

**Health and Disease in the Ancient Mediterranean as  
Demonstrated through the Application of  
Anthropological, Paleopathological and  
Paleoradiological Methods**

By

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## ABSTRACT

The present thesis investigates health and disease in the ancient Mediterranean basin in a selected number of published cases, by applying anthropological, paleopathological and paleoradiological methodologies, in an effort to offer a comprehensive understanding of the impact of nosological entities on ancient individuals, in the light of the current international biomedical literature and the broader paleopathological context.

While the focus of the thesis is not primarily methodological in spirit, a great attention is paid to the key role played in such multidisciplinary investigations by the discipline called ‘paleoradiology’, which by adopting X-ray and CT-scan imaging allows anthropologists and paleopathologists to describe in much greater detail the architectural changes that occurred in the human skeleton and soft tissues alike, and offers a chance to digitalize bioarchaeological data and create 3D models. This is explained in the introduction to the topic, which also offers a summary of the development of the field of paleopathology and a concise analysis of its disciplinary nature.

Specifically, the research includes an assessment of the multiple presence of Klippel-Feil syndrome, a complex congenital anomaly, in the ancient Sardinian population of Alghero (16<sup>th</sup> century AD) combining anthropological and radiological methods; the transdisciplinary evaluation of the likelihood of the attribution of a skull preserved in the anatomical museum of the University of Bologna to king Athalaric (AD 516-534); the multi-level study of a case of osteoid osteoma of the frontal sinus in an individual from the late Roman empire; the analysis of prehistoric congenital anomalies of the spine from the Hypogeum of Calaforno (Sicily); the evaluation of traumatic injuries and the first ever reported case in Italy of bilateral non-osseous calcaneonavicular coalition in skeletons from the medieval Sicilian phase of the archaeological site of Troina.

To these are also added papers examining how mummies were interpreted in ancient Greece and how that civilization viewed the preservation of the body. Finally, papers are included that assess the case of the mummy Cairo CG 61076 from the Royal mummy cachette DB 320 in which an identification attempt is made, and a facial reconstruction is presented.

All these studies demonstrate that ancient populations in the Mediterranean region experienced diseases which are also found today, and this thesis furthers our understanding of paleopathology in this geographical area.

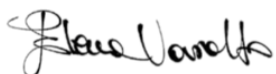
## DECLARATION OF AUTHORSHIP

I hereby certify that my thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma at any university; and that, to the best of my knowledge, it does not include any material previously published or written by another person except where due reference is made in the text.

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### *Statement on the peer-review process*

All the papers presented in this PhD thesis have been already peer-reviewed by qualified scholars and approved of by the editors of the scientific venues in which they are contained, according to their publication standards and the standards of the discipline wherein they are published.

### *Definition of the material used*

This thesis focuses on the health conditions of ancient Mediterranean populations investigated mostly by applying morphological (anatomical) and paleoradiological techniques.

### *Declaration of Ethics*

Ethical clearance was either not needed or is declared in every published paper following the legal requirement of the respective country and museum (or owner).

## **ACKNOWLEDGEMENTS**

I would like to thank all my coauthors, with whom I have collaborated over the years, for their stimulating suggestions and great help. I am also truly grateful to the cultural heritage institutions, especially the Assessorato Regionale dei Beni Culturali e dell'Identità Siciliana (Sicily, Italy), its provincial Superintendences and its officials for having allowed me to conduct and publish several studies in anthropology and paleopathology of Sicilian populations.

Also, I cannot forget the invaluable help of my supervisor, Prof. F. Donald Pate, for his continued assistance and support, my Flinders-based colleagues, Francesco M. Galassi and Michael E. Habicht for encouraging my studies and providing critical feedback on my results and theories, as well Prof. Maciej Henneberg (The University of Adelaide) for his bright and authoritative example.

Last, but not least, words of gratitude must be addressed to Carla and Stefano for their continued support of my work.

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Figure 2: Adopted workflow for the osteological material. Chart by the candidate made with CANVA. Page 30.

## INTRODUCTION TO THE INVESTIGATED TOPIC

Archaeology is defined as the scientific study of material remains, including pottery, buildings, and tools, which represent the heritage of ancient societies and civilizations whose trajectories are investigated through the application of a multidisciplinary methodology (Merriam-Webster.com Dictionary 2022). Reid, Schiffer and Rathje (1975) argue that ‘archaeology can be defined simply as the study of relationships between human behavior and material culture’. This focus on behavioural inferences from material remains in both past and contemporary contexts emerged from the New Archaeology of the early 1970s (Deetz 1972; Leone 1972; Gould and Schiffer 1981; Rathje and Schiffer 1982; Schiffer 1983, 1987, 2010).

In the past, archaeology was undoubtedly more focused on the evidence of material culture from ancient peoples and – compared to the present time – little attention was paid to the very protagonists of humankind’s past, whose mortal remains, most often discovered already skeletonized, could be studied and whose biological profiles (i.e. the combination of information about sex, age-at-death, stature, ancestry, pathology, trauma; Austin and King 2016) could be inferred. Although this would have inevitably yielded much more information on past human groups and their endeavours, bones were often regarded as something unimportant and, as many witnesses can confirm in the Mediterranean area, particularly in Sicily, one of the key areas for this study but also in other parts of Italy, they would end up collected to be deposited in modern cemeterial ossuaries, without any possibility for them being thoroughly analyzed by specialists. This approach meant the loss of an immense amount of data over the past decades, that only recently introduced new approaches have managed to fix (Milanese 2021).

A major shift happened in the second half of the 20<sup>th</sup> century with the introduction of the concept of *human bioarchaeology* by Grahame Clark (1907-1995) and successively by Clark Spenser Larsen (born 1952), who highlighted how the application of anthropological methodologies to skeletal remains found in archaeological excavation contexts could yield vital information for the understanding of the past of human societies, to the extent that this would even surpass that derived from the classic study of material culture (Larsen 2015).

As a sub-branch of this research – without forgetting, nonetheless, its close connection with the medical field, in particular with the human normal and pathological anatomies – the discipline of paleopathology emerged, which, with a peak in communicated research and published literature again



in the second half of the 20<sup>th</sup> century, started to systematically assess the antiquity of pathological conditions, hence offering an interesting perspective on the global health burden in past societal groups, with the possibility to compare it with the current global situation, which, by itself, also paved the way for an evolutionary assessment of paleopathological findings (Ortner and Putschar 1981; Aufderheide and Rodríguez-Martín 2011; Rühli et al. 2016; Buikstra 2019).

Paleopathology can be defined as the study of diseases in the past and how they occurred centuries, millennia, tens of thousands of years ago (Aufderheide and Rodríguez-Martín 2011). The materials it deals with are essentially skeletons and mummies – both artificially embalmed human bodies, such as Egyptian mummies, and naturally preserved bodies (Shin and Bianucci 2021). The discipline has its origins in the great pioneers of the 19<sup>th</sup> and early 20<sup>th</sup> centuries and in that spirit of fascination with antiquity and the people who were its protagonists, summed up by archaeologist Howard Carter's exclamation (although it appears that he may not have said exactly these words) 'Yes, wonderful things' to his patron, Lord Carnarvon, who impatiently asked him 'Can you see anything?' at the fateful moment of entering Tutankhamun's tomb, still untouched by any visitor (Fritze 2020).

Mummies were even considered a medicine for a long time (Dawson 1927): indeed, the powdered mummy (called *mumia vera*) was used as a medicine and was considered very powerful against a whole range of illnesses, from epilepsy to joint pain and gastrointestinal problems; there was even a controversy between various schools of thought as to which type of mummy was best. It is curious how a great physician, the French Ambroise Paré (1510-1590), noted that ingesting mummy powder not only did not cure illnesses, but even had the opposite effect; even a notable figure of the Renaissance, such as King Francis I of France (1494-1547), was persuaded that it could cure him of every ailment and always carried a pouch tied to his belt containing this powder, convinced that it would eventually stop hemorrhages. Instead, the intake of mummy dust, due to the benzene it probably contained – a component of the bitumen with which ancient bodies were embalmed (especially in the late stages of Egyptian and even medieval history) – had precisely the opposite effect, namely that of causing hemorrhages (Gorini 2005; Galassi 2022a).

That fascination, at times naive and irrational but the *primum movens* of the discipline, has at times overstepped its natural scientific bounds, giving rise, in the context of studies of Egyptian mummies, to episodes of 'paleopathological Egyptomania'. This is the case of Pharaoh Akhenaton to whom many illnesses have been attributed, from acromegaly (an endocrinological disease leading to an enlargement of the hands, feet and face due to an overproduction of growth hormone) to temporal

lobe epilepsy (Ashrafian 2012). However, thanks to the anthropological study of the mortal remains attributed to Akhenaton (reigning ca. 1353-1336 or 1351-1334 BC), it has been possible to clarify how none of these diseases were actually diagnosable retrospectively; logically, on epilepsy it is only fair to give the benefit of the doubt since, as the brain is no longer present in the skull, it is not possible to investigate this aspect in detail, as there is also a lack of neurological data that can only be obtained in the living patient (Habicht et al. 2021).

While racking one's brains over Akhenaten's illnesses, real or presumed, can be an idle exercise, it is sometimes possible, again by studying the biographies of great figures in history, to reconstruct how they were affected by diseases that can be re-investigated by analyzing literary sources: the Renaissance warlord Cesare Borgia (1475-1507), for instance, is said to have suffered from venereal syphilis. Although it is proposed by some scholars that this disease was already present in Europe before Columbus's voyages, for now the most probable hypothesis wants syphilis present on the European continent only after 1492, when it manifested itself in a devastating epidemic form (Baker et al. 2020). Even the medical prescriptions of Gaspar Torella (1452-1520), one of the leading physicians of the time, were of no use to the health of the Cesare Borgia. Venereal syphilis is not only still present in our world but is making a disruptive comeback (Tampa et al. 2014; GOV. UK 2022; Frøland 2022).

Clearly, the study of ancient bodies has evolved over time: in the Renaissance until the mid-19<sup>th</sup> century, paleopathological studies were mainly descriptive, inaccurate isolated observations and, above all, pathologies were seen as learned curiosities rather than true sources of medical and scientific information (Aufderheide and Rodríguez-Martín 2011).

From 1850 to 1913 (this phase is called 'genesis of paleopathology'), pathological lesions were observed incidentally by scholars who were curious about the nature of the disease that may have caused them; such an interest always remained, however, in the anthropology of human skeletons (focused mostly on racial origins) in large osteological collections without any epidemiological interest (Aufderheide and Rodríguez-Martín 2011). The period ranging from the Ruffer era to the end of WW2 (1913-1945) saw a disciplinary consolidation taking place and subsequently paleopathology expanded, with new techniques (such as radiology and histology) being more and more applied. In addition, statistics (paleo-epidemiology) started to be introduced. Through this innovation, diagnoses improved and the concept of linking disease to culture drove the emergence of the evolution of paleopathology as a scientific discipline. Among the prominent new techniques featured paleogenetics and its study of aDNA (ancient DNA) as well as the employed methodology became

increasingly standardized. Major paleopathologists of the post-war period include Donald J. Ortner (1938-2012), T. Aidan Cockburn (1912-1981), Eve Cockburn (1924-2003), and Arthur C. Aufderheide (1922-2013).

The Cockburns launched, in 1973, the *Paleopathology Newsletter (PPNL)* and, after a phase in which it was called '*Paleopathology Club*' (meeting in Detroit, Michigan), founded the *Paleopathology Association (PPA)* in 1974. Both institutions still exist today and the discipline continues to grow.

Special attention will be paid in this thesis to the discipline of paleoradiology, whose methods will be applied in a set of papers collected in this cumulative dissertation.

This is particularly evidenced by the role that paleoradiological (or more generally radiological) methods are playing also in the forensic context. It is worth pointing out how the radiological study of osteological injuries may not be optimally achieved despite the collaboration between a medical radiologist and a forensic anthropologist, both experts in their respective fields (Galassi 2022b). There is, as a matter of fact, a further field of research that goes by the name of 'paleoradiology', which can make a valuable contribution to the questions posed to forensic medicine and forensic anthropology in a judicial context (Chhem and Brothwell 2008) beyond the paleopathological realm.

The first X-ray study of human and animal mummies was performed by Walter Koenig (1859-1936) in 1896, but the terms 'paleoradiology' and 'paleoradiologist' were coined much later by Derek N. H. Notman, a radiologist at the Park Nicollet Medical Center in Minneapolis, in his article published in the *American Journal of Roentgenology* in 1987 (Notman et al. 1987).

Although the term 'paleoradiology' etymologically means 'ancient radiology' or 'radiology of ancient items', it is clear that, when used in the context of paleopathology, it defines, without confusion, the applications of radiological tests to bioarchaeological findings (Chhem and Brothwell 2008). The availability of CT scans in the early 1970s and the continued development of computed tomography machines in the following decades provided better visualization of the anatomy and paleopathological lesions in mummies and ancient skeletal remains. Currently, new generations of CT scans with their three-dimensional (3D) and surface rendering capabilities can create a virtual 3D reconstruction of the face or whole body of mummies. These have become extremely useful for anthropological studies and museum displays, and attract enormous media attention, even entering the medico-legal field thanks to the virtopsy technique, a form of virtual cadaveric autopsy (Thali et al. 2003; Dirnhofer et al. 2006).

As noted by R.K. Chhem (Chhem and Brothwell 2008), one of the fathers of modern paleoradiology, many paleopathologists simply end up comparing the radiographs of an artefact with textbook radiological images to establish the final diagnosis, an approach, the latter, that has led to numerous interpretative errors as most radiographic models are non-specific and the differential diagnosis is not adequately discussed. The latter represents, in fact, a fundamental moment in the medical act and in related disciplines such as paleopathology and anthropology, and consists in the process based on the comparison between the signs and symptoms reported by the patient and the signs objectively highlighted by the diagnostic examinations with the aim of excluding some possible diagnoses characterized by some manifestations similar to other diseases but not including the whole clinical picture of the disease triggering the clinical picture for which the patient reports his condition. Thus, at present, the paths of anthropologists and radiologists rarely cross, and the importance of paleoradiology, a discipline in which some anthropologists and paleopathologists on the one hand and radiologists on the other have been increasingly specializing in recent years, has become established (Chhem and Brothwell 2008).

Generally speaking, paleopathology has made it possible to discover how some diseases that are considered modern have actually existed since ancient times. For example, we often hear that cancer or cardiovascular diseases are an exclusive product of the modern world, while they were found in ancient populations (Thompson et al. 2013; Galassi and Varotto 2019).

Cancer has, on the contrary, always existed and not only in the human species, as evidenced by tumour manifestations found in dinosaur fossils and earlier life forms; for example, osteoma, a benign tumour of the bone, was identified in the *Phanerosteon mirabile* (ca. 300 million years ago) (Capasso 2005). Cancer has certainly been present from the earliest times in the human species too, and one has to agree with the scholars who, by analyzing numerous skeletal series from ancient Egypt, have clearly revealed its presence. This has been made possible by morphological and paleoradiological analysis, paleohistological study of tissues and, finally, paleogenetics (Esche et al. 2010).

An additional aspect of paleopathological studies should be addressed, in that not only do they deliver us information on the health status of past populations, but they also inform us on how those conditions would be received at societal level with their consequences in those days.

While nowadays we are unfortunately witnessing, especially on the web, the emergence of antiscientific tendencies which could be summarized with the expression ‘repudiated knowledge and willful ignorance’, historically there existed an even older phase, one in which ignorance and

helplessness when facing diseases were also associated with blaming specific groups of individuals. In fact, the history of poliomyelitis also has a much darker, lesser-known side to it, involving social and cultural aspects. The search for a scapegoat as a rudimentary etiological explanation for disease is a phenomenon as old as the world. Extremely unfortunate in the history of poliomyelitis has been the blaming and guilt-tripping of women, especially nannies, the nurturers predisposed to the care of children. In the Bible (*Second Book of Samuel*), the story is told of the child Mephibosheth [also known as Merib-Bàal], son of Jehoshaphat, son of King Saul, who, on hearing of the military defeat at Mount Gilboa, in which both father and grandfather perished, was rescued by his wet-nurse. In the same passage it is also said that the child was crippled in both feet (Milne 1958). For a long time, before the ancient skeletons and mummies mentioned above were discovered, the story of Mephibosheth was considered the earliest case of the disease, dating from around 900/550 BC. The idea that the lack of care and caution of nurses was at the root of trauma and falls in children, which then led to the paralysis typical of poliomyelitis, would be a mark of infamy on women for millennia. Still in 1892, the theory of the carelessness of nurses was proposed as one of the causes of poliomyelitis by one of the fathers of modern medicine Sir William Osler (1849-1919) in his seminal work *The Principles and Practice of Medicine* (Milne 1958).

Today, almost reversing a millennial trend, scientific publications have emphasized the key role of nurses in poliomyelitis eradication in countries where this disease has claimed many victims (Nkowane et al. 2009).

As far as the discipline's relations and intersections with other disciplines are concerned, it should be highlighted that paleopathology, perhaps much more than other academic subjects, not only uses but also finds its foundation in multidisciplinary. This very special status rightfully places it at the intersection, in a sort of middle ground, between various disciplines, often older and more prestigious ones. These include history, which is fundamental for placing pathologies in the historical context in which they manifested themselves; the history of medicine, which is very useful for assessing the actual degree of understanding of the nature of diseases, as well as the diagnostic and therapeutic strategies at the time in question; archaeology, which is crucial for contextualizing a paleopathological find; philology, to understand the exact meaning of the words used to describe pathologies in a given era; the history of art to assess whether a depiction in a work of art is a plausible pathological sign or an iconographic choice on the part of the artist; numerous specialist medical and biological disciplines, such as normal human anatomy, pathological anatomy (and its sub-branch, histopathology), comparative anatomy, forensic medicine, physical and forensic anthropology,

pharmacology, etc. In recent years, further contributions to paleopathology have been made by disciplines such as botany, entomology, parasitology (Aufderheide and Rodríguez-Martín 2011). Indeed, radiology, histo(-patho-)logy, botany and parasitology are often given the prefix paleo-, resulting in paleo-radiology, paleo-histo(-patho-)logy, paleo-botany and so on.

The correct use of the techniques and methodologies of the mentioned disciplines, always subjected to rigorous historical and archaeological scrutiny, allows for the most complete and accurate paleopathological retrospective diagnosis possible. In this sense, the paleopathologist, irrespective of his or her basic training (in most cases medical, biological, or archaeological) must be ready to confront and make his or her own various methodologies and knowledge from other fields of research and subjects, sometimes very different from his or her initial course of study and not immediately acquired. Often, there is also a need for a real change of perspective from which to observe the phenomena one aims to study, immersing oneself in a new reality and, so to speak, wearing new professional clothes: in this way, the scientist will be able to describe an ancient pathological phenomenon by observing it from different perspectives.

As to the materials investigated in this thesis and, generally speaking, assessed by means of the multidisciplinary studies above described within the paleopathological field, there are three major groups that need to be acknowledged: osteology, mummy studies and indirect sources (literary and artistic evidence) (Rühli et al. 2016). The latter will not be assessed in full in this venue and only some occasional references will be made to it.

Most ancient mortal remains are skeletons, generically referred to as ‘bone remains’ or ‘osteological remains’. This is due to the fact that the skeleton represents the component of the human body most resistant to post-mortal decomposition and diagenetic phenomena (a term that indicates all the chemical, physical and biotic transformative processes that affect bones in the environment in which they lie) (Buikstra and Ubelaker 1994; Mallegni and Lippi 2009). The vast majority of osteological remains comes from archaeological excavations, where they are unearthed by archaeologists, sometimes specializing in bioarchaeology, or better still, assisted by physical anthropologists during recovery operations. A much smaller quantity of skeletal remains is represented by musealized finds, i.e. displayed in dedicated museums, such as the numerous anatomical, anatomo-pathological and medico-legal collections in the historical venues of the world’s oldest universities. Bony remains make it possible to retrieve a wealth of data, sufficient to draw up a biological profile of the ancient individuals to which they belonged and to shed light on some of the pathologies that afflicted them.

When these collections are identified, namely for each skeleton, fundamental information such as sex, age at death, occupation, cause of death, etc. is known, they are not only of descriptive importance, but also make it possible to precisely contextualize the diseases present and to develop anthropological and paleopathological standards useful for comparison with unidentified skeletal remains (Buikstra and Ubelaker 1994; Mallegni and Lippi 2009).

However, as pointed out by the Austrian-born American physician Walter G. J. Putschar (1904-1987), the discovery of traces of skeletal pathologies often does not coincide with the discovery of an individual's cause of death. It may be added that not all diseases primarily or exclusively affect the skeletal system, but rather the internal organs and soft tissues. It follows that, however rich, the amount of data obtained from the study of bones can never provide as comprehensive a picture of the state of health of ancient populations as remains that also preserve soft tissue (Buikstra and Roberts 2012).

The main aim of paleopathology can thus be said to describe the form in which pathologies occurred in past centuries and the overall impact they had on the individual and collective health of ancient populations. Furthermore, by identifying the oldest preserved cases of specific diseases, the discipline aims to describe their origin, chronology and, where possible, the organisms and factors that caused them. Being able, then, to analyze, in addition to single case studies, a copious number of human remains belonging to ancient populations from different times and places, this science provides medical and historical research with a series of epidemiological information, i.e. relating to the frequency with which certain diseases occurred in the past and the particular conditions that favoured or hindered their clinical manifestation (paleo-epidemiology) (Rühli et al. 2016).

In the space of a few decades, this science has rapidly risen from the rank of a mere morphological discipline to that of an eminently technological branch of knowledge. The traditional figures of the physician or anthropologist with a passion for the antiquity of disease have gradually been joined by that of the biomolecular researcher.

This also leads to some forecasts on its future. The paleopathology of the future will necessarily have to make use of the new technologies made available to it, without, however, forgetting the fundamental anatomical-morphological foundations from which, in any case, the analysis must begin and find its justification. Notwithstanding the very important discoveries made by biomolecular techniques, the discipline must never forget to distinguish between the genotype and phenotype of a given pathological condition. For example, to find in a mummy particular genetic mutations typically

associated with the development of cardiovascular conditions nowadays only means that that ancient ‘patient’ would have had the potential to develop certain diseases of that class. This does not mean, however, that he actually developed these nosological entities during his lifetime, i.e. that particular genotype was expressed in its predictable phenotype: only the anatomical-morphological confirmation of the eventual expression allows such a retrospective diagnosis of cardiovascular disease to be made (Rühli et al. 2016; Galassi et al. 2017; Grauer 2018).

The ideal situation, as emphasized in various places in this work, is one in which there is concordance between morphological (anatomical, autoptic, radiological, histological, etc.) and molecular data.

As an additional introductory consideration, it must be stressed that, unlike many other fields of study, paleopathological research is based on ancient findings that are not always easy to access. In fact, it is not uncommon that, once analyses have been carried out on ancient human remains, the competent authorities choose not to grant new permissions to study the same finds unless a new scientific question truly deserving of an answer is posed. This is particularly evident in the case of so-called invasive or minimally invasive examinations, i.e. those analyses that require an autoptic approach and the removal of a certain amount of biological tissue from the remains under study (Mays et al. 2013). This precarious balance between scientific demand and the need to preserve these precious biological materials almost inevitably generates a very high level of competition for the study of the materials between the various research groups, in a sort of grotesque competition for ‘primary resources’ and/or a sort of monopoly on ancient human remains aimed at weakening the competition, which, unable to access the materials, is cut off from the scientific process even in the absence of proven results of value by the monopolistic counterpart.

Scientific research – even and especially paleopathological research – is not, however, a sort of treasure hunt, and the sharing of data among colleagues is essential to allow both the discipline and the profession itself to progress harmoniously and successfully along the road that leads to true knowledge of the subject. Moreover, to this day, the style of a paleopathological study, somewhat as it was for 19<sup>th</sup> century medicine, is still often determined by the particular direction of the different academic ‘schools’. In the years to come, without prejudice to the peculiarities of each researcher and the school to which he or she belongs, it will be essential, especially in Italy, to arrive at a ‘standardization’ of paleopathological study protocols and the formulation of methodological guidelines that are fully shared by most scholars, in order to integrate with the rest of the international community of paleopathologists.



This thesis will focus on cases from the area of the Mediterranean. To define Mediterranean bioarchaeology as a whole would be too complex a task since this geographical region contains several different archaeological and anthropological schools which followed different approaches and prioritized specific research goals through history. With special reference to paleopathological research and the Italian Peninsula, prominent roles have been played by the ‘schools’ of Chieti, Turin, Pisa and Rome, in particular, which have provided national (i.e. Italian) and international scholarship with a compelling description of diseases that not always had already been described in the international record (Fornaciari 2013). This has helped science open a window on past Mediterranean-Italian populations and their health statuses. The work done on the population of Herculaneum, for example, was even able to combine data of paleopathological relevance with information about a mass disaster, the Vesuvius volcano eruption of AD 79 (Capasso 2001). Regarding studies in Sicily – a geographical region which is the main focus for many of the investigations presented in this thesis –, following the tradition of Paolo Orsi (1859-1935), the pioneer of Sicilian archaeology (Calloud 2013), they have focused more on funerary rituals and the ongoing debate on the peopling of the island than on the manifestation of specific pathologies or their frequency.

The combined application of the methods derived from the sciences of biological anthropology and paleoradiology, as well as the approaches and philosophical considerations previously described, will be applied in this thesis to the study of a set of cases and contexts aimed at elucidating the state of health and diseases in ancient individuals whose stories have been contextualized and assessed in a series of publications collected here and presented in the pages that follow.

Finally, the following objectives are set for the present thesis:

- To characterize the occurrence of skeletal anomalies and pathologies in individuals from the ancient Mediterranean region.
- To reconstruct previously unknown biological profiles, whenever possible, also adding key cultural anthropological information, to offer a more comprehensive contextualization of life, disease and death in this important historical and geographical area.

## PRESENTATION OF THE PAPERS COLLECTED IN THE THESIS

This section provides a summary of the papers included in this thesis. For those works which have an official abstract in the original publication that is also reproduced.

**PAPER 1: Varotto, E., P.M. Militello, E. Platania, P. Sferrazza and F.M. Galassi. 2021. Paleopathological study of a podal osteochondroma from the prehistoric Hypogeum of Calaforno (Sicily). *Clinical Anatomy* 34(1);19-23.**

### Abstract

In this article, we report a case of isolated podal osteochondroma from the prehistoric Hypogeum of Calaforno (Giarratana, Ragusa, Sicily). Although the phalanx exhibiting the benign tumoral mass comes from a context featuring several commingled remains, the very good state of preservation of this bone allowed us to perform a comprehensive study of the neoplasm by applying a multidisciplinary approach encompassing archeology, morphology, stereomicroscopy, and radiology. The results from this very ancient specimen have been assessed in the light of the available paleopathological literature and clinical implications currently encountered in modern patients.

**Keywords:** anthropology; clinical anatomy; imaging; osteochondroma; paleopathology; tumor.

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In this paper on which I am the first author, I conducted a multidisciplinary analysis of a foot phalanx retrieved from Chamber 24 of the Prehistoric Hypogeum of Calaforno (Ragusa, Sicily). By complementing morphological investigations, including stereomicroscopy, with X-ray and CT scan imaging it was possible to demonstrate the presence of a podal osteochondroma, a benign tumour (with potential malignant evolution) known in the global paleopathological literature but never described in Sicily. Due to the antiquity of the human remains, relatively dated based on contextual archaeological finds, it also represents one of the earliest known cases of this benign tumour so far and it enriches the global record on this condition. Radiocarbon dating was not possible, unfortunately, because of preservation concerns, but it is known from archaeological data that the Chamber in question is known to have been used for funerary purposes particularly during the Sicilian Early/ Middle Bronze Age (2<sup>nd</sup> millennium BC).

This study has also been recently quoted in the Čavka et al. work on a case of a large pedunculated-type osteochondroma from late medieval Croatia published in the *Journal of Archaeological Science: Reports* (Čavka et al. 2022).

The radiological analysis permitted to clearly define the tumoural mass by distinguishing it from other typologies of bony growth, for which reason a relevant section of the paper is dedicated to a discussion of differential diagnosis, as typical of contemporary medicine and as recommended in methodological paleopathological papers. CT scan images were also used to obtain 3D reconstructions, and a final clinical framing of this condition, particularly in the light of recent literature is offered, with a cautious inference on how this ancient individual may have lived with this foot mass.

Limitations: The Karakostis et al. regression for sex determination has 83.6% accuracy. Had the sex determination not been attempted, treating the phalanx as indeterminate would not have changed its morpho-radiological assessment and description, but the possibility to also determine sex makes this case more defined.

**PAPER 2: Varotto, E., M. Milanese, E. Tognotti, D. Caramella, A. Montella, P. Bandiera. 2020. Klippel-Feil Syndrome in an ancient Sardinian population (16th century AD) – A paleopathological study of four cases from the S. Michele cemetery in Alghero. In: Spani, G. and E. Varotto (eds). *Malattie e medicina tra letteratura, storia e antropologia*, pp. 139-154. Holden, Massachusetts: Quod Manet.**

This paper, written as a multi-authored book chapter in a historico-medical and anthropological edited volume, analyzes four cases of Klippel Feil Syndrome from the Modern Age plague cemetery of Alghero, Sardinia (AD 1582-1583).

Klippel-Feil Syndrome is a rare disorder also affecting the skeleton and highlighted by an abnormal segmentation of two or more cervical vertebrae, hence resulting in a short neck. The condition has been described in the past with cases as old as those found in the Alepotrypa Cave in Greece (Papathanasiou 2005) and attributed to famous historical figures such as Pharaoh Tutankhamun (ca. 1341-ca. 1323 BC) and Alexander the Great (356-323 BC), although in them no sufficient evidence, historical and anthropological could be detected. It was described by two French physicians, Maurice Klippel and André Feil, in 1912.

The cervical vertebrae affected by this congenital anomaly characterized by lack of developmental segmentation are investigated in all cases using an anatomico-morphological approach, while, in one case, an X-ray imaging methodology is applied. The contribution also offers an archaeological contextualization of the investigated burials and also of the techniques used to diagnose KFS in both the modern clinical setting and in past populations. This work represents an extensive contribution which represents the start of a focus on this congenital anomaly, on which I am in the process of finishing a comprehensive paleopathological review.

Limitations: Since this book chapter was designed for a humanities venue, less space was reserved for the anthropological methodological section, while more attention was paid to the paleopathological diagnostic methods.

**PAPER 3: Armocida E., F.M. Galassi, G. Gruppioni, S. Zambruno, E. Varotto, M. Traversari, L. Calcagnile and A. Ruggeri. 2021. Brief communication: The Presumed Skull of Athalaric, King of the Ostrogoths (AD 516-534): Questioning of a Century-Old Attribution and Paleopathological Study. *Anthropologie (Brno)* 59(1);93-96.**

#### **Full text of article**

'ARMOCIDA E, GALASSI FM, GRUPPIONI G, ZAMBRUNO S, VAROTTO E, TRAVERSARI M, CALCAGNILE L, RUGGERI A, 2021: Brief communication: The Presumed Skull of Athalaric, King of the Ostrogoths (AD 516-534): Questioning of a Century-Old Attribution and Paleopathological Study. *Anthropologie (Brno)* 59, 1: 93-96'.

#### **Abstract**

The "Luigi Cattaneo" Museum of Anatomical Waxes of the University of Bologna houses a skull (Figure 1a, 3D virtual reconstruction Figure 1d) labelled as Skull of Athalaric, King of the Ostrogoths (Cranio di Atalarico, Re degli Ostrogoti), which represents the object of the present analysis, aimed at assessing the genuineness of the attribution as well as the health status of this individual. To achieve this goal, a multidisciplinary approach including historical, archival, anthropological, paleopathological, paleoradiological analyses and radiocarbon dating was implemented.

#### **DOI**

<https://doi.org/10.26720/anthro.20.08.05.1>

In this paper, to which I contributed as part of a multi-authored team, a skull attributed to the Ostrogothic king Athalaric (AD 516-534) was multidisciplinary investigated by combining historical, archival, anthropological and paleoradiological methods. Contrary to what the museum of anatomy of the University of Bologna and some local tour guides maintain as a result of a long tradition, the skull does not belong to king Athalaric since he died as an adolescent, while this skull belongs to a male individual with a mean age of 52.5 years at the time of death. The analysis also includes the localization of an ethmoid sinus osteoma with radiocarbon dating indicating an age of AD 1510-1650 with a 68.2% probability, hence making it absolutely impossible, also from a chronological standpoint, that it can really be Athalaric. This work can be regarded as part of a larger reassessment of pathological conditions affecting the Theodorician dynasty, inclusive of a full-length analysis of the *causa mortis* of king Theoderic the Great (AD 454-526).

Limitations: The skeletal analysis and differential diagnosis for the ethmoidal osteoma are limited due to the ‘brief communication’ nature of this paper, which has a lower word count than other article types, and the fact that the skull’s identification (in this case negative) was the article’s primary goal. With respect to this, potential pathologies linked to the deranged life habits reported in the sources for king Athalaric were considered but none of them was identified (dentoalveolar or diabete-related alterations compatible with an adolescent/young adult individual).

**PAPER 4: Galassi, F.M. and E. Varotto. 2021. Brief Communication: The alleged shoes of Michelangelo Buonarroti: anthropometrical considerations. *Anthropologie (Brno)* 59(1);97-99.**

This article investigates the stature of the Renaissance genius and artist Michelangelo Buonarroti Caprese (6<sup>th</sup> March 1475 – Rome, 18<sup>th</sup> February 1564). Since Michelangelo’s mortal remains are buried in the Basilica of Santa Croce in Florence, no analysis of them can take place, hence all considerations about his bodily features and pathologies are to be inferred – with understandable limitations caused by the indirect or partial nature of such sources – from his own works of art, poetry, letters, and objects he used throughout his life.

In 2018, my coauthor and I had the unique opportunity of visiting the Casa Buonarroti Museum in Florence (Fig.1), which houses a set of items that belonged to Michelangelo himself and his descendants, being granted the possibility to investigate, amongst other things, three shoes that, based on archival record and tradition, appear to have belonged to him. Radiocarbon dating was not permitted due to conservatorial concerns but, thanks to the help of history of fashion expert Dr Elisa

Tosi Brandi, Adjunct Professor at the University of Bologna, we could determine that the shoe was compatible with the era in which Michelangelo lived.

After this initial historico-archival-stylistic assessment, the shoes were measured and the individual's stature was estimated using the Uhrová et al. formulae with regression equations, yielding an average of 160 cm, compatible with body height of Tuscan populations of that time and confirming his Vasari's description. The study received international media attention, including the *Smithsonian Magazine*.

After this paper, I additionally co-authored a paper on some pathological aspects attributed to Michelangelo, in which my coauthors and I downsized the hypothesis that he really suffered from goitre (Martini et al. 2021).



*Figure 1: A photograph showing me, the undersigned candidate, inspecting the shoes and preparing for their measurement in the Casa Buonarroti in Florence (image taken by F.M. Galassi with his own camera, with his permission to reproduce it here).*

Limitations: This brief article focuses on this specific historical personage and is not meant to examine the anthropological problem of reconstructing past individuals' biological profiles from items belonged to them. I also acknowledge that the use of the expression 'biological traces' used in this paper may not be chosen by all anthropologists and bioarchaeologists working in the field. By that my coauthor and I meant that in this case we are speaking of real objects that reflected anatomical characteristics of specific individuals and we are not dealing with very indirect evidence such as literary mentions of diseases or pictorial representations that may well contain in them pathological details but are mediated through an artistic form of expression. Moreover, leather is a biological product.

**PAPER 5: Varotto E., M.T. Magro, R. Brancato, C. Lubritto, L. Memeo and F.M. Galassi. 2019. Unique Osteoid Osteoma of the Frontal Sinus from the Late Roman Empire. *Journal of Craniofacial Surgery* 30(4);965–966.**

This article, published in the specialized biomedical venue *Journal of Craniofacial Surgery*, presents the first – so far known – case of osteoid osteoma of the frontal sinus discovered in a skeleton from Pianotta di Calatabiano, Catania, Sicily. That anatomical location is only known to occur for this benign tumour in a very limited number of cases in the contemporary world and, until the time this study was published, no such cases had been reported in the medical and paleopathological literature. The study represents a collaboration between various specialties, ranging from archaeological considerations to anatomical, paleoradiological (X-Ray, CT scan imaging and 3D reconstructions) and paleohistological examinations. The tumour is discussed contextually with other lesions found in the same frontal sinus (particularly chronic sinusitis) and clinical considerations on this ancient individual are made. The study received extensive media attention in Italy.

Limitations: I acknowledge that the expression 'ancient patient' may not be used or accepted by all fellow paleopathologists in the field. Be it clear, nonetheless, that by that my coauthors and I did not mean 'an ancient patient under examination today', instead we limited our word choice to the very Latin meaning of the word 'patient', he/she who suffers/bears (from *patior*, 'I suffer/bear'). A term widely used in medicine across all ages that can reasonably be applied to paleopathological studies, too. In addition, this condition developed into a chronic problem for this ancient individual, who could not find any remedy against it, which would instead be possible today. For this reason, the notion of bearer of a pathological condition also appears justified.

**PAPER 6: Galassi F.M. and E. Varotto. 2020. Ancient Greece and mummies: the primacy of the soul over the body' In: Shin, D.H. and R. Bianucci (eds.) *The Handbook of Mummy Studies*. Springer, Singapore, pp. 1-6.**

**[https://link.springer.com/referenceworkentry/10.1007/978-981-15-1614-6\\_54-2](https://link.springer.com/referenceworkentry/10.1007/978-981-15-1614-6_54-2)**

This contribution, part of a book chapter in D.H. Shin's and R. Bianucci's prestigious volume *Handbook of Mummy Studies* (published by Springer), examines the topic of mummies in Ancient Greece, or to be more precise how the ancient Greeks viewed mummies and the very concept of it (considering the long-established relations with the nearby kingdom of Egypt) in light of their own culture, religion and customs. By examining ancient historical sources, including the philosopher Plato, together with my coauthor I explored the ancestral fear the Greeks had for the corpse and why they favoured the concept of the immortality of the soul over that of the physical immortality of the soul's cage, the body. In this topical paper, we also consider the written accounts on what appears to be an exception to the aforementioned 'rule', that is the preservation of bodies of ancient Spartan kings in honey, highlighting how this was merely a temporary solution to avoid the rapid putrefaction of corpses that were destined to receive funerary rituals at distant places to which they had to be transported. The paper combines considerations that followed the methods of mummy studies and biological anthropology with a study of the historical sources.

Limitations: I realize that this paper is more of a review and touches on aspects that are more anthropological than physical ones, yet I have chosen to include it in this selection of publications because throughout this thesis I have adopted a global approach to the description of pathologies and health in general, hence it is important to highlight the preservation modality of human remains for certain ancient Mediterranean societies instead of others. This appears relevant if one thinks of the many more reports of soft-tissue pathology coming from Egypt (and Egyptian mummies) and the much more limited record for Greece and geographical areas with a similar mindset.

**PAPER 7: E. Varotto. 2021. Congenital Anomalies of the Spine from the Prehistoric Hypogeum of Calaforno (Ragusa, Sicily, Italy). *Acta Palæomedica. International Journal of Palæomedicine* 2;47-54.**

This study examines the skeletal anomalies found in the osteological remains retrieved in Chambers 26, 27 and 29 of the Prehistoric Hypogeum of Calaforno (Giarratana, Ragusa, Sicily) – used for



funerary purposes, particularly from the Late Eneolithic (2600-2300 BC) to the Middle Bronze Age (1450/1400-1250 BC), but later used in various ways, for example as a sanctuary, a shelter, etc. until the definitive abandonment of the site in the 11<sup>th</sup> century AD. Both morphological and paleoradiological examinations were performed. In Chamber 26 (stratigraphic unit 14), a spondylolysis could be found in an L5 vertebra; in Chamber 27, instead, a case of sacralization of the coccyx; in Chamber (stratigraphic unit 1), a case neural arch on a lumbar vertebra was detected, which is a congenital defect that prevents the closure of the posterior arches. This study enriches our knowledge on the most ancient congenital anomalies on the island of Sicily, a topic considered to be of primary importance by contemporary paleopathology.

Limitations: While many etiologies are described for congenital anomalies, there does not exist a broad range of differential diagnoses, hence their morphological presentation directs a researcher to their identification. Additionally, these remains from Calaforno are commingled, thus it cannot be known whether those individuals were characterized by more anomalies potentially constituting a syndrome or it was just isolated manifestations.

**PAPER 8: Ingolia C., F.M. Galassi and E. Varotto. 2020/21. Una sepoltura medievale da Troina (XIII secolo): approcci multidisciplinari per la ricostruzione della storia del sito. *Cronache di Archeologia* 39;13 pp.**

This contribution, published in the archaeological journal *Cronache di Archeologia* (Edizioni Quasar, University of Catania), systematically examines the excavation, taphonomical, anthropological and paleopathological aspects of Tomb 15 from the Medieval site of Troina in Sicily. By combining archaeological rationale, traumatological considerations and paleoradiological imaging, pathological alterations including rhizarthrosis (also known as trapeziometacarpal arthritis) are demonstrated.

Limitations: The article was originally published in Italian; hence an English-language translation was prepared by the undersigned candidate and has been made available in this thesis.

In addition, to furnish more details on this excavation and the scientific background to the research discussed in the previous paper, I attach the text of ‘note from the field’, recently submitted to the *Newsletter of the Paleopathology Association (PPA-PPLN)*. This contribution is not meant to be added to the list included in the present thesis but simply serves the purpose of offering more details

and context on the research at Troina, which features in two articles of this body of work (articles 8 and 9).

**Text of ‘note from the field’ submitted to the Editor of the PPLN, Dr J. Marla Toyne  
(published in the Sept. 2022 Issue)**

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**PAPER 9: Varotto, E., L. Zurla, F.M. Galassi and C. Ingoglia. 2021. The earliest known Italian case of bilateral non-osseous calcaneonavicular coalition from the mediaeval cemetery of Troina (Enna, Sicily). *Archaeological and Anthropological Sciences* 13, 154. <https://doi.org/10.1007/s12520-021-01427-9>**

Original Paper | [Published: 23 August 2021](#)

## The earliest known Italian case of bilateral non-osseous calcaneonavicular coalition from the mediaeval cemetery of Troina (Enna, Sicily)

[Elena Varotto](#) , [Lorenzo Zurla](#), [Francesco M. Galassi](#) & [Caterina Ingoglia](#)

[Archaeological and Anthropological Sciences](#) 13, Article number: 154 (2021) | [Cite this article](#)

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### Abstract

In this article, we detail a case of tarsal coalition in the osteological remains of an adult female individual from the mediaeval cemetery of the Catena district of Troina (Enna, Sicily). The burial that contains the skeleton described in this work (*Burial 2*) was subjected to a multidisciplinary analysis starting from the excavation on the field and ending with a full palaeopathological study including palaeoradiology and 3D virtual reconstructions. The obtained results contribute to our understanding of this congenital condition in the past and present, to the best of our knowledge, the first case ever reported from Sicily and the Italian peninsula of bilateral non-osseous calcaneonavicular tarsal coalition.

This article details a case of bilateral nonosseous calcaneonavicular coalition discovered in the skeleton excavated from Burial 2 of the Medieval cemetery of Troina (Enna, Sicily). A multidisciplinary analysis starting from the excavation in the field and completed with a full paleopathological study inclusive of paleoradiology and 3D virtual reconstructions. The results obtained through the various steps of the study were also assessed in the context of a review of the literature on this congenital anomaly in the paleopathological record. In addition, this case represents the currently earliest known incidence of this condition in Sicily and in the Italian peninsula.

**PAPER 10: Moraes, C., E. Varotto, M.E. Habicht, F.D. Pate and F.M. Galassi. 2020. Facial reconstruction of the mummy Cairo CG 61076 from the Royal Mummies Cachette DB 320. A princess from the late 18th Dynasty? In: Habicht M.E. (ed). *Under the Seal of the Necropolis*, Vol. 6, Berlin: Epubli, pp. 11-24.**

This book chapter, to which I gave a significant contribution particularly with the anthropological assessment, multidisciplinary investigates the ancient Egyptian mummy Cairo CG 61076 that was found in the royal cachette of Deir el-Bahari (DB 320), also labelled as Baqt. The existing literature has been reinvestigated in the light of contemporary knowledge in the fields of Egyptology, archaeology and bioarchaeology. From a morphological examination and thanks to contextual chronological elements, it was possible to link it to the 18<sup>th</sup> dynasty, potentially being a daughter of Akhenaton and Nefertiti or the enigmatic princess Baketaton, the youngest daughter of Pharaoh Amenhotep III and the royal great wife Tyi. By re-analyzing published photographs of the Cairo CG 61076 skull and assessing the available anthropometric data, we also reconstructed the ancient individual's face using sophisticated computer software in close collaboration with co-author and forensic artist Cicero Moraes. The study attempts to give a face to an ancient unknown individual and to shed light on who this person might be in the royal Egyptian court.

Limitations: My coauthors and I had no access to the mummy remains and had to work with published data, but we were still able to generate certain biological-profile information.



## DISCUSSION

Health is currently defined by the World Health Organization (WHO) as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’, a definition which additionally highlights that ‘the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition’ (WHO 1948). This all-encompassing definition is very much close to the etymology of the word ‘health’ itself, which, through its Old-English predecessor *hǣlþ*, comes from the reconstructed Proto-Germanic form *\*hailitho* and the Proto-Indoeuropean *\*kailo-*, carrying both the idea of ‘wholeness’ and of ‘health’ (Online Etymology Dictionary 2018), hence meaning that a real state of health cannot be limited to the determination of the absence or presence of a pathological condition.

This definition highlights the complexities associated with the determination of past states of health in ancient populations – in this thesis populations and individuals from the Mediterranean Basin area ranging from prehistoric societies to more advanced 16<sup>th</sup> century urban dwellers – and how much information is already lost due to the passing of time when an anthropologist or paleopathologist assesses ancient human remains. For this reason, while a holistic, WHO-like enunciation of health for ancient populations may seem impossible to achieve, a comprehensive multidisciplinary analysis of the available osteological, and, more generally, anthropological, sources of information should be sought for as this can actually yield very important data capable of helping scholars understand the puzzle of ancient health and disease.

The area of the Mediterranean Basin proves to be particularly apt for this task in that it, over the time span of thousands of years, it hosted an incredibly high number of ancient societies and civilizations, constantly interacting with one another, be it in the form of warfare or peaceful relations, through commerce and the spread of ideas or via religious conflicts and ideological opposition (Tusa 2017). Talking about the Mediterranean and the Greeks living along its shores, the Greek philosopher Plato (428/427-348/447 BC) in his work *Phaedo* has his mentor Socrates (470/469-399 BC) say (*Phaedo* 109a-b): ‘I believe that the earth is very large and that we who dwell between the pillars of Hercules and the river Phasis live in a small part of it about the sea, like ants or frogs about a pond, and that many other people live in many other such regions’ (Plato 1966). Archaeologist Sebastiano Tusa (1952-2019) further stressed the role of the Mediterranean as a most

important milieu for archaeological and (we shall add) bioarchaeological studies by underlining that sea's unique role and following in the footsteps of British historian David S. H. Abulafia (b. 1949) who had described the Mediterranean as the most dynamic place of interaction between diverse societies on the face of planet, hence in Tusa's words we are talking about 'a sea where everything is in flux, and rather than abstract identities, the strong individualities that have forged events and environments stand out' (original Italian: *un mare dove tutto è in divenire e più che le astratte identità spiccano le forti individualità che ne hanno forgiato eventi ed ambienti*) (Tusa 2017).

Moreover, Tusa (2017) also compared the Mediterranean to a sculpture by the French Dadaist artist Hans Arp (1887-1966) which consisted of 'a large block of stone carved to represent two large rounded wedges or axes inserted symmetrically on each other along the long side. The two elements had an enlarged front that ended like the slash of an axe. The back part, considerably reduced in size, was, on the other hand, truncated' (It. *un grande blocco di pietra scolpito in modo da rappresentare due grandi cunei o asce arrotondati ed inseriti simmetricamente l'uno sull'altro lungo il lato lungo. I due elementi avevano la parte anteriore allargata che terminava come il fendente di un'ascia. La parte posteriore, notevolmente ridotta dimensionalmente era, invece, tronca*). This shape gave the author the impression 'of an immense but concluded universe; of something strongly projected towards infinity but at a certain point finite; of a prodigious and unstoppable force but at a certain point exhausted' (*l'impressione fu quella di un universo immenso ma concluso; di qualcosa di fortemente proiettato verso l'infinito ma ad un certo punto finito; di una forza prodigiosa ed inarrestabile ma ad un certo punto esaurita*), a graphic metaphor which well explains the diversity and compactness at a time of this complex and fascinating environment (Tusa 2017). In Tusa's reflection, the island of Sicily, the final or temporary destination of many seafarers through history, exemplified the multi-layers and multi-cultural elements of the Mediterranean, with logical consequences also for the study of phenomena like health and disease.

The present study, illustrated by this collection of publications, has attempted to score this very goal by offering a rational workflow of techniques ranging from classical morphological approaches to paleohistological ones, and, as mentioned in the introductory section, paying a great deal of attention to the pivotal diagnostic role played by paleoradiological investigations (Hoffman et al. 2002; Chhem 2006), which have been applied to the majority of case studies shown in this venue. Their implementation has been particularly effective when determining the nature of the Late Roman era osteoid osteoma found in the frontal sinus of the investigated skeleton, in that it allowed for a precise identification of characteristics known both in the paleopathological and modern medical literature

to be associated with this benign tumoural form (Greenspan 1993). This preliminary – yet quite high-end – piece of diagnostic information has thus scientifically justified the need of an invasive paleohistological study which has finally demonstrated the previously stated evidence. Similar considerations can also be expressed in the two cases from the Medieval necropolis of Troina, especially in the assessment of the earliest known Italian case of nonosseous bilateral calcaneonavicular coalition, which featured the first ever use of CT scan for the study of such a congenital anomaly, while, before that, only external morphological studies and conventional radiography had been implemented (most notably in the assessment of the case of the famous Kennewick Man, Case and Burnett 2012).

The cases examined come on many occasions from the *Sicily Paleopathology Project*, co-headed by the undersigned candidate, and investigated by the team of the *FAPAB Research Center*, which as of 2022 counts 18 bioarchaeological sites under scientific study. This project particularly allows for the multidisciplinary implementation of the set of techniques, prominently paleoradiological ones, highlighted above.

In its first stages, the *Sicily Paleopathology Project* aims to detect and publish pathological cases after an initial screening of the necropolis under study – a good number of instances having already been issued and some included in this thesis, while the longer term goal, based on data still unpublished or soon to be released, is to statistically describe these populations' state of health and disease and to relate to contemporary trends derived from modern medical studies in Sicily.

Comparable results, from the methodological perspective, have been achieved in the assessment of Klippel-Feil syndrome where radiology matched the externally visible anatomical presentation in one of the most complex cases of the analyzed series of cervical vertebrae (hence excluding other potential cases of adult-life fusions happening instead of congenital lack of segmentation) or in the assessment of the skull attributed to king Athalaric, which also helped to characterize this skull paleopathologically thanks to the demonstration of an ethmoid sinus osteoma (Pons et al. 2013; Frikha et al. 2020).

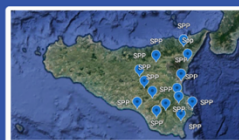
Based on these considerations, a graphic workflow (Fig.2; images from skeletal cases by the undersigned candidate) is offered to describe the procedure implemented in the here collected publications.

# Adopted workflow

Aim: tracing health and disease in ancient human remains in Sicily (Italy).

## Search

Searching for necropolises or cemeteries suitable for the 'Sicily Paleopathology Project'.



## Authorizations & ethics

Obtaining the necessary authorizations from the local Superintendence and agreeing on the research steps (non-invasive VS invasive approaches).



## Preliminary operations

Cleaning the bones, restoration, labelling, laying them in anatomical position.



## Morphological study

Anthropological and paleopathological assessment.

Data collected using standardized methods.



## Paleoradiology

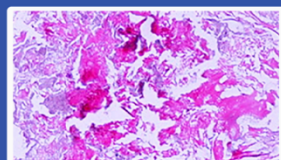
X-Ray and CT Scan imaging. Virtual 3D reconstruction.

> Non-invasive analyses.



## Paleohistology, isotopic analyses, aDNA

When the scientific question is justified, these invasive steps can be considered.



## Outcomes

Reports sent to the Superintendence.  
Conference presentations, scientific publications.  
Third mission > communication to the public.



Figure 2: Adopted workflow for the osteological material. Chart by the candidate made with CANVA.

An example of this workflow can be seen in the evaluation of a series of spinal congenital anomalies from the Calaforno hypogeum, a prehistoric Sicilian site, in which, however, the first, preliminary step was represented by the necessity to rationalize the commingled remains found therein, for example by determining the general state of preservation of the remains and the minimum number of individuals (MNI), while other ongoing papers on this topic, not included in this thesis, focus on the hypogeum's taphonomy, funerary rituals and all the retrieved pathologies (Varotto and Galassi 2021; Varotto 2023).

This approach finds a solid confirmation in the international paleopathological literature. With reference to the Italian paleopathological bibliography, it is worth recalling the study of the castrato singer Gaspare Pacchierotti (1740-1821), exhumed in 2013 and subjected to a set of analyses in which the use of computer tomography (CT scan) proved extremely important in showing pathological and, above all, occupational markers that helped reconstruct this individual's history and physical alterations induced by his personal hormonal condition and specific work (Zanatta et al. 2016), adding many more data than those previously known thanks to the (prominently morphological, partly radiological) analysis of another castrato singer, known as Farinelli (1705-1782) (Belcastro et al. 2011).

While mostly focused on unpublished skeletal material subjected to the aforementioned investigations, the present thesis also partly stresses the importance of non-osteological sources when trying to obtain certain set of information about ancient individuals, as exemplified by the study of the shoes attributed to Michelangelo Buonarroti, from which, by applying anthropometrical formulae (see details in the paper), it was possible to estimate their owner's stature, shown to fit the range of the historical Tuscan populations of the time (Giannecchini and Moggi-Cecchi 2008).

To this set of papers also belong the one on the status – and the very notion of – mummies in the ancient Greek world, which starting from potential Mycenaean, Schliemann-conveyed mentions assessed how Greek philosophers and thinkers favoured the preservation of the soul over that of the mortal body (Lorenz 2009), hence indicating how themes traditionally ascribed to biological anthropology can also expand their boundaries and rightfully enter the humanities and their debates in the fields of cultural anthropology and philosophy alike.

## CONCLUSION

This thesis, focused on a set of published studies based on ancient Mediterranean human remains, demonstrated the feasibility of a rational implementation of a research workflow that can be optimal in the acquisition of data of the utmost relevance while attempting to determine the existence and presentation of pathological conditions in the past, both at the population and individual levels. Population level applications included the description of four cases of Klippel-Feil Syndrome in Modern-Era Sardinia, and the analysis of commingled remains from the prehistoric Sicilian context of Calaforno. Cases at the individual level involved in-depth investigations aimed at diagnosing ancient diseases where the use of standard methods from physical anthropology alone could not have provided full descriptions, but simply a partial visualization of past disease patterns.

Moreover, case-studies such as shown by the two papers on individuals from the Medieval site of Troina, but also thanks to the multimodal assessment of the case of frontal sinus osteoid osteoma from the Late Roman necropolis of Pianotta di Calatabiano, without forgetting the negative identification of a skull wrongly attributed to the Ostrogothic king Athalaric, a substantial advancement in the diagnostic workflow and overall precision was achieved by implementing the use of radiological techniques including the realization of 3D models, which are both useful in the assessment of anatomical features and also help preserve a volumetric digital copy of skeletal remains that are inevitably doomed to decay over time, in spite of the best attempts to preserve them. The continued, constant and large-scale application of paleoradiological approaches to the study of human remains since, albeit almost universally welcome by scholars in the fields of anthropology and paleopathology, cannot still be said to be routinely implemented, often resulting in morphology-only based diagnoses or genetics-driven sampling sessions prior to the digitalization of the said human remains under investigation. In addition, case-studies such as the anthropometric reconstruction of the stature of Michelangelo Buonarroti from shoes attributed to him, the evaluation of the views on the preservation of bodies after death and on mummies by one of the Mediterranean civilizations with the longer influences on ideas and culture for centuries to come, i.e. the Greek one, allow us to see how broader the boundaries of anthropological research can become if traditional study methods are linked with historical sources and cultural anthropological ones, hence merging notions derived from the humanities and the so-called ‘hard biomedical sciences’, enabling researchers to gain a much more precise picture of the past of humankind and its health status.

Furthermore, the study of ancient Egyptian human remains and creation of a facial reconstruction based on a previously published report highlights the importance of applying anthropological and paleopathological methodologies not only to direct sources that can be assessed via a traditional hands-on analysis, but also to data that were collected with now outdated methodologies but can still be utilized and processed using more advanced approaches and more modern procedures, hence making the most of what is available especially in geographical contexts where the request of a new investigations may not be particularly easy or viable at all.

Finally, this work circumscribed to a set of cases from a definite part of the world aims to highlight the absolute relevance of the combination of traditional anthropological methods with state-of-the-art paleoradiological (and paleohistological) techniques and proposes that, on the account of the achieved results, it be systematically adopted. Additionally, future research aimed at bridging traditional and current methods may not only better elucidate past living conditions (the first goal for such studies) but also play a key role in the longstanding debate between invasive and non-invasive studies, still open to multiple schools of thoughts and conflicting interpretations.

In conclusion, all the data obtained from the described studies demonstrate that ancient Mediterranean populations experienced diseases which are still in the focus of current health policies and biomedical research such as tumours or congenital disorders. This can help to expand our knowledge and understanding of the paleopathological record from this region. In addition, having added some cultural anthropological aspects to the work, a comprehensive contextualization has been offered.

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## **APPENDIX**

Here follow the ten papers included in this thesis.

## ARTICLE LINKS

Links to the articles included in this thesis are given because their pdf versions are protected by copyright, hence they cannot be made publicly available through this thesis.

The full version of the thesis consists of 152 pages.

1. <https://onlinelibrary.wiley.com/doi/10.1002/ca.23603>
2. <https://quodmanet.com/01.malattie-e-medicina.html>
3. <http://puvodni.mzm.cz/Anthropologie/article.php?ID=2320>
4. <http://puvodni.mzm.cz/Anthropologie/article.php?ID=2290>
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6. [https://link.springer.com/referenceworkentry/10.1007/978-981-15-3354-9\\_54](https://link.springer.com/referenceworkentry/10.1007/978-981-15-3354-9_54)
7. <https://www.torrossa.com/en/resources/an/5350368>
8. <https://edizioniquasar.it/products/cronache-di-archeologia-39-2020>
9. <https://link.springer.com/article/10.1007/s12520-021-01427-9>
10. [https://books.google.it/books/about/Under\\_the\\_Seal\\_of\\_the\\_Necropolis\\_6\\_First.html?id=4zIEEAAAQBAJ&redir\\_esc=y](https://books.google.it/books/about/Under_the_Seal_of_the_Necropolis_6_First.html?id=4zIEEAAAQBAJ&redir_esc=y)