Sessione

Antropologia dello Scheletro e Bioarcheologia

comunicazioni orali

Morphological Variation of the Hip Bone: Integrating Diachronic, Geographic, and Sexual Dimorphism Patterns Through 3D Geometric Morphometrics

Carla Figus[1], Kristian Carlson [2], Eugenio Bortolini [1], Vitale Stefano Sparacello [3], Rita Sorrentino [1], Maria Giovanna Belcastro [4], Jean-Jacques Hublin [5], Markus Bastir [6], Tim Ryan [7], Stefano Benazzi [8]

[1] *University of Bologna*

[2] *University of Southern California*

[3] *Università di Cagliari*

[4] *Università di Bologna*

[5] *Collège de France, Paris, France*

[6] *Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain*

[7] *Pennsylvania State University*

[8] *University of Bologna, Department of Cultural Heritage*

The human pelvis reflects a complex interplay of locomotor, obstetric, and evolutionary pressures—but not all pelvic regions preserve the same signals of biological variation. This study investigates how different parts of the hip bone— the complete coxal bone and the acetabulum—capture variation related to sex, ancestry, geography, function, and diachronic trends. Using 3D geometric morphometrics (GM), we analyzed a diverse sample of modern and prehistoric individuals to explore patterns of morphological diversity and factors that shape them.
Our comparative sample includes modern Italians from Bologna and North American individuals of varying ancestries (European, Hispanic, Native American), as well as Upper Paleolithic individuals from Arene Candide and Dolní Věstonice.
Principal Component Analysis of the coxal bone revealed strong sexual dimorphism as the primary source of variation (18.3% on PC1), with clear separation between male and female morphologies across populations. Archaeological male individuals clustered with modern males, suggesting long-term stability in sex-specific hip morphology despite substantial temporal distance. Population differences in morphology were more pronounced in females, while males remained more morphologically homogeneous across groups. The analysis of variance (ANOVA) confirmed significant differences between sexes (p¡0.001), with more limited significant differences between males among populations.
The acetabulum, however, told a different story: geographic/population variation is the primary explanatory factor (PC1=23.4%) rather than sexual dimorphism. Bologna specimens (males and females) clustered separately from North American groups, suggesting strong population-specific morphology in this feature. Integration of size (form space analysis) amplified the acetabular differences between groups.
These findings suggest that different regions of the hip bone may reflect distinct aspects of human variation: while the complete coxal bone predominantly captures sexual dimorphism, the acetabulum may reflect ancestry, function, and diachronic trends. This pattern has critical implications for sex estimation and body mass in paleoanthropological contexts and suggests different selective pressures affecting these anatomical regions throughout human evolution. Our preliminary results contribute to understanding the complex interplay between function, development, and biological diversity in shaping human hip morphology.

Anthropology of the Eneolithic Site of Colombardo

Luca Sineo[1], Saverio Scerra [2], Giuseppe Terranova [2], Francesca Meli [1]

[1] *Università di Palermo*

[2] *Soprintendenza di Ragusa*

Evidence of settlements and necropolises of Eneolithic culture in Sicily is scarce. This work presents the first anthropological data of a settlement and hypogeal necropolis discovered in Contrada Colombardo, in the province of Ragusa. The excavation, conducted in 2015 by the Superintendence of Ragusa, on the occasion of the decommissioning of a large industrial storage facility, brought to light a complex settlement, characterized by three Long Houses and a hypogeal tomb, which constitutes a typological unicum in the funerary landscape for the Copper Age on the Hyblean hills. The tomb is divided into three burial chambers, one of which incomplete and unused. The tombs were found inviolate and sealed by lithic doors. The first chamber housed a single burial (T1: S1), a male individual in right lateral decubitus and in a crouched position. The second chamber hosted a collective burial of 8 individuals (T2: S2-S8). The intensive use of red ochre is visible in both chambers. In chamber 2 there is evidence of depositional rituals, such as the particular arrangement of some bodies in secondary position. The anthropological study highlighted the presence of adult individuals of both sexes and of an infant individual. Anthropological, Archaeometrical, Paleopathological and Isotopical parameters useful for the reconstruction of the biological profile and of the paleoecology of the human group were detected. On the basis of the investigations conducted, it is possible to hypothesize a familiarity between the occupants of the hypogeal complex, the possible cause of death of the individual in T1 and the health status of the group. Morphometric differences support the hypothesis of a population heterogeneity.

Biological and cultural insights from the Eneolithic necropolis of Celletta dei Passeri (Forlì, Italy): proteomic and multi-isotope analyses

Teresa Nicolosi[1], Sara Silvestrini[1], Sara Bernardini[1], Federico Lugli[2], Anna Cipriani[2], Mario Carić[3], Antonino Vazzana[1], Rita Sorrentino[4], Mario Novak[5], Maria Giovanna Belcastro[4], Monica Miari[6], Stefano Benazzi[1]

[1] *Department of Cultural Heritage, Alma Mater Studiorum University of Bologna, Bologna, Italy*

[2] *Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Modena, Italy*

[3] *Centre for Applied Bioanthropology, Institute for Anthropological Research, Zagreb, Croatia*

[4] *Department of Biological, Geological and Environmental Sciences, Alma Mater Studiorum University of Bologna, Bologna, Italy*

[5] *Centre for Applied Bioanthropology, Institute for Anthropological Research, Zagreb, Croatia, Department of Archaeology and Cultural Heritage, Faculty of Humanities, University of Primorska, Koper, Slovenia*

[6] *Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Bologna e le province di Modena, Reggio Emilia e Ferrara, Bologna, Italy*

The necropolis of Celletta dei Passeri was excavated between 2009 and 2010 in the city of Forlì (Italy). The site represents the largest and best documented Eneolithic necropolis in Emilia Romagna and one of the most important ones in northern Italy. It encompasses 75 graves, only 51 containing human remains, along with the intentional burial of a dog. As regards grave goods, most individuals are buried with a jug placed at their feet, while some of them are distinguished by the presence of copper weapons (seven adults) and flint arrowheads (19 adults and four non-adults). This study aims to reassess the biological profile of these individuals and to investigate their provenance and dietary habits in order to highlight potential differences that may help to better define their role within the community.

For the reassessment of the biological profile, we strengthen the sex estimation through enamel peptide analysis targeting the amelogenin protein. We were able to analyse all the adult individuals buried with copper weapons, along with some of those associated with flint arrowheads (including all the non-adult individuals and four adults for which at least one tooth was preserved). To investigate provenance, we conducted Sr isotope analysis on 32 individuals, as well as on some faunal remains from the site, including the dog. Finally, 13 individuals – both armed and non-armed – were subjected to C and N isotope analysis to reconstruct their diet.

Amelogenin peptide analysis confirmed that two of the adult individuals with copper weapons are female, as previously suggested by anthropological analysis. These represent the first documented cases of armed female burials in Eneolithic Italy, challenging traditional assumptions about gender roles in prehistoric societies. As regards provenance, the vast majority of the analysed individuals appear to be local, with the sole exception of a young adult male buried with copper weapons. In addition, some faunal remains – including the dog – are non-local, raising new questions about transhumance and trade networks. As for diet, no major differences were observed, being the results consistent with a C3 plant-based diet, typical of the period.

In conclusion, the multidisciplinary analysis of Celletta dei Passeri combined biological and cultural data, providing new insights into the complexity of Eneolithic funerary practices and social dynamics.

Human remains from the Monte Claro site of Acquacadda (Nuxis, Italy): archaeothanatology and implications for funerary activities at the cave.

Roberta Anedda[1], Vitale Stefano Sparacello [1], Marco Cabras [2], Riccardo Cicilloni [2]

[1] *Dipartimento di Scienze della Vita e dell'Ambiente, Università degli Studi di Cagliari*

[2] *Dipartimento di Lettere, Lingue e Beni Culturali, Università degli studi di Cagliari*

Caves have always been of interest to humans. As well as providing shelter and dwelling places, their suggestive nature made them an ideal choice for religious and burial practices. Sardinia has an established tradition of cave occupation, dating back to the island's first colonisation. The ritual and funerary use of caves is attested from the late Neolithic, persisted throughout prehistory, and reached its peak during the Copper Age, with the Monte Claro culture (2700-2200 BCE). These people practiced a great variety of burial practices, with cave burials being a prominent feature of southwestern Sardinia. The study of this aspect has been limited by the complex nature of cave diagenesis but has recently gained momentum. The site Acquacadda (Nuxis – SU, Italy) is a karstic cave located adjacent to the copper mine of 'Su Montixeddu' and was used as a dumping site for mining debris. The archaeological significance of the site was well-known for decades, but only in 2019 the University of Cagliari initiated a formal excavation. Five campaigns have revealed the presence of an impressive expanse of pottery fragments of various sizes and types, all belonging to the Monte Claro culture. This 'pavement' is likely linked to ritual practices of great importance. In addition, human remains have been found in almost all the areas investigated, scattered and with no anatomical connection preserved. Through archaeothanatology, this study contributes to the investigation of the processes that led to the formation of the assemblage, and the funerary practices that took place inside the cave. We conducted the mapping of the skeletal elements through GIS along the anthropological study of the bones. Based on 1074 human bones that were identified with different degrees of preservation and fragmentation, a MNI of 14 individuals (7 adults and 7 sub-adults) was calculated. All skeletal districts are represented, suggesting that the assemblage derives from disturbed primary burials, whose original position is unknown. The scattered dispersal of the bones in relation to the ritual pavement suggests that the agent of disturbance is water, which recurrently flooded the cave. Future campaigns will reveal the extent of the anthropogenic use of the cave and the primary position of the inhumations. Acquacadda is to date the largest cave site of the Sardinian Copper Age, and its exploration will be fundamental to our understanding of the ritual behaviors of the Monte Claro people.

Exploring population dynamics through phenotypic diversity: A Gower-Based Analysis of the Terramare necropolises

Giulia Vescovo[1], Barbara Bramanti [1]

[1] *Università di Ferrara*

This study investigates the biological relationships of Bronze Age populations associated with the Terramare culture in Northern Italy through a comprehensive biodistance approach. Recent research has highlighted the value of integrating diverse phenotypic variables to better understand past population dynamics. In line with this, the present analysis combines metric and non-metric cranial and dental traits, which are non-destructive, macroscopically observable, and biologically informative.

The Gower distance coefficient - well-suited for datasets that include both continuous and categorical variables - was applied to five analytical scenarios, each of which incorporated an expanding set of comparative populations from Europe and beyond (comprising Eneolithic and Late Bronze Age Western Romania, Classical Chersonesos, Late Neolithic to Early Iron Age Southwest Germany, and Roman-period Lebanon). Principal Coordinates Analyses (PCoAs) were used to visualise inter- and intra-population relationships and to assess how the inclusion of additional groups affected clustering patterns. The results consistently show increasing internal cohesion among individuals from the Terramare necropolises, suggesting shared ancestry or prolonged biological interaction.

Notably, individuals from Olmo di Nogara - the earliest site in the Terramare sample - frequently occupied intermediate positions in the multivariate space, indicating its potential role in the demographic structuring of the Terramare populations. Some patterns also suggest biological affinities with Eneolithic populations from Western Romania, pointing to deeper historical connections that may reflect broader migratory processes across Europe during the second millennium BCE.

The patterns revealed through this analysis emphasise the complexity of the Terramare populations. To validate and expand upon these findings, our current research incorporate targeted ancient DNA and isotopic studies, particularly focusing on individuals exhibiting unexpected clustering - especially females - who may represent non-local individuals and pathways of mobility within the Terramare network.

Of Graves and grains: Isotopic Signatures of Social Differentiation at Novilara (Central Italy, 8th-7th c. BCE)

Marco Milella[1], Michael A Beck De Lotto[2], Chiara Delpino[3], Sandra Lösch[4], Zita Laffranchi[5]

[1] *Department of Biology - University of Pisa*

[2] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University, Via Caserta 6, 00161, Rome (Italy)*

[3] *Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Chieti e Pescara, Via degli Agostiniani 14, 66100 Chieti (Italy)*

[4] *Department of Physical Anthropology, Institute of Forensic Medicine, University of Bern, Murtenstrasse 26, 3008 Bern, Switzerland*

[5] *CTS-112: Biological Anthropology. Human Paleoecology. Department of Legal Medicine, Toxicology, and Physical Anthropology, University of Granada, Avda. de la Investigación 11, 18016 Granada (Spain)*

The Early Iron Age in Italy represents a key moment in the formation of pre-Roman cultural identities, marked by the emergence of distinct groups such as the Latins, Villanovans, or Picenes. This cultural diversification was accompanied by the development of increasingly differentiated social structures, as reflected by funerary variability. However, the biological implications of these inequalities - and how they shaped individual life histories - remain largely unexplored. In this context, dietary analysis offers a valuable approach to test whether differential access to resources can serve as a proxy for social stratification. This study investigates carbon (^{13}C), nitrogen (^{1}N), and sulfur (^{3}S) stable isotopes from bone collagen at Novilara (Marche region, 8th–7th century BCE), one of the largest and most significant necropolises of this period. Culturally linked to the Picene of Central-Eastern Italy, the site exhibits marked variability in grave goods, suggesting a society structured around distinct roles and unequal access to economic resources. To reconstruct dietary habits, we analyze bone collagen from 148 individuals (37 males, 73 females, 12 unsexed adults, and 26 non-adults), alongside four faunal samples.

Isotopic data are compared by sex, funerary treatment (type and number of grave goods), and skeletal and dental proxies of developmental stress (stature, enamel hypoplasia, cribra orbitalia). Results indicate a primarily terrestrial diet based on C plant products and variable animal protein input. Statistically significant differences in ^{13}C and ^{1}N values separate the sexes, with males showing higher ^{1}N and ^{13}C values than females (mean differences = 0.4‰ and 0.2‰, respectively). Among adults, ^{1}N values correlate positively with stature, and in males, individuals buried with weapons tend to exhibit higher ^{1}N ratios, although these trends are not statistically significant. No specific patterns characterize ^{3}S values, but outliers suggest the presence of nonlocals, possibly from the hinterland.

The results suggest that socio-economic status may have influenced access to food resources for a limited subset of individuals within the community. Conversely, the primary axis of dietary differentiation appears to be structured according to sex criteria. These results highlight the value of stable isotope analysis in reconstructing subtle forms of social differentiation that may not be fully captured by material culture alone.

Bodies at work: bioanthropological evidence of occupational stress in the Baratti necropolis (4th–3rd Century B.C.)

Simona Minozzi[1], Vera Bucci , Alfonso Maria Pugliese , Valentina Giuffra [2]

[1] *Divisione di Paleopatologia, Università di Pisa*

[2] *Divisione Paleopatologia, Università di Pisa*

The study of skeletal changes due to functional activity has long been a central topic in anthropological research. Despite methodological limitations associated with the assessment of specific indicators, widely discussed in the scientific literature, the integrated analysis of various biomechanical and functional stress markers allows for the development of interpretive models to reconstruct the daily activities and living conditions of past populations.
This study examines burials from the Baratti necropolis (Populonia, Livorno), dating back to the 4th - 3rd century B.C. The site comprises over 150 tombs discovered along the beach. Archaeological evidence suggests that this funerary area was predominantly utilized by individuals engaged in local port and metallurgical activities. To date, the bioanthropological analysis has focused on 65 individuals of both sexes and all age groups.
In addition to reconstructing the demographic profile, the study examined skeletal indicators useful for detecting adaptive modifications: stature, development of muscle attachments, traumatic injuries, joint degeneration, cranial porosities, and lesions attributable to physical activity.
The results reveal clear signs of a selected population: the low presence of children and the predominance of males (more than twice the number of females) suggest a community with a strong labor-related character.
Trauma is prevalent: over half of individuals have bone fractures (F: 60%, M: 52.4%) and more than 70% show signs of repeated microtrauma. Joint diseases are common, especially in young men (60% ages 20–35, 88.9% ages 36–45). Around 33% of vertebrae in both sexes exhibit spondyloarthrosis, mainly in the thoracic and lumbar regions, with notable sex-based differences. Muscular attachment development suggests intense physical activity from a young age in both genders.
Skeletal evidence from Baratti shows a sample population engaged in physically demanding labor. Biomechanical stress markers, high trauma rates, degenerative conditions, and the biological profile of the sample suggest a group involved in labor-intensive and hazardous tasks with exposure to occupational risks.
This study highlights the relationship between labor, the human body, and social structure, providing substantial information about the living conditions of workers during the Etrusco-Roman period at Populonia.

A Bioarchaeological Study of Burial Unit 1 from the Church of Santa Maria Maggiore in Vercelli

Marta Licata[1], Chiara Villa [2], Paolo Spina [3], Stefano Vanin [4], Giuseppina Carta [4], Nicol Rossetti [1], Arianna Vanni [5], Chiara Tesi [1], Enrico Caruso [1], Carmelo Messina [6], Francesca Garanzini [7], Roberta Fusco [1]

[1] *Department of Biotechnology and Life Science, University of Insubria, Varese, Italy*

[2] *Department of Forensic Medicine, University of Copenhagen, Denmark*

[3] *Cantonal Institute of Pathology, Ente Ospedaliero Cantonale, Locarno, Switzerland*

[4] *Earth, Environment and Life Sciences Department (DISTAV), University of Genoa, Italy*

[5] *Department of Medicine and Surgery, University of Insubria, Varese, Italy*

[6] *Radiology Department, ASST Gaetano Pini-CTO, Milan, Italy*

[7] *Superintendence of Archaeology, Fine Arts and Landscape for the Provinces of Biella, Novara, Verbano-Cusio-Ossola and Vercelli*

1. Context and aim of the study: Situated in Vercelli, in Piedmont, the Church of Santa Maria Maggiore was built in the 18th century and includes an underground burial area conceived in tandem with the main church structure. This expansive subterranean cemetery was a burial place for local clergy and nobility members until the mid-1800s. Burial Unit 1, the first tomb encountered upon entering the space, was intended for a single occupant. Set against the wall, the burial consists of a brick-built trapezoidal structure housing a wooden coffin. Within lies a mummified individual in primary deposition, remarkably well preserved and still dressed in garments that remain in excellent condition.
2. Methods and Materials: This study presents the anthropological and paleopathological analyses of the individual, carried out through CT imaging and 3D visualizations to construct a biological profile and assess skeletal diseases and trauma. The investigation was further complemented by histological examinations, entomological studies, historical costume analysis, and gas chromatography performed on medical gauze wrapped around the individual's head.
3. Results: The mummy belonged to a middle-aged male, with an estimated stature of 173 cm, who exhibited multiple pathological conditions. These included dysplasia of the left hip with advanced osteoarthritis, as well as generalized degenerative changes affecting the vertebrae, shoulders, and knees. CT imaging also revealed multiple vascular calcifications in the heart and aorta, consistent with arteriosclerosis. Histological analysis showed a thick keratinized layer corresponding to the outermost part of the epidermis, with no preservation of the underlying Malpighian epithelium or other soft tissues. Entomological investigation identified insect fauna characteristic of underground burial environments, indicating that the body had not been exposed before interment. The study of the clothing confirmed that the garments dated to the second half of the 18th century and were consistent with the attire worn by a man of high social rank.
4. Conclusion: The multidisciplinary investigation of Burial Unit 1 from the Church of Santa Maria Maggiore in Vercelli provides valuable insights into the life, death, and health of an 18th-century high-status individual. The study highlights the significance of combining advanced imaging, laboratory analyses, and historical material culture to reconstruct past lives.

Transformed by fire, a ritual practice dating back to the Early Neolithic in Italy. Interdisciplinary analysis of burnt bone remains in Lugo di Grezzana (Veneto), 5000-4850 cal BCE

Omar Larentis[1], Giacomo Capuzzo [2], Angela Maccarinelli [3], Stefano Marconi [4], Ilaria Gorini [5], Annaluisa Pedrotti [6]

[1] *Bagolini Laboratory of Archaeology, Archaeometry, Photography (LaBAAF), Department of Humanities, University of Trento, Trento, Italy, Centre of Research in Osteoarchaeology and Paleopathology (CROP), Biotechnologies and Life Sciences Department (DBSV), University of Insubria, Varese, Italy*

[2] *Radiocarbon Dating Laboratory, Royal Institute for Cultural Heritage, Brussels, Belgium, Archaeology, Environmental Changes & Geo-Chemistry,Vrije, Universiteit Brussel, Brussels, Belgium*

[3] *Sheffield Zooarchaeology Lab, Department of Archaeology, University of Sheffield, Sheffield, England*

[4] *Archaeozoology and Dendrochronology Laboratory, Civic Museum Foundation of Rovereto, Rovereto, Italy*

[5] *Centre of Research in Osteoarchaeology and Paleopathology (CROP), Biotechnologies and Life Sciences Department (DBSV), University of Insubria, Varese, Italy*

[6] *Bagolini Laboratory of Archaeology, Archaeometry, Photography (LaBAAF), Department of Humanities, University of Trento, Trento, Italy*

The use of fire for the treatment of human remains in funerary rituals characterises Italian prehistory since the Neolithic, being the dominant funerary practice from the Late Bronze Age to the Early Roman period, with regional differences. New osteoarchaeological and radiometric data allow us to confirm the occasional use of fire as a transformative element for the body already in the Early Neolithic. During the excavation of the Early Neolithic settlement of Lugo di Grezzana in 2003 and 2005 (Fiorano Culture – province of Verona, Veneto, northeastern Italy), five pits were discovered, each containing burnt osteological remains. One pit, interpreted as an oven (ES 541 sector XVI), yielded numerous bones intermingled with abundant fragments of pottery and flint. Most of the bones were identified as non-human remains. However, the morphological examination revealed fragments of diaphyses with characteristics consistent with human bone. Subsequent histomorphological analysis confirmed the taxonomic identification of these fragments as belonging to the genus Homo and provided insights into the age distribution, indicating that they belonged to individuals spanning different age groups.
The 14C analysis of charcoal and bones suggests that the use of ovens dates from 5400 to 5000 cal BCE. A new radiocarbon date of a calcined human bone fragment has been placed between 5024 and 4845 cal BCE, indicating that the oven was likely reused as funerary structure during the final phase of the site use. This discovery has increased the number of recent findings of burnt human bones within Neolithic contexts in Italy, prompting us to reflect on the significance of their presence as possible evidence of the early evidence of fire rituals involving the treatment of human remains in the Italian Peninsula.

A microscopic analysis of cremated bone microstructures preservation and age-at-death estimation in an Imperial Roman community in central Italy

Alessia Galbusera[1], Owen Alexander Higgins [2], Stefano Magri [2], Martina Trevisan [3], Vito Giuseppe Prillo [3], Massimo Vidale [3], Vincenzo Torrieri [4], Stefano Benazzi [2], Luca Bondioli [5], Alessia Nava [1], Melania Gigante [3]

[1] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome, Italy*

[2] *Department of Cultural Heritage, University of Bologna, Italy*

[3] *Department of Cultural Heritage, University of Padua, Italy*

[4] *Soprintendenza Archeologia, Belle Arti, Paesaggio, L'Aquila-Teramo, Italy*

[5] *Institute of Geological Sciences, Polish Academy of Sciences, Poland*

Cremation was a widespread funerary practice in antiquity, carrying symbolic and cultural significance associated with the treatment of the body and the transition to the afterlife. Nevertheless, the elevated temperatures involved in the cremation process induce substantial modifications and alterations in skeletal and dental remains, thereby limiting the ability to reconstruct the biological profile of ancient cremated individuals.
The present study focuses on the potential of histological and histomorphometric analyses applied to a sample of 18 long bone fragments (humeri and femora), pertaining to different cremations, from the Imperial Roman necropolis of La Cona (Teramo, Abruzzo, 1st century BCE - 1st century CE), which is distinguished by a high number of cremations.
The bone fragments have undergone standard histological procedures, which involve embedding in epoxy resin, cutting with a diamond blade low-speed saw, grinding to a thickness of approximately 100 µm, and polishing with alumina powder. Thin sections were examined under transmitted light microscopy to assess the degree of preservation of the cortical microstructures and determine any changes related to bone remodelling and ageing process. The age at death was estimated using the osteon population density (OPD) parameter; while secondary osteons, Haversian canal areas and osteon circularity index were collected for each specimen.
Results show a good preservation of the bone microstructures, despite the substantial macroscopic alterations. A high inter-individual variability in OPD was observed, which aligns with the macroscopic estimation of the age at death. As the body undergoes the process of ageing, secondary osteons and Haversian canals tend to decrease in their dimensions and become more circular. The observed trends reveal a positive correlation between biological age, bone remodelling, and histomorphometric features. This study confirms the reliability of microscopic bone analyses in elucidating the biological and ageing dynamics of human bones, highlighting its value in the investigation of ancient cremations. This study enabled the refinement of the demographic profile of the cremated population of La Cona and the acquisition of significant information regarding the cremation ritual in this population during the Roman period.

Taphonomy and archaeothanatology reveal details of the different mortuary programs in collective burials from prehistoric and protohistoric Sardinia

Carla Maserati[1], Roberta Anedda [2], Riccardo Cicilloni [1], Gianfranca Salis [3], Vitale Stefano Sparacello [1]

[1] *Università degli Studi di Cagliari*

[2] *LAMPEA - Laboratoire Méditerranéen de Préhistoire Europe Afrique*

[3] *Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Cagliari e le province di Oristano e Sud Sardegna*

The practice of collective burial is a widespread phenomenon in prehistory and protohistory. Conceptually, it has been proposed that the commingling of skeletal remains may reflect the societal value of group identity and the construction of an ancestral collectivity. Themes of separation, decomposition, and reintegration of human remains are attested in ethnographic studies and have been proposed as part of the mortuary program for various archaeological settings. However, specific mortuary gestures and phases of manipulation can vary widely within this broader categorization, reflecting ritual, cultural, and social differences – including early forms of stratification – despite a collective funerary presentation. Applying archaeothanatological and taphonomic principles to human remains can help identify these gestures, such as defleshing, secondary deposition, or repeated disturbance of primary depositions, thus revealing distinct funerary programs.

We analyzed collective burials from different Sardinian cultural contexts spanning the Neolithic to the Bronze Age. Results suggest that commingled assemblages from Giants' Tombs (e.g. Muttas Nieddas, Gesico) result from continuous disturbances of primary depositions, given the finding of skeletal elements from labile joints (e.g. carpals, phalanges, hyoid bones). Conversely, funerary sites in caves from the Late Bronze Age (e.g. Lu Maccioni-Alghero and Grotta Tueri-Perdasdefogu) have yielded cutmarks compatible with defleshing on the skull and long bones, suggesting that decomposition happened outside, and that selected elements were carried in the cave, performing a cleaning action when necessary. A similar practice may apply to the Late Neolithic domus de janas of San Benedetto (Iglesias), where remains appear selected, mostly comprising crania and long bones. However, evidence for cut marks is inconclusive due to taphonomic degradation. At Bingia 'e Monti, a hypogeic-megalithic tomb built in the mid-late Copper Age and with a complex history of reusing in the initial Bronze Age, primary depositions and their later disturbances are apparent from excavation pictures. Strikingly, we discovered one instance of cut marks in a frontal bone from lower layers, hinting to a succession of different funerary programs at the site. This ongoing study offers skeletal evidence aiding the reconstruction of multi-stage mortuary practices and to the detecting cultural changes in socially-mediated funerary representations.

Osteobiography of the people from Nora. Life and death at the Phoenician and Punic Nora (7th to the 2nd cent. BC): A bioarchaeological and multianalytic approach to organic evidence from the western necropolis

Melania Gigante[1], Noemi Ruberti [1], Vito Giuseppe Prillo [1], Federico Lugli [2], Jacopo Bonetto [1], Alessia Nava [3], Luca Bondioli [4]

[1] *Department of Cultural Heritage, University of Padova*

[2] *Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia*

[3] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome*

[4] *Institute of Geological Sciences, Polish Academy of Sciences, Krakow*

The archaeological site of Nora, located in southern Sardinia (Cagliari), serves as a pivotal case study for the reconstruction of population dynamics, bio-cultural exchange, and individual mobility within the Mediterranean societies of the 1st millennium BC.
Excavations conducted by the University of Padua in the western Phoenician and Punic necropolis have revealed a stratified funerary record, spanning from the 7th to the 2nd cent. BC, including single secondary cremations and both primary and secondary inhumations. This diachronic sequence provides critical insight not only into the evolution of mortuary practices, but also into the biology of the people living at Nora during the transition from the Phoenician to the Punic sociocultural framework.
This contribution presents the results of a multi-proxy bioarchaeological study that integrates human osteology, histology, biogeochemistry and proteomics, archaeozoology and archaeobotany aiming to reconstruct the individual osteobiographies, funerary customs and asses their variability in relation to biological parameters, rituals structures, and mechanisms of social inclusion and exclusion.
Our results emphasise a dynamic spectrum of funerary and ritual behaviours, reflecting evolving cultural frameworks and social structures over time. Practices such as the selective inclusion of individuals, age-differentiated treatment—especially of subadults—and variability in the use of faunal deposits indicate the presence of structured ritual grammars and evolving conceptions of the body and personhood. The exceptional recovery of textile fragments associated with cremated remains offers rare insight into post-cremation treatment and the symbolic role of perishable materials within the funerary rite.
Archaeozoological and archaeobotanical evidence further clarify the operational sequences underlying these practices, revealing nuanced links between organic offerings and the biological and social identity of the deceased. As such, Nora provides a methodologically rich context for examining biocultural interactions, mobility patterns, and identity formation in a culturally-mixed setting, advancing the interpretive potential of bioarchaeology within the Phoenician and Punic studies.

Conflict, Plague, and Burial: Multi-Proxy Evidence from a Medieval Urban Cemetery of Verona

Elena Fiorin[1], Christina Cheung [2], Stefania Vai [3], Silvia Ghirotto [4], Giacomo Capuzzo [5], Brunella Bruno [6]

[1] *Department of Oral and Maxillofacial Sciences, Sapienza University of Rome, Italy*

[2] *Department of Anthropology, The Chinese University of Hong Kong, Hong Kong*

[3] *Università di Firenze*

[4] *Università degli studi di Ferrara*

[5] *Radiocarbon Dating Laboratory, Royal Institute for Cultural Heritage, Brussels, Belgium*

[6] *Soprintendenza Archeologia, Belle Arti e Paesaggio per le Provincie di Verona, Rovigo, e Vicenza, Italy*

This study provides a multi-proxy investigation of an urban cemetery in Verona, northern Italy, offering new insights into infectious diseases, healthcare practices, and funerary behaviour during the late medieval period. Focusing on the Arditi d' Italia Square cemetery, which contains approximately 800 burials, the research presents the results of bioarchaeological analyses conducted on selected individuals interred in double and single burials and mass graves. New radiocarbon dates indicate that part of the cemetery was used between the 12th and 14th centuries, a period characterised by a critical political and military phase in Verona's history that overlaps with the outbreak of the Black Death. By combining anthropological, archaeothanatological, paleopathological, aDNA, and isotopic analyses, this research aims to explore how the local community reacted to these periods of crisis and confronted death. Due to the complexity and extent of this cemetery, 54 burials containing 102 individuals were selected for this study. The preliminary results show that mass graves were used between the 12th and 13th centuries, while most single and double graves were interred in the 14th and later centuries. The unusual position of the bodies buried within the mass graves and the irregular pit morphology suggest that the individuals were laid down in haste. Conversely, the individuals buried in the double burials were positioned with care, with some embracing each other. The individuals buried in the mass graves were mostly men, whereas the remaining burials showed a homogeneous distribution of male and female individuals, with a slight prevalence of females and children. Carbon and nitrogen isotope analysis revealed differences in diet between the individuals. Those buried in the 12th-13th-century mass graves had a diet based on the consumption of C4 plants, whereas the other individuals, buried in the 14th century, had a diet based on C3 plants. This extraordinary context offers an opportunity to investigate the intertwined impacts of conflict and epidemics on late medieval Italian urban communities.

Directional Limb Asymmetries and Lifestyle: A Diachronic Analysis of Three Pre-Industrial Populations from the Abruzzo Region (Central Italy)

Jacopo Cilli[1], Arianna Di Felice [2], Michele Dell'Aquila [3], Ruggero D'Anastasio [3]

[1] *Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila*

[2] *Department of Humanities, Art and Social Science, "G. d'Annunzio" University of Chieti-Pescara*

[3] *Department of Medicine and Aging Sciences, "G. d'Annunzio" University of Chieti-Pescara*

Humans are known to exhibit a certain degree of limb asymmetry, partly due to genotypic and phenotypic variability (fluctuating asymmetry), but more significantly as a result of lifestyle and preferential limb use over the course of life (directional asymmetry). Previous studies have reported a general population-level pattern of right-sided upper limb and left-sided lower limb dominance, although this may vary according to daily activities. This study aims to evaluate the degree of directional asymmetry in three populations from Abruzzo (central Italy), spanning different historical periods and subsistence strategies, in order to assess changes in the degree and pattern of asymmetry over time and in relation to lifestyle. Thirty sagittal and transverse dimensions were recorded from paired humeri, radii, ulnae, femora, tibiae, and fibulae in adult individuals from Opi – Val Fondillo (Bronze Age, hunter-gatherers, 59 individuals), Sulmona – Contrada Santa Lucia (Classical Age, quarry workers, 49 individuals), and Teramo – Sant'Anna (Medieval Age, craftsmen, 38 individuals). Directional asymmetry (%DA) was calculated for each measurement and statistically compared both within and between populations. Population-level handedness was also assessed. As expected, greater asymmetry favoring the right upper and left lower limbs was observed in the more ancient populations with more physically demanding lifestyles. Statistically significant asymmetries were found not only in transverse dimensions (related to muscular development) but also in sagittal ones, suggesting that intense physical activity began during skeletal development. In contrast, the more recent and sedentary Teramo population showed lower asymmetry (limited to right-side dominance) and a largely symmetrical skeleton in 18 out of 30 measurements. These findings indicate that right upper limb dominance remained consistent over time and across subsistence strategies, whereas left lower limb dominance appears more influenced by lifestyle and environmental factors. Overall, the observed reduction in limb asymmetry over time reflects broader changes in lifestyle and physical labor, particularly the shift from natural/rural to urban environments and from dynamic, labor-intensive activities to more sedentary and evenly distributed ones.

Keywords: Directional asymmetry, limb dominance, handedness, Abruzzo, skeletal anthropology, lifestyle

New Perspectives on Neolithic Lifeways in Northeastern Italy: Stable Isotope Evidence from Arco and Riva del Garda (Trento)

Stella Erriu[1], Irene Dori [2], Vitale Stefano Sparacello [3], Alessandro Riga [2], Elisabetta Mottes [4], Alex Fontana [5], Giorgio Manzi [1], Guy André [6], Alessandra Varalli [6]

[1] *Sapienza Università di Roma*

[2] *Università di Firenze*

[3] *Università di Cagliari*

[4] *UMSt Soprintendenza per i beni e le attività culturali, Ufficio beni archeologici, Trento*

[5] *MUSE - Museo delle Scienze di Trento*

[6] *Aix Marseille Univ, CNRS, Minist Culture, LAMPEA, Aix-en-Provence*

Following the transition to a Neolithic lifestyle, the consolidation of agricultural and pastoral practices is reflected in the 'Middle Neolithic' cultures, represented in northern Italy by the Square Mouthed Pottery (SMP) Culture. This phenomenon lasted throughout the 5th millennium BCE and is characterized by both cultural uniformity and adaptability to diverse geographical environments. Archaeobotanical and archaeozoological evidence indicates varied subsistence strategies, including agriculture, livestock breeding, and pastoralism. However, limited information is available on human adaptations in such contexts, particularly in northeastern Italy. Recent excavations in the Upper Lake Garda area have uncovered new cemeteries of the Square Mouthed Pottery Culture at Arco – Via Degasperi (14 burials) and Riva del Garda – Via Brione (10 burials), located about 5 km apart. Most of the individuals were placed in stone cist graves, lying on their left side and facing east. By combining archaeology, anthropology and stable isotope analysis, this study investigates dietary practices using carbon, nitrogen, and sulphur isotopes in bone collagen from 24 humans and 8 domesticated animals. Additionally, 9 permanent teeth were also analysed to explore infant feeding practices and early-life physiological stress. Animals from Trentino show high carbon values, possibly reflecting pasturing in open environments, while human samples exhibit more negative carbon values. This suggests non-alimentary exploitation of the sampled animals. Most humans from Arco and Riva del Garda had a terrestrial diet based on resources from a temperate C3 environment, but higher nitrogen values at Riva del Garda suggest a greater intake of animal protein, with freshwater resources as a possible contributing factor. Sulphur values show no differences between humans and fauna, indicating a local origin for most individuals, except for one potential non-local case, an individual associated with distinctive grave goods. Comparisons between Trentino and other sites in Liguria, Emilia-Romagna, and Veneto reveal distinct isotopic patterns within the SMP horizon. This study confirms interregional variability and highlights a striking intra-regional variability in human resource exploitation and adaptative strategies, contributing to a deeper understanding of Neolithic lifeways in northern Italy.

Reconstructing Bronze Age Diets in the Po Valley: Bone and Dentine Isotope Evidence

Francesca Meli[1], Alessandra Varalli [2], Giuseppe Egidio De Benedetto [3], Mary Anne Tafuri [4], Marco Romboni [4], Nicoletta Zedda [5], Giulia Vescovo [6], Martina Di Matteo , Barbara Bramanti [5]

[1] *Università di Palermo*

[2] *Aix Marseille Univ, CNRS, Minist Culture, LAMPEA, Aix-en-Provence, France*

[3] *Dipartimento di Beni Culturali, Laboratorio di Spettrometria di Massa Analitica e Isotopica, Università del Salento, Lecce*

[4] *Department of Environmental Biology, Sapienza University of Rome, Italy*

[5] *University of Ferrara, Ferrara, Italy*

[6] *Università di Ferrara*

This research investigates local ecological dynamics, subsistence models, and differences in access to food resources, following the ecological hypotheses developed within the PRIN 2022 SHOVELING project. A central focus is the notably high prevalence of shovel-shaped incisors among Terramare sites in Bronze Age Northern Italy. This study aims to determine whether individuals with and without this dental trait show distinct dietary patterns, potentially reflecting different cultural or biological backgrounds. To explore this, stable isotope analysis of bone and dentine collagen is employed.

We analyzed 344 humans and 20 terrestrial animals of both domestic and wild species from four Terramare necropolises in the Veneto region: Castello del Tartaro, Bovolone, Franzine Nuove, and Olmo di Nogara. Faunal remains provide a local terrestrial isotopic baseline representative of a diet mainly based on C plants. Compared to this baseline, results show that human ^{13}C and ^{1}N values are higher than those of animals, indicating regular consumption of animal proteins and C plants, such as millet. Overall, the Terramare communities show relatively homogeneous isotopic values, suggesting a shared diet and broadly equal access to resources, as observed at sites like Olmo di Nogara. However, some sites, such as Bovolone, show greater variability, likely reflecting sex-based dietary differences, with more variation among males. No significant isotopic differences were observed between individuals with and without shovel-shaped incisors. Based on current data, no distinct dietary practices can be associated with this trait.

Incremental dentine analysis was carried out on 20 first molars from individuals already sampled for bone collagen. Isotopic profiles (^{13}C, ^{1}N, ^{3}S) trace early-life diet, including breastfeeding and weaning. Preliminary data show similar weaning ages (3–4 years), though isotopic evidence suggests variation in the timing of C plant consumption, with earlier or later intake observed between individuals. These findings highlight the complexity of dietary practices at Terramare sites in Bronze Age Northern Italy. While isotopic homogeneity suggests a broadly shared diet and equitable access to resources, site- and sex-based differences point to localized variability. From a broader perspective, the data reflect shared cultural habits alongside adaptative strategies shaped by ecological and social factors in the Po Valley.

Tracing lives in isotopes: multi-isotope perspectives on diet and mobility in Fermo (Marche, Italy) during the Iron Age

Fabiana Faccioni[1], Kaitlin Hull [2], Richard Madgwick [3], Emily Holt [3], Melania Gigante [4], Alexandra Nederbragt [5], Carmen Esposito [6]

[1] *Università degli Studi di Padova*

[2] *York Archaeology, York, United Kingdom*

[3] *School of History, Archaeology and Religion, Cardiff University, Cardiff, United Kingdom*

[4] *Department of Cultural Heritage, University of Padua, Italy*

[5] *School of Earth and Environmental Sciences, Cardiff University, Cardiff, United Kingdom*

[6] *Department of Cultural Heritage, University of Bologna*

In recent years, growing interest in dietary habits and mobility in past societies has increasingly drawn the attention of scholars, becoming one of the most discussed topics in archaeological research. This trend has been driven by the development of new and advanced biogeochemical methodologies that have significantly enhanced the study of ancient diet and mobility patterns. In this framework, isotope analysis of archaeological teeth and bones has become a key tool for investigating changes in habitat, animal herding, dietary tendencies and migration patterns in the past.

This paper explores the dietary and mobility patterns at the important Early Iron Age site of Fermo (chronology, Marche, central Italy), through a multi-isotopic analysis (^{13}C, ^{1}N, ^{1}O, and ^{3}S) of 33 human tooth root samples and 30 tooth enamel samples of inhumed individuals, along with some faunal bone samples for recreating the baseline.

Since the first systematic studies, the archaeological site of Fermo – comprising the Misericordia and Mossa necropolises, used from the 9th to the 5th century BCE – has been in a lively scholarly debate. Although situated within the territory traditionally associated with the Picene cultural sphere, both its organizational structure and the burial practices reveal notable affinities with the renowned and intricate Villanovan material culture, along with elements of the Picene tradition itself. The funerary complexity of Fermo has made it one of the most debated Iron Age sites in Italy within the academic community, both in past and recent research.

This study is part of a broader research project and aims, first, to demonstrate how a multi-isotope approach can provide a more detailed understanding of dietary and mobility patterns than a single-isotope approach, while integrating with existing isotope data from previous studies at Fermo. Secondly, it seeks to compare these results with data from other contexts across the Italian peninsula to build a comprehensive scenario of the complex social and political dynamics of Iron Age populations.

Enamel histomorphometry of pre-Mesolithic and Neolithic individuals from al-Khiday (Khartoum, Sudan)

Giusy Capasso[1], [2], Alessia Galbusera [1], Martina Trocchi [3], Donatella Usai [4], Luca Bondioli [5], Alessia Nava [1]

[1] *Dipartimento di Scienze Odontostomatologiche e Maxillo Facciali, Sapienza Università di Roma*

[2] *Dipartimento di Scienze dell'Antichità, Sapienza Università di Roma, Italia*

[3] *Istituto dei Sistemi Complessi (ISC) – CNR, Roma*

[4] *Centro Studi Sudanesi e Sub-Sahariani - Ente Terzo Settore, Treviso*

[5] *Institute of Geological Sciences, Polish Academy of Sciences, Kraków, Poland*

Since 2005, archaeological excavations at site al-Khiday (Khartoum, Sudan) revealed a multi-stratified cemetery (site 16-D-4, al-Khiday 2) with distinct burial phases dating from the Late Pleistocene to the 2nd century CE. This study advances the analysis of the site's bioarchaeological record, previously reliant on standard anthropological approaches, by introducing new data from dental enamel histomorphometry.

Due to its appositional development and lack of remodeling, dental enamel preserves a high-resolution temporal record of early life. Histomorphometric analysis of enamel microstructures provides key data on infants' growth trajectories and physiological stress, allowing for the reconstruction of individual biological life histories.

Seventeen teeth from pre-Mesolithic and Neolithic individuals from al-Khiday were analysed for enamel histomorphometric parameters, including Daily Secretion Rate (DSR), Crown Formation Time (CFT), and Enamel Extension Rate (EER), as well as the identification and prevalence of Accentuated stress Lines (ALs).

In the pre-Mesolithic subset, deciduous upper canines (n=2) show faster DSRs and shorter CFTs than modern standards (mean: 439 days), with their formation beginning early during pregnancy (18 gestational weeks). Compared with modern references, the first permanent molar has a shorter CFT (832 days) and slower DSR, whereas the second permanent molars (n=12) have longer CFTs (mean: 1365 days). Neolithic first permanent molars (n=2) have shorter CFTs (mean: 799 days) and DSRs consistent with modern human variability. All the adults show at least two ALs, with stress peaks identified in first permanent molars around 9 months and second molars at 45 months.

The results suggest that, compared to modern humans, children in al-Khiday grew faster, in line with evolutionary trends towards slower growth trajectories over time. The shorter CFTs in the first permanent molars reflect fast EERs (mean: 22.8 µm/day), whereas the prolonged formation of pre-Mesolithic second molars may relate to their larger size. The observed peaks in ALs at ˜9 and ˜45 months may correspond to critical developmental transitions such as the weaning process.

This study highlights the potential of enamel histomorphometry to reconstruct growth and health status during infancy in past human populations, which complements traditional bioarchaeological approaches and provides new insights into recent evolutionary trajectories.

Tracing Mobility in the "Celtic" Necropolis of Casalecchio di Reno (BO, early 4th – early 3rd c. BCE) through Strontium Isotopes

Davide Mameli[1], Rita Sorrentino [1], Valentina Mariotti [1], Giselle Luzzati [1], Sara Bernardini [2], Teresa Nicolosi [2], Silvia Volpe [1], Friederike Novotny [3], Michaela Spannagl-Steiner [3], Federico Lugli [4], Peter C. Ramsl [5], Maria Giovanna Belcastro [1]

[1] *Department of Biological, Geological and Environmental Sciences, Alma Mater Studiorum University of Bologna, Bologna, Italy*

[2] *Department of Cultural Heritage, Alma Mater Studiorum University of Bologna, Bologna, Italy*

[3] *NHM Vienna, University of Vienna, Austria*

[4] *Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Modena, Italy*

[5] *Department of Prehistoric and Historical Archaeology, University of Vienna, Vienna, Austria*

The necropolis of Zona "A" in Casalecchio di Reno (Bologna, Italy) is the earliest known "Celtic" cemetery in the region and is attributed to the Boii, a group traditionally associated with East-Central Europe. The necropolis was in use for about a century, spanning at least four generations. Unlike other coeval Celtic contexts in northern Italy, where grave goods often reveal local influences, the funerary assemblages of Casalecchio are characteristically La Tène. This cultural uniformity suggests strong ties with transalpine Iron Age populations. Both archaeological evidence and ancient written sources support the hypothesis of a southward "Celtic" migration beginning in the early 4th century BCE. However, the extent and nature of this demographic movement remain debated.

To investigate mobility patterns, strontium isotope ratios (Sr/Sr) were analyzed from the dental enamel of early mineralizing teeth of 89 individuals, out of 94 recovered skeletons. The sample includes both sexes and all age groups. Results were compared to local baseline values derived from regional isoscapes. Individuals whose values fell outside this range were classified as non-local.

Given the span of the necropolis, a substantial presence of local individuals was expected. Indeed, 46% of the sample shows isotopic signatures within the established local range (0.7092–0.7087). Another 31.5% falls within a lower range (0.7087–0.7080), possibly still local, considering regional geological variation. The remaining individuals display a wide array of values, suggesting heterogeneous life histories and possibly multiple migration events. Some diverge markedly from the local baseline, possibly reflecting distant origins, while others differ only slightly, suggesting movement from nearby areas. Non-local individuals include both sexes and some subadults.

The strong cultural alignment with continental "Celts" raises questions about the biological background of this population and its interaction with local Etruscan groups. Ongoing analysis of non-metric dental traits will contribute to this discussion.

This research is part of the project "CATA – Celts across the Alps", funded by the Austrian Science Fund (FWF, project no. P36086-G).

The Chemical Memory of Teeth: Insights into Lead Exposure during pregnancy and Infancy

Alessia Nava[1], Federico Lugli [2], Szymon Mianowski [3], Robert Anckziewicz [4], Wolfgang Müller [5], Luca Bondioli [6]

[1] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome*

[2] *Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Modena, Italy*

[3] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome, Rome, Italy*

[4] *Institute of Geological Sciences, Polish Academy of Sciences, Kraków, Poland*

[5] *Frankfurt Isotope and Element Research Centre (FIERCE), Goethe University Frankfurt, Germany*

[6] *Institute of Geological Sciences, Polish Academy of Sciences, Krakow*

Teeth serve as retrospective archives of individual biological life histories, preserving information from intrauterine life through early childhood and beyond. While dental microstructures embed information on infants' growth trajectories and physiological stress exposure, the chemical composition of dental mineralized tissues may permanently preserve the signatures of the exposure to toxicant during their formation.
Heavy toxic metals can be readily absorbed by humans through food, air, and water, leading to detrimental health outcomes. Among these metals, Pb is particularly significant due to its widespread presence in (proto)industrial human activities. Although extensive research has investigated lead poisoning throughout human history, limited knowledge exists regarding the incorporation of Pb into mineralized human tissues during gestation and the early postnatal period.
In this study we used time-resolved histology-driven laser ablation ICPMS analysis to measure the variation in [Pb] in human dental enamel from contemporary (exfoliated deciduous teeth, N=15), modern (early 20th century, exfoliated deciduous teeth, N=14) and archaeological (seven Roman Imperial necropolises of Central Italy, permanent first molars, N=32) dental specimens. Results show a decreasing trend of Pb concentrations through time. Roman Imperial individuals are characterized by the highest Pb levels (mean = 4.63, SD = 10.91ppm); early 20th century individuals show moderate Pb levels in both prenatal (mean = 3.25, SD = 1.64 ppm) and postnatal (mean = 2.53, SD = 1.86 ppm) enamel, while contemporary children have the lowest Pb concentration (mean = 0.11, SD = 0.2 ppm). The Roman Imperial samples show a very high variability intra and inter necropolises, as confirmed by the high coefficient of variation (CV = 2.36). Peaks in [Pb] are visible before and around birth, probably linked to the remobilization of Ca from the maternal skeleton at the end of pregnancy.
This research underscores the importance of gaining deeper insight into the mechanisms by which lead is embedded in dental microstructures during odontogenesis, and it offers new opportunities for reconstructing historical exposure to toxic metals.

Refining adult age-at-death estimation through semi-automated tooth cementum annulation (TCA) counting

Stefano Magri[1], Paola Cerrito [2], Alessia Nava [3], Luca Bondioli [4], Eugenio Bortolini [1], Rita Sorrentino [5], Maria Giovanna Belcastro [5], Stefano Benazzi [1]

[1] *Dipartimento di Beni Culturali, Università di Bologna, Ravenna*

[2] *Department of Evolutionary Anthropology, University of Zürich, Zürich*

[3] *Dipartimento di Scienze Odontostomatologiche e Maxillo Facciali, Sapienza Università di Roma, Roma*

[4] *Institute of Geological Sciences, Polish Academy of Sciences, Kraków*

[5] *Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Bologna*

The accurate determination of age at death is a fundamental aspect of biological anthropology and particularly important on bioarchaeology. This is because it is crucial for the reconstruction of individual life histories and the demographic profiles of past populations. In subadult individuals, maturation stages of skeletal and dental markers, such as tooth formation and eruption and fusion of the ossification centres, are reliable approaches due to the well-defined stages of dental and skeletal development during growth. Conversely, in adult individuals, conventional methods rely on the assessment of degenerative changes, such as dental wear and joint surface modification, or on bone histomorphometry, which are idiosyncratic and influenced by environmental factors.
Among human remains, teeth preserve permanent incremental markers within their microstructure since they don't undergo remodelling. Dental cementum, the mineralized tissue covering the tooth root, continues to form throughout life in rhythmic, annual, layers known as annulations, which are visible in ground sections. These incremental markers offer a tool for a more precise adult age-at-death estimation. However, the process of counting cement annulation is complex and time-consuming.
This study proposes a semi-automated histological analysis of cementum annulations using a proprietary R script to improve accuracy and reproducibility. We analysed 30 permanent canines from the Documented Collection of the Certosa Cemetery (Bologna, Italy, 19th-20th century), selecting specimens based on documented age to explore possible biological variation.
Results indicate a progressive increase in cementum thickness with age, along with a corresponding increase in the number of detectable annulations. However, a slight decline in the precision of exact age-at-death estimation was observed in older individuals, as expected based on previously published work, likely due to the biological decrease of cementum rate deposition over time
By integrating traditional histological techniques with automated image analysis, this approach offers a refined and replicable method for age-at-death estimation. Our results hold significant potential for application in forensic anthropology, bioarchaeology, and palaeoanthropology, contributing to a more accurate reconstruction of mortality profiles in both modern and ancient populations.

Diachronic Variation in Daily Secretion Rates of Human Dental Enamel

Roberto Germano[1], Alessia Galbusera [2], Jessica Bergamini [3], Claudia Stefani [2], Alessandra Sperduti [4], Luca Bondioli [5], Giorgio Manzi [1], Alessia Nava [2]

[1] *Department of Environmental Biology, Sapienza University of Rome, Rome, Italy*

[2] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome, Rome, Italy*

[3] *Department of Science of Antiquities, Sapienza University of Rome, Rome, Italy*

[4] *Bioarchaeology Service, Museum of Civilizations, Rome, Italy*

[5] *Institute of Geological Sciences, Polish Academy of Sciences, Kraków, Poland*

Human dental enamel is a valuable biological record for reconstructing ontogenetic trajectories and physiological stress prevalence in humans. This study investigates the variation in dental enamel daily secretion rates (DSRs, i.e. the daily rate of enamel secretion along the enamel prisms) of first permanent molars in the Roman Imperial period, comparing them with the values available in literature for the same period and for contemporary individuals. Few studies so far have reported a diachronic variation in DSRs: One study suggested a decrease in prenatal DSRs of deciduous incisors between Imperial Roman and contemporary individuals, while another highlighted a diachronic decreasing trend in first permanent molar DSRs in Britain. By examining variations in DSRs, this research aims to investigate possible developmental trends over time.
Fifty-nine first permanent molars dated to Roman Imperial time from the necropolises of Isola Sacra, Centocelle, and Castel di Guido (Rome, Italy), Velia (southern Italy), Civitanova Marche, Urbino, Porto Recanati, and Villarey (central Italy) have been analysed. Histomorphometric assessments on thin sections of the dental crowns allowed quantification of enamel incremental markers to calculate the DSRs.
Results reveal variability in DSRs among Roman Imperial samples. Comparisons with published Roman Imperial and contemporary datasets yield statistically significant differences in mean values, showing a decreasing trend in infants' growth trajectories through time. The lateral inner enamel DSR shows a significant difference among the means of the necropolises, while for the cuspal inner enamel DSR means remain similar.
This research underscores the importance of understanding the regional and temporal variation in enamel growth dynamics and the interplay of biological and environmental factors shaping dental ontogeny. Further studies involving larger datasets from different geographic and chronological horizons are needed to refine interpretations of diachronic changes in human enamel development and their implications for recent human evolution.

The chemistry of birth: rethinking the neonatal line through trace elements LA-ICP-MS profiles

Jessica Bergamini[1], Szymon Mianowski [2], Robert Anckziewicz [3], Wolfgang Müller [4], Luca Bondioli [3], Alessia Nava [1]

[1] *Sapienza Università di Roma*

[2] *Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome, Rome, Italy*

[3] *Institute of Geological Sciences, Polish Academy of Sciences, Kraków, Poland*

[4] *Frankfurt Isotope and Element Research Centre (FIERCE), Goethe University Frankfurt, Germany*

The integration of high-resolution *in situ* laser-based ICP-MS trace element (TE) analysis with the histological record of dental enamel enables near-weekly resolution of the chemical signatures recorded into the forming tissue. The neonatal line (NNL – the birth marker), present in all the deciduous teeth and often in the first permanent mandibular molar, clearly distinguishes prenatal and postnatal enamel. Its position and histological identification are the reference points for verifying the survival of the individual, as NNL forms between 8 and 14 days after birth, and allows the registration of chemical and/or histomorphological key events along the individual's lifetime.

Synchrotron-based XRF analyses showed distinct shifts in trace element distribution at the neonatal line, with increased Zn concentrations observed in prenatal dentine and enamel across the NNL.

In the present study, conducted on 11 contemporary deciduous teeth with known clinical and dietary history, TE profiles (Sr, Ba, Mg, Zn, and Pb, the latter as a proxy for pollution) were analysed by LA-ICP-MS across the NNL and along the Enamel Dentine Junction.

In most of the cases Zn and Pb show a recurring pattern in proximity of the NNL: a rise of the profile followed by a decline, consistent with a physiological transition associated with the onset of extrauterine life, plausible as metabolic adaptation causing the remobilization of elements from the maternal skeleton to be incorporated in the foetal growing dental tissues. This signal of 'chemical birth' can be misaligned with the histologically observed NNL. The mismatch varies between samples, with an average deviation of about 20 days, which can manifest itself either as an advance or a delay concerning the histological observation.

This discrepancy suggests that chemical and histological signals can reflect distinct and possibly asynchronous physiological processes, while the topographical variation of the enamel thickness along the crown could play a role as well. This study highlights the need for a better understanding of the complex physiology associated with birth, which can be read by histology-driven LA-ICP-MS.