisors:**

- Dr. NDJOH JULES JULIEN, Senior Lecturer of Periodontology and Implant Dentistry
- Dr. METOGO NTSAMA JUNIE ANNICK, Senior Lecture in Obstetrics and Gynecology

**Subject:** An invitation to take part in the study

**Study aim:** Osteoporosis is a major public health problem worldwide that affects millions of people and causes significant morbidity, mortality, and economic burden [87]. However, BMD measurements via dual-energy X-ray absorptiometry (DXA) are not widely available in many developing countries, including Cameroon, due to its high cost, limited accessibility, and lack of reference data [7, 9]. We sought to assess the applicability of panoramic radiographic indices for estimating mandibular BMD in a Cameroonian female population.

**Study sites:** The Laboratory of Periodontology and Implantology

**Duration:** December 2023 to May 2024

**Procedure:** We screened panoramic radiographic registries and checked follow-up records from the mentioned laboratory to obtain relevant information to determine whether the patients met the inclusion criteria. We assessed the patients' dental panoramic radiography through a questionnaire and evaluated their radiomorphometric indices.

**Benefits:** You will receive free screening via your dental panoramic radiography for osteoporosis.

**Risks and inconveniences:** There are no major risks associated with this study

**Cost:** The assesment and control of dental panoramic radiography will be performed free of charge. You will not be given any material or financial incentives to participate in the study. Participation will be your free will.

**Ethical considerations**: Permission was obtained from the appropriate persons in charge of the study sites, and authorization was obtained from the National Ethics Committee. An encryption code should be used rather than your name for all the documents containing the collected data. The data will be handled with the greatest confidentiality. You can opt out of the study at any

point, and refusal to participate or opting out will involve no penalties or alter the relationship between you and your attending physician, hospital, study investigator or employer.

**Contacts:** For more information or further clarification about the study, the investigator can be contacted through the following telephone number (680791628) and email address: hakumbom7@gmail.com

## APPENDIX V: Notice d'information

**Titre :** Profil de la densité minérale osseuse mandibulaire chez les femmes camerounaises pré et post-ménopausées : Une analyse radiographique panoramique

**Investigateur:** Je suis ACHUMBOM HAGGAI AKUMBOM, étudiant en dernière année de médecine dentaire à la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé I, Cameroun.

**Directeur:** Professeur ZEH ODILE FERNANDE, Professeur titulaire de Radiologie et imagerie médical.

**Codirecteur(s):**

- Dr. NDJOH JULES JULIEN, Chargé de cours de Parodontologie et d'implantologie
- Dr. METOGO NTSAMA JUNIE ANNICK, Chargé de cours en Gynécologie Obstétrique

**Objet:** Invitation à participer à l'étude

**However, de l'étude :** L'ostéoporose est un problème majeur de santé publique dans le monde, affectant des millions de personnes et causant une morbidité, une mortalité et un fardeau économique importants [87]. Cependant, la mesure de la BMD par absorptiométrie à rayons X à double énergie (DXA) n'est pas largement disponible dans de nombreux pays en développement, y compris le Cameroun, en raison de son coût élevé, de son accessibilité limitée et de son manque de données de référence [7, 9]. Nous cherchons à évaluer l'applicabilité des indices radiographiques panoramiques pour l'estimation de la DMO mandibulaire dans une population féminine camerounaise.

**Sites d'étude :** Le Laboratoire de Parodontologie et d'Implantologie

**Durée:** Décembre 2023 à mai 2024

**Procédure:** Nous examinerons les registres de radiographie panoramique, nous vérifierons et suivrons les dossiers du laboratoire mentionné pour obtenir des informations pertinentes pour voir si vous remplissez les critères d'inclusion, nous évaluerons la radiographie panoramique dentaire du patient à travers un questionnaire et évaluerons les indices radiomorphométriques.

**Avantages:** Vous recevrez un dépistage gratuit de votre radiographie panoramique dentaire pour l'ostéoporose.

**Risques et inconvénients :** Il n'y a pas de risques majeurs associés à cette étude.

**Coût:** L'évaluation et les radiographies de contrôles seront effectuées gratuitement. Vous ne recevrez aucune incitation matérielle ou financière pour participer à l'étude. La participation sera de votre libre arbitre.

**Considérations éthiques:** La permission a été obtenue auprès des responsables des sites d'étude et l'autorisation a été obtenue auprès du Comité National d'Ethique. Un code de cryptage sera utilisé plutôt que votre nom, sur tous les documents contenant des données

collectées. Les données seront traitées avec la plus grande confidentialité. Vous pouvez vous retirer de l'étude à tout moment et le refus de participer ou le retrait n'entraînera aucune sanction et ne modifiera pas les relations entre vous et votre médecin traitant, les hôpitaux, les investigateurs de l'étude ou vos employeurs.

**Contacts:** Pour plus d'information ou de précisions sur l'étude, vous pouvez contacter l'investigateur au numéro de téléphone (680791628) et à l'adresse électronique suivante: hakumbom7@gmail.com

## APPENDIX VI: Informed consent form

**Title: Profile Of Mandibular Bone Mineral Density In Pre And Postmenopausal Cameroonian Women: A Panoramic Radiographic Analysis**

**Investigator:** ACHUMBOM HAGGAI AKUMBOM, final year dental medical student in the Faculty of Medicine and Biomedical Sciences, University of Yaoundé I.

**Supervisor**: Professor ZEH ODILE FERNANDE, full professor Radiology and Medical Imaging of the Faculty of Medicine and Biomedical Sciences, University of Yaoundé I

**Co supervisors:** Dr. NDJOH JULES JULIEN, Senior Lecturer of Periodontology and Implant Dentistry; Dr. METOGO NTSAMA JUNIE ANNICK, Senior Lecturer in Gynaecology and Obstetrics

I undersigned,

Mr./Mrs./Ms.

……

Confirm that I was asked to take part in this study, which is part of a D.M.D. thesis that seeks to assess the applicability of panoramic radiographic indices for estimating mandibular BMD in a Cameroonian female population. I hereby agree that:

- I understand the study's aim, benefits and risks, as mentioned in the information sheet provided for this study.
- All the questions I had concerning this study have been answered appropriately.
- The risks and benefits of this study have been explained in detail.
- I understand that I am free to either accept or decline to be a part of the study.
- My consent does not relieve the investigators of their responsibilities, and I retain my rights as ordained by law

I freely agree to participate in this study according to the specified conditions on the information sheet:

- All the questions asked about the study were answered truthfully.
- Authorize the consultation of my medical records and radiological exam records

I also freely authorize findings obtained from me for publication.

Date: ……/……./…

Investigator's signature and name Participant's signature and name

## APPENDIX VII: Fiche de consentement éclairé

**Titre :** Profil de la densité minérale osseuse mandibulaire chez les femmes camerounaises pré et post-ménopausées : Une analyse radiographique panoramique

Investigateur : ACHUMBOM HAGGAI AKUMBOM, étudiant en dernière année de médecine dentaire à la Faculté de Médecine et des Sciences Biomédicales, Université de Yaoundé I.

**Superviseur :** Professeur ZEH ODILE FERNANDE, professeur titulaire de radiologie et d'imagerie médicale à la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé I.

**Co-superviseurs :** Dr NDJOH JULES JULIEN, maître de conférences en parodontologie et odontologie implantaire ; Dr. METOGO NTSAMA JUNIE ANNICK, maître de conférences en gynécologie et obstétrique.

Je soussigné(e),

M./Mme.

.....

Confirme qu'il m'a été demandé de participer à cette étude, qui fait partie d'une thèse de doctorat en médecine visant à évaluer l'applicabilité des indices radiographiques panoramiques pour l'estimation de la DMO mandibulaire dans une population féminine camerounaise. Je reconnais par la présente que :

Je comprends l'objectif, les bénéfices et les risques de l'étude, tels que mentionnés dans la fiche d'information fournie pour cette étude.

Toutes les questions que j'ai posées concernant cette étude ont reçu une réponse appropriée.

- Les risques et les avantages de cette étude m'ont été expliqués en détail.
- Je comprends que je suis libre d'accepter ou de refuser de participer à l'étude.
- Mon consentement ne décharge pas les investigateurs de leurs responsabilités et je conserve mes droits tels qu'ordonnés par la loi.

J'accepte librement de participer à cette étude selon les conditions spécifiées sur la fiche d'information, pour :

- Répondre sincèrement à toutes les questions posées concernant l'étude.
- Autoriser la consultation de mon dossier médical et de mes dossiers d'examens radiologiques

J'autorise également librement les résultats obtenus de ma part, à être publiés.

Date: ...../...../.....

Signature et nom de l'investigateur Signature et nom du participant

## APPENDIX X: RESEARCH QUESTIONNAIRE

### SECTION 1: SOCIODEMOGRAPHIC DATA

| | | |
|---|---|---|
| **1** | **Age** | …… years |

### SECTION 2: CLINICAL AND THERAPEUTIC DATA

| | | |
|---|---|---|
| **4** | Family history of osteoporosis | ☐ Yes ☐ No |
| **5** | Date of Last Menses (Specific to postmenopausal women) | …… years |
| **6** | Comorbidities | ☐ Yes ☐ No |
| | | If yes, precise:<br>Smoking: ☐ Yes ☐ No |
| | | Alcohol consumption: ☐ Yes ☐ No |
| | | Sedentary lifestyle: ☐ Yes ☐ No |
| | | Rheumatoid arthritis: ☐ Yes ☐ No |
| | | Hyperthyroidism: ☐ Yes ☐ No |
| | | Hyperparathyroidism: ☐ Yes ☐ No |
| | | Chronic kidney disease: ☐ Yes ☐ No |
| **7** | Have you ever had a fracture due to a minor injury? | ☐ Yes ☐ No |
| **8** | Are you currently taking any medications that can affect bone density, such as glucocorticoids or anticonvulsants? | ☐ Yes ☐ No |

### SECTION 3: PANORAMIC RADIOGRAPH EVALUATION

| | | | |
|---|---|---|---|
| **9** | Dentition | Tooth loss<br>Number of tooth lost | ☐ Absent ☐ Present<br>_____ |
| **10** | Periodontal Bone lost | Vertical alveolar bone loss<br>☐ Sever ☐ Mild ☐ Low | |

| | | | |
|---|---|---|---|
| **11** | Periapical radiolucencies | | ☐ Present ☐ Absent |

**SECTION 4: RADIOMORPHOMETRIC INDICES**

| | | |
|---|---|---|
| **12** | **MCI** Mandibular cortical index | ☐ C1 ☐ C2 ☐ C3 |
| **13** | **GI** Gonial index | _____ |
| **14** | **AI** Antegonial Index | _____ |
| **15** | **MI** Mental Index | _____ |
| **16** | **PMI** Panoramic Mandibular Index | ____ Superior PMI ____ Inferior PMI<br>PMI ____ |

## APPENDIX XI : IMAGES

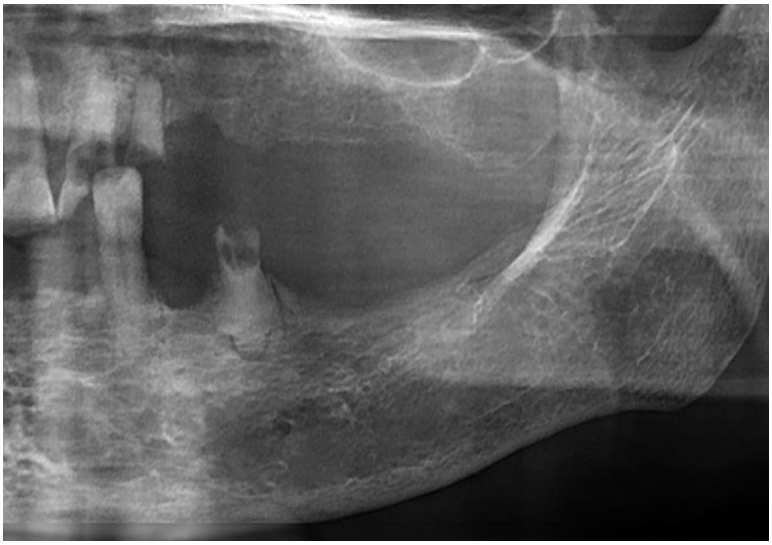

**Figure 26:** MCI Class III

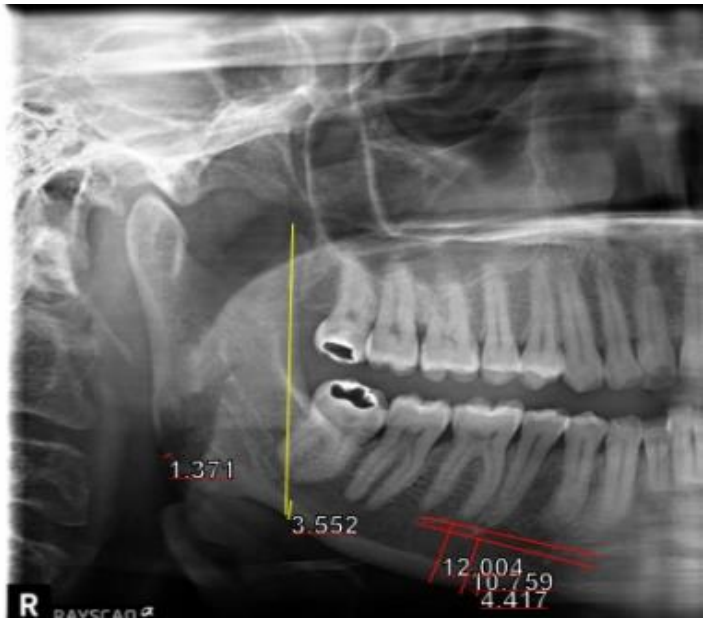


**Figure 25:** Measuring Radiographic Indices on DPR half cut

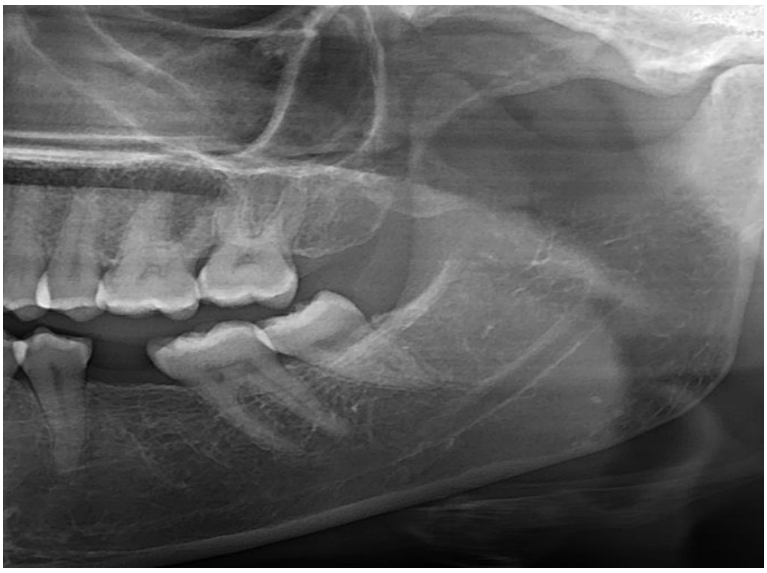

**Figure 27:** MCI Class I

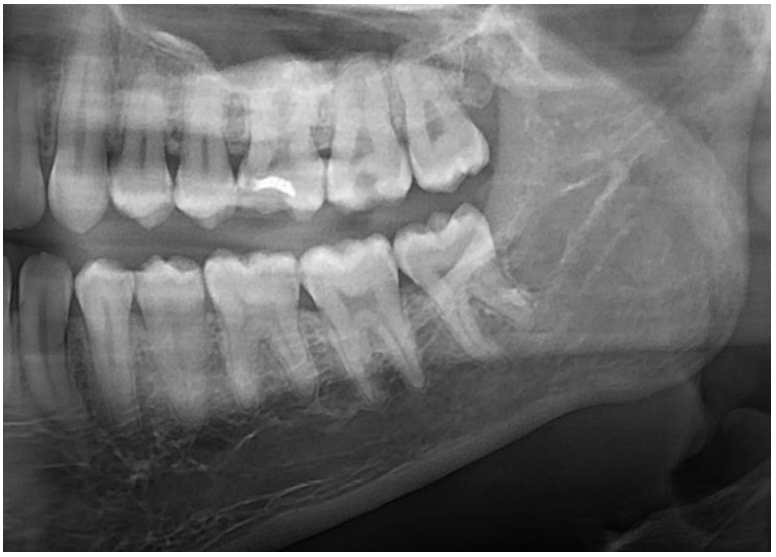

**Figure 28:** MCI Class II

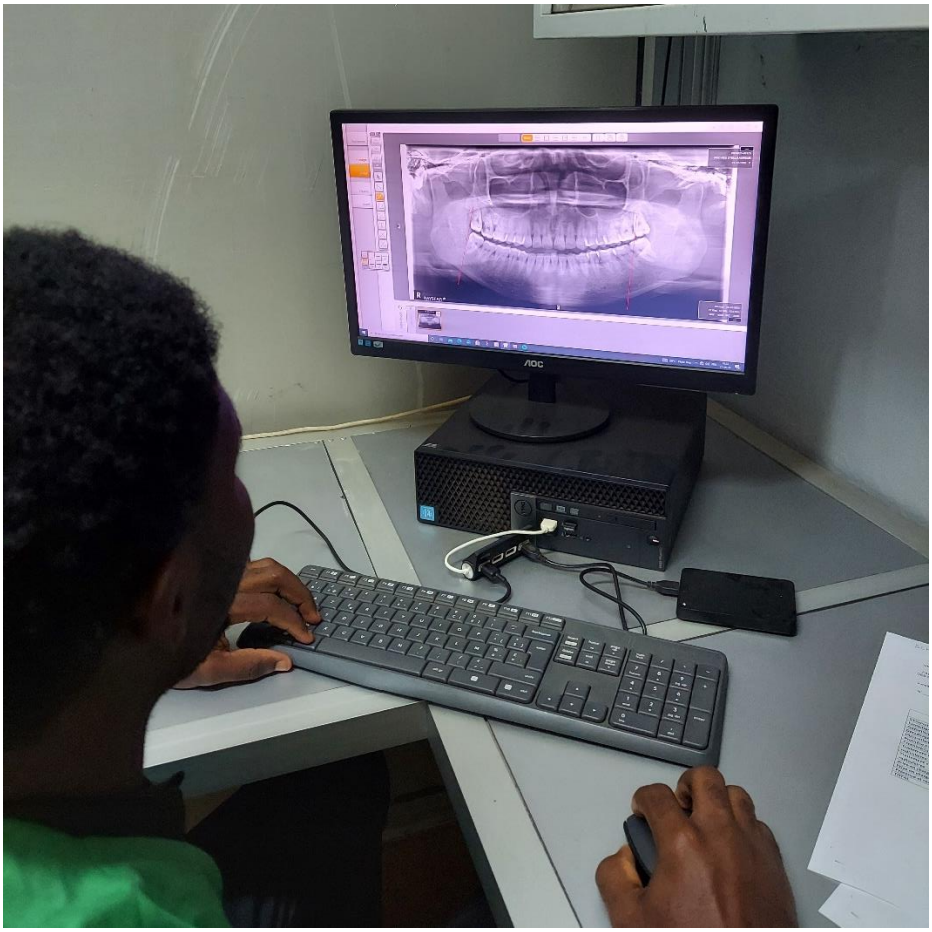

**Figure 29:** A Picture of the Recruiter Working On the Rayscan Software

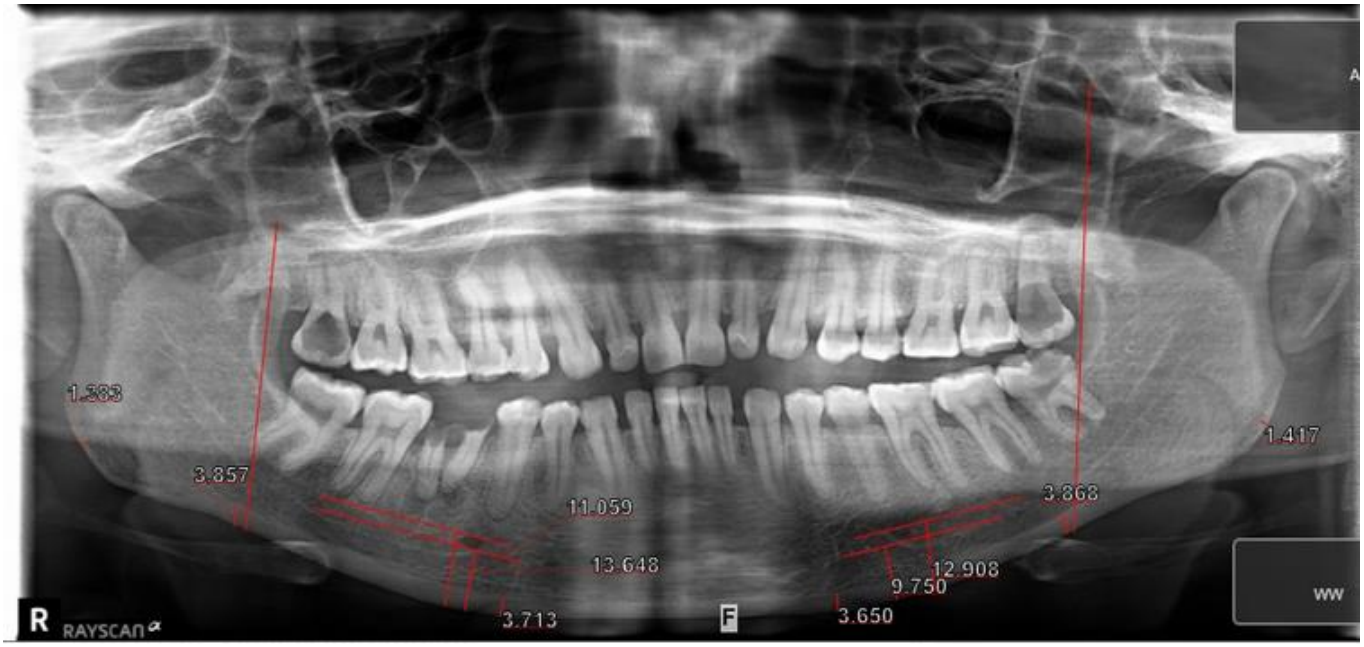


**Figure 30:** Measuring Radiographic Indices with the RayScan Alpha software