Radiomorphometric indices of the mandible in the assessment of bone mineral density in historical populations

Bone loss conditions in historical populations provide crucial insights into past health patterns and biocultural adaptation processes. While osteoporosis is often considered a modern disease, bioarchaeological evidence reveals its presence in various historical periods. This study aimed to evaluate the feasibility of utilising mandibular radiomorphometric indices as non-invasive tools for assessing bone mineral density (BMD) in historical populations. **The research hypothesis of the dissertation assumes that radiomorphometric indices of the mandible may be associated with skeletal mineral status in historical populations.** The primary objective was to determine relationships between mandibular radiomorphometric measurements and femoral BMD, and examine their associations with biological and environmental factors in medieval and early-modern skeletal series from Lower Silesia included in the osteological collection of the Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences.

The study analysed 197 individuals from two skeletal collections: 62 from medieval Milicz (12th-14th century AD) and 135 from early-modern Wrocław (16th-18th century AD). Nine mandibular radiomorphometric indices were measured from panoramic radiographs, including Mandibular Cortical Width (MCW), Panoramic Mandibular Index (PMI), Mandibular Ratio (MR), Gonial Index (GI), Antegonial Index (AI), Gonial Angle (GA), Antegonial Angle (AA), Antegonial Depth (AD), and Mandibular Cortical Index (MCI). Femoral BMD was measured using dual-energy X-ray absorptiometry (DXA), obtaining four measurements: neck, Ward's triangle, trochanter, and Total BMD value. Oral health status was assessed for caries, periodontitis, enamel hypoplasia, and antemortem tooth loss. Statistical analyses included comparisons regarding age category, sex within series, and series differences using Student’s t-test or the Mann-Whitney U test, as well as variance analysis (ANOVA), correlation analysis, and multiple regression.

Significant sex differences were observed in several mandibular indices, with males showing higher MCW values and Total BMD, while females exhibited wider gonial angles. Age-related changes were evident, particularly in the Wrocław series, where MCW, MR, AI, and BMD measurements at the neck and Ward's triangle showed significant declines with age. Moderate correlations were found between mandibular indices and femoral BMD, with the strongest associations observed for AI and Ward's triangle BMD ($r = 0.577$, $p < 0.001$) in the Milicz series. Multiple regression analysis revealed that MCW, MR, and AI were significant

positive predictors of femoral neck BMD, explaining 23.9% of the variance. Interpopulation comparisons showed that the medieval Milicz population had significantly higher cortical thickness (MCW, AI) but lower femoral neck BMD compared to the early-modern Wrocław series. Oral health conditions showed limited associations with radiomorphometric indices and BMD, except for enamel hypoplasia in the Wrocław series, which was linked to lower BMD across all measured regions.

The findings demonstrate that mandibular radiomorphometric indices can serve as moderate indicators of bone mineral density in historical populations, though their utility varies by population and specific indices. The age-related patterns align with clinical observations of progressive bone loss, particularly in metabolically active trabecular regions. Interpopulation differences suggest that urbanisation and dietary changes during the transition from medieval to early-modern periods may have introduced new health challenges, including potential vitamin D deficiency and increased refined carbohydrate consumption, despite presumed improvements in living standards. The association between enamel hypoplasia and reduced BMD indicates that early-life physiological stress may have lasting consequences for skeletal health.

This study confirms that certain mandibular radiomorphometric indices, particularly MCW, AI, AA, and AD, exhibit significant relationships with femoral bone mineral density in historical populations. However, these associations are moderate and population-specific, limiting their use as standalone diagnostic tools. The research hypothesis is partially confirmed: while mandibular indices can reflect bone mineral density and respond to age, sex, and environmental influences, their predictive utility requires careful interpretation within broader bioarchaeological contexts. Future research should integrate these indices with additional biological indicators to develop more comprehensive models for assessing bone health in ancient populations.