Overcoming Issues of Past Preservation: Recent Research in Bioarchaeology in Cyprus

Workshop hosted by the Department of Bioarchaeology of the Austrian Archaeological Institute of the Austrian Academy of Sciences, 3–4 September 2018, Vienna

Michelle Gamble (ed.)

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Content

Foreword

It is with great pleasure that I foreword the publication of the proceedings of the workshop »Overcoming Past Preservation lssues: Current Research in Cyprus Bioarchaeology« hosted by the Austrian Archaeological Institute of the Austrian Academy of Sciences, in Vienna, on the 3rd and 4th of September 2018.

During the last decades, we have witnessed great advances in molecular archaeology, with the input of new-age technological tools and innovate methodological approach. One of the disciplines greatly benefited from these scientific leaps is bioarchaeology as, progress in genetic and biochemical analysis have made it possible to decipher hidden until now aspects of past population lives, allowing us unique insights into topics such as migration patterns, diseases and epidemics, diet and social differentiations and many more.

As a result, the traditional bioarchaeological approach is now enhanced to the point where the stories of people that lived hundreds of years ago unfold in such precision that they become easily relatable to our own, bridging the gap between the past and the present, and connecting us closer to our ancestors.

Indeed, the Department of Antiquities records further confirm this rapid growth of interest in studying osseous collections, from individual researchers and academic institutions in Cyprus and abroad. The inclusion of relevant chapters in publications and peer-reviewed articles has become the norm when dealing with newly-excavated sites, and it is greatly gratifying to witness the scientific community's urge to re-examine and re-evaluate past excavations in the island.

This workshop provided a unique opportunity for bioarchaeology experts to directly communicate on their research approach, sharing their knowledge and experience in working with Cypriot skeletal collections. It was satisfying to note that the programme covered such a diverse range of interesting topics such as attempts to overcome issues of bad preservation, application of new methods, current research trends, analysis of osteological collections derived from new excavations and new approaches to old collections. Most importantly, it laid the foundations for the creation of a common scientific platform, one that I especially look forward to see repeat.

Overall, I would like to praise the organising committee for the initiative of assembly this workshop, and congratulate all those who worked hard and have contributed to it.

Marina Solomidou-Ieronymidou
Director of the Cyprus Department of Antiquities
Lefkosia, April 2019

Introduction

Michelle Gamble

Human remains provide the primary resource for understanding the lives and lifeways of past people and populations. Due to preservation issues of skeletal tissue in Cyprus, studies of archaeological human remains have been slow to gain appropriate recognition for their informative possibilities within the overall archaeological record of past populations. However, with advances in the theory and methods of osteological analysis and improved excavation methodologies and practices due to increased awareness of the importance of human remains to the archaeological record, the opportunity to provide comprehensive bioarchaeological research is now possible. Thus, it seemed timely to bring together scholars who are working in Cyprus on human skeletal material from the past, and to present this information in a synthetic volume. This publication stems from the workshop hosted by the Department of Bioarchaeology of the Austrian Archaeological Institute of the Austrian Academy of Sciences, sponsored by Holzhausen Verlag, on the 3rd and 4th of September 2018 in Vienna, Austria. The workshop invited a range of international researchers, along with members of the Department of Antiquities of Cyprus, to present their current work and methodological approaches, and to discuss future strategies on how the application of improved techniques could be used to explore the full potential of human remains. It is hoped that as Cyprus is geographically central to the Eastern Mediterranean region, it can also become central in the analyses of human remains from the past to inform on a variety of research questions, including those exploring living conditions, population structure, and migration in ancient times.

Bioarchaeology provides an interpretive framework for contributing to our understanding of past populations through their human biological remains[1]. An easy definition of all that bioarchaeology includes is not readily available as it encompasses a range of methods, techniques, and theoretical approaches[2]. J. E. Buikstra defines »bioarchaeology« as focusing on the »reconstruction of human histories with emphasis on anthropological problem-solving and the integration of archaeological data«[3]. This approach is multi-disciplinary, encompassing human osteology, funerary practice and social organisation, daily activities and division of labour, palaeodemography, population movement and genetic relationships and diet and disease[4]. It is within this definition that we find the studies within this volume, though the methods and approaches vary considerably.

While there is a long history of physical anthropology on Cyprus, and some of the roots of the bioarchaeological framework can be seen in the work of J. L. Angel on Cyprus, who discussed biological change in the context of historical and cultural change[5], unfortunately, the great potential of human remains in problem-oriented bioarchaeological research has only been realised in

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1 Larsen – Walker 2010; Roberts 2006, 438; Roberts 2010.

2 Buikstra – Beck 2006, 18 f.; Larsen 1997, 3. It must be noted here that for this volume, »bioarchaeology« refers exclusively to research involving human remains. While in some areas, bioarchaeology refers to any research which places biological material at the centre of problem-oriented archaeological questions, such as archaeobotany and archaeozoology, we are using the definition given by J. E. Buikstra.

3 Buikstra – Beck 2006, 19.

4 Buikstra 1977, 67.

5 Angel 1966; Angel 1972; Angel 1978; Harper 2008 – for a synopsis on early anthropological work on Cyprus, see Harper – Fox 2008 and Lorentz 2011.

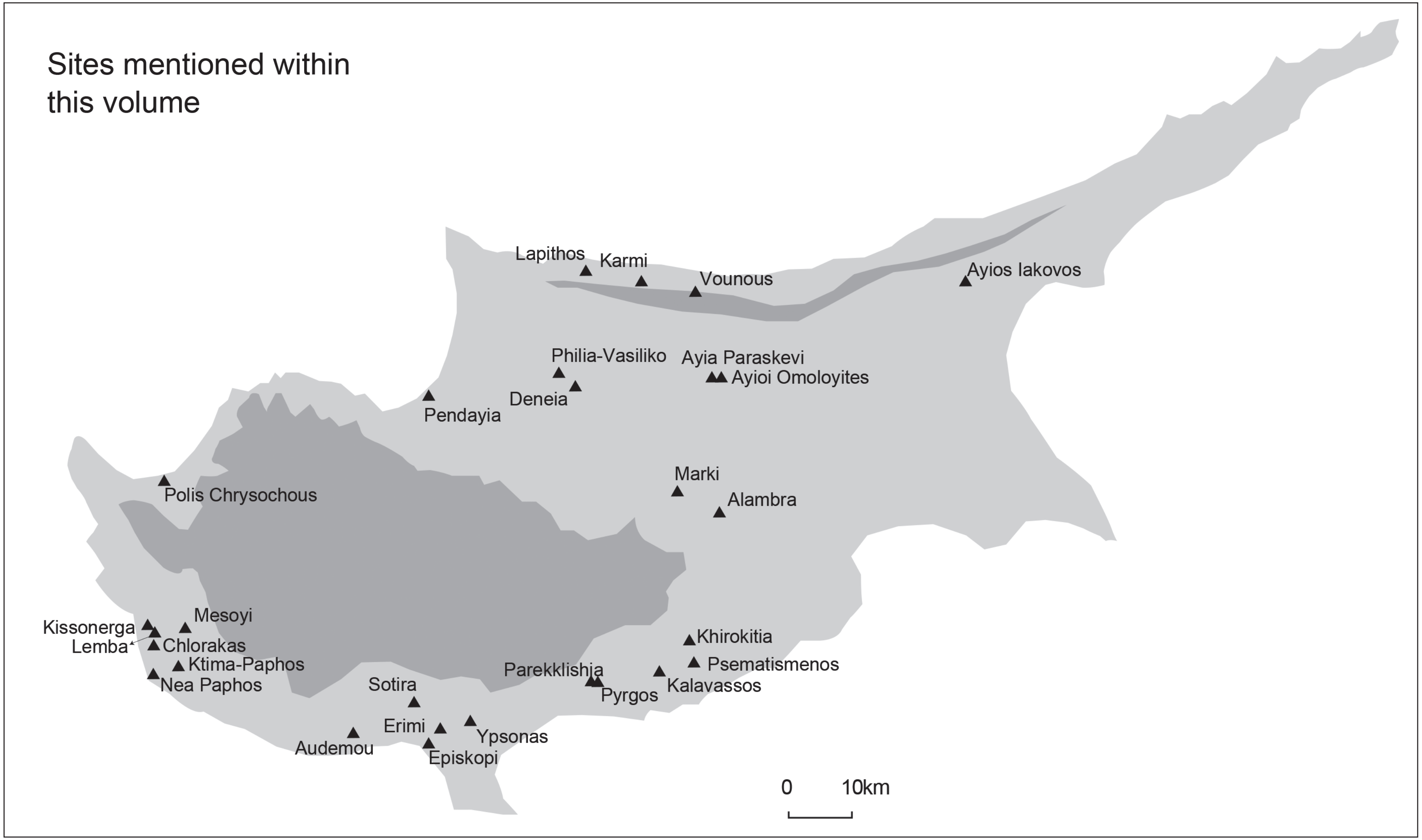

Fig. 1 Map of Cyprus with sites listed in the volume (Note that it is the local town, which is recorded on the map. Therefore, for example, Kissonerga relates to the location of Kissonerga-*Mosphilia*, *Mylouthkia* and *Skalia*, and Kalavassos refers to both the Bronze Age village and nearby Neolithic site of *Tenta*) (map adapted by M. Gamble)

Table 1 Chronology of periods in Cyprus, taken from the Department of Antiquities website (<http://www.mcw.gov.cy/mcw/da/da.nsf/DMLchtable_en/DMLchtable_en?OpenDocument> [17.02.2021])

Cultural/Technological period	Chronology
Pre-Pottery (Aceramic) Neolithic	10th–6th millennia B.C.
Ceramic Neolithic	5500–3900 B.C.
Chalcolithic	3900–2500 B.C.
Early Bronze Age	2500–2000 B.C.
Middle Bronze Age	2000–1650 B.C.
Late Bronze Age	1650–1050 B.C.
Geometric	1050–750 B.C.
Archaic	750–475 B.C.
Classical	475–312 B.C.
Hellenistic	312–58 B.C
Roman	58 B.C. – A.D. 395
Early Christian	395 – mid 7th century A.D.
Byzantine – Arab raids	mid 7th century – A.D. 965
Byzantine	A.D. 965–1191
Frankish	A.D. 1191–1489
Venetian	A.D. 1489–1571
Ottoman	A.D. 1571–1878
British	A.D. 1878–1960

Cyprus over the last twenty years[6]. Current research is embracing the bioarchaeological approach with vigour and a diverse range of interests, some of which are presented within this volume.

Broadly, the topics discussed within the workshop can be divided into three main areas of research – methodological approaches (D. Aristotelous, S. Douglas and N. Herrmann et al.), insights from digital microscopy and isotopic data (F. Le Mort et al.), and palaeopathological analyses representing lifeways and experiences (B. Baker, M. Gamble, G. Ioannou and M. Monaco). Further to this, discussions around collagen and DNA preservation were central to the workshop, as biomolecular and isotopic research is becoming increasingly important in the analyses within bioarchaeological studies. Additional techniques, such as digital microscopy and synchrotron analyses were presented and discussed as other options for non-destructive research. Finally, the applications of bioarchaeology within areas of tourism and education in Cyprus were explored, and the need for more public outreach was raised. The papers within this volume do not represent a comprehensive reflection of all the bioarchaeology work being conducted on Cyprus, but it provides an excellent insight and starting point for understanding the wide-range of research possible on the island, for all periods. To provide quick reference for the reader, figure 1 is a map of the sites referenced in this book, and table 1 shows the dates and cultural periods referred to through the volume.

In the first paper of this volume, Demetra Aristotelous presents the position of the Department of Antiquities of Cyprus and the continually improving resources on the island. She helpfully presents the steps required for accessing human osteological material from the Department and the role the Department plays in the protection, preservation, and dissemination of information of heritage material. This paper is an essential read for any researcher intending to work on

6 For example (not a comprehensive list): Baker et al. 2007; Baker – Bolhofner 2014; Fox 2005; Harper 2010; Harter-Lailheugue et al. 2005; Le Mort 2000; Le Mort 2007; Le Mort 2008; Lorentz 2006; Lorentz 2008a; Lorentz 2008b; Lorentz 2008c; Lorentz 2009; Lorentz 2010; Parras 2004; Parras 2006; for further references see Lorentz 2011.

skeletal material on the island and outlines the expectations and involvement of the Department of Antiquities. This is followed by the insightful paper by Sarah Douglas, demonstrating the application of osteological data to theoretical and conceptual aspects of archaeology. Forming a part of her PhD research, this paper usefully provides a detailed synopsis of the osteological data available for the Bronze Age in Cyprus, a period which is the focus of much archaeological research. Additionally, Nicholas Herrmann and colleagues present a novel and effective set of methods for dealing with complicated commingled excavations and datasets while providing a synopsis of some of the results of their palaeopathological analyses of the human remains from the Hellenistic and Early Christian graves from the Ayioi Omoloyites neighbourhood in Lefkosia. Given the number of commingled and disarticulated graves from various periods in Cyprus, their detailed method of recording the material is extremely valuable for future excavations and continued work on previously excavated skeletons.

The areas of research, which have perhaps seen the most advancement in the last decade within bioarchaeological studies, are digital microscopy and biomolecular and isotopic analyses (including aDNA). Here, Cyprus is increasingly presenting opportunities to significantly expand our abilities within these methods, as the poor preservation tends to push the boundaries of our current capabilities. Françoise Le Mort and colleagues effectively demonstrate how some of these methods can be usefully applied to archaeological skeletal material to elucidate a long-standing problem in palaeopathology – identifying anaemia in the skeletal record. Understanding anaemia is particularly important in Cyprus, where modern prevalence rates of the disease are still very high. Françoise Le Mort and colleagues present their results of the 3D CT scans of potential anaemia sufferers from Neolithic Khirokitia.

Palaeopathological analyses form the basis of understanding the lives, lifeways and experiences of people in the past. Palaeopathological analyses have a long history within archaeological studies aiming to gain a greater understanding not only of the diseases suffered by those in the past, but to obtain a better idea of where and how diseases originated. Creating a worldwide, comprehensive histiography of disease will provide the opportunity to trace various pathologies throughout time and place. In the past, these analyses were consigned to the appendices in site reports, as a basic part of the recording of the skeletal material, but with bioarchaeological research becoming more prevalent, we now see problem-oriented publications presenting interpretations regarding socio-cultural questions about the past, placing skeletal material at the centre of the enquiry. This volume contains four papers which use palaeopathological analysis to discuss different aspects of populations in the past, with various approaches.

Michelle Gamble presents a synopsis of the palaeopathological analysis of three contemporaneous skeletal collections from the Chalcolithic period in the southwest of Cyprus. In this paper, which formed a part of her PhD, the results that are presented show a relatively healthy prehistoric population with minimal differentiation amongst sites, but some differences in pathological expression between the sexes. Chalcolithic skeletal material is also the focus of Martina Monaco's paper, exploring entheseal changes using Mariotti's graded visual reference system to discuss aspects of social differentiation. Her work, which is part of her larger PhD research, contributes to the growing understanding of the differences in activities based on sex within the Chalcolithic settlement populations in the southwest of Cyprus. The contribution of Grigoria Ioannou moves us out of the prehistoric periods and into the historic, exploring the health and lives of individuals from Ktima Paphos in the Hellenistic and Roman periods. In this paper, which forms a portion of her PhD, she presents results of her observations of dental and osseous pathologies, which demonstrate that these graves contained predominantly adult individuals, and dental pathologies form a significant portion of the pathologies observed. Brenda J. Baker was the keynote address for the workshop, and she provides insights into working in Cyprus using examples of her research on the Late Antique to Early Medieval cemetery site at Polis-tis-Chrysochous. Her detailed look at some of the interesting palaeopathological cases she has identified, framed by her experience of working on previously-excavated material, gives an excellent overview of some of the challenges and solutions encountered whilst working on skeletal material in Cyprus. Her examination of healed trauma and non-alimentary use of the teeth reflects the wide variety of skeletal indicators, which can be explored to elucidate past experiences of individuals.

Bioarchaeological research in Cyprus is continuing to grow and inform on new and innovative areas – E. Anastasiou and P. Mitchell have demonstrated that palaeoparasitological analysis holds much promise in Cyprus[7]; G. Goude et al. and C. Scirè Calabrisotto's isotopic and radiocarbon dating work will continue to provide further precision of chronology and understanding of diet and migration on the island as the methods of collagen extraction and analysis improve[8]; DNA work by P. Chrysostomou and the Committee for Missing Persons, M. Gamble, and others is enabled by new techniques and the impressive improvements to aDNA detection and replication methods[9]; K. O. Lorentz and G. Ioannou are pushing new boundaries with synchrotron research on various human remains such as hair and teeth[10]; along with S. Lemmers whose dental anthropological approach will provide new insights into areas such as mobility and the lives of infants and children[11]; and E. Nikita, who has a diverse range of projects on mobility, methods of dealing with commingled remains and promoting archaeological sciences in Cyprus[12] – to name a few of the many researchers from around the world who are working on the human remains from Cyprus. Perhaps most exciting is involvement of Cypriots and Institutes on Cyprus, as pointed out by D. Aristotelous in her paper in this volume and P. Chrysostomou's project on Byzantine Cypriot material[13], reflecting a local interest and skill set which are invaluable to the promotion of bioarchaeology on the island. With the support and collaboration from the Department of Antiquities, Cyprus, the Archaeological Unit of the University of Cyprus and the Science and Technology in Archaeological Research Centre of the Cyprus Institute, there is a very bright future for bioarchaeological research and the integration of human remains into wider archaeological work on Cyprus.

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[7] Anastasiou – Mitchell 2013.

[8] Bombardieri et al. 2018; Goude et al. 2018; Scirè Calabrisotto et al. 2012; Scirè Calabrisotto et al. 2013; Scirè Calabrisotto 2017; Scirè Calabrisotto – Fedi 2017.

[9] Ktori – Baranhan 2018; recent results from the »Tracing 3000 Years of Disease History« project at the OeAW-OeAI has a preliminary extraction and replication of nucleic DNA from a Hellenistic/Roman grave from Ktima Paphos (Gamble, unpublished).

[10] Lorentz et al. 2020. For details of their work and upcoming publications, see <https://www.cyi.ac.cy/index.php/starc/about-the-center/starc-our-people/itemlist/user/88-kirsi-lorentz.html> and <https://www.cyi.ac.cy/index.php/starc/about-the-center/starc-our-people/itemlist/user/866-grigoria-ioannou.html> (11.12.2020).

[11] For details on her work and upcoming publications, see <https://www.cyi.ac.cy/index.php/starc/about-the-center/starc-our-people/itemlist/user/1023-simone-lemmers.html> (11.12.2020).

[12] For details on her work and upcoming publications, see <https://www.cyi.ac.cy/index.php/starc/about-the-center/starc-our-people/author/859-efthymia-nikita.html> (11.12.2020).

[13] Chrysostomou – Violaris 2018; <http://www.mcw.gov.cy/mcw/DA/DA.nsf/All/75D517AC0E02AA3D42257AC300234652?OpenDocument> (11.12.2020).

and Sarah Douglas who provided technical support for the map within this chapter. Finally, I would like to thank the Director of the Department of Antiquities in Cyprus, Marina Solomidou-Ieronymidou, for her support and attendance at the workshop and to all the speakers who came from all over the world to participate, particularly those from the United States.

Bibliography

Anastasiou – Mitchell 2013 E. Anastasiou – P. D. Mitchell, Human intestinal parasites from a latrine in the 12th century Frankish castle of Saranda Kolones in Cyprus, International Journal of Paleopathology 3/3, 2013, 218–223.

Angel 1966 J. L. Angel, Porotic Hyperostosis, Anemias, Malarias, and Marshes in the Prehistoric Eastern Mediterranean, Science 153, 1966, 760–763.

Angel 1972 J. L. Angel, Ecology and Population in the Eastern Mediterranean, World Archaeology 4/1, 1972, 88–105.

Angel 1978 J. L. Angel, Porotic Hyperostosis in the Eastern Mediterranean, Medical College of Virginia Quarterly 14, 1978, 10–16.

Baker et al. 2007 B. J. Baker – C. E. Terhune – A. Papalexandrou, Sew Long: A Seamstress Buried at Medieval Polis, American Journal of Physical Anthropology Suppl. 132, 2007, 67.

Baker – Bolhofner 2014 B. J. Baker – K. L. Bolhofner, Biological and social implications of a medieval burial from Cyprus for understanding leprosy in the past, International Journal of Paleopathology 4, 2014, 17–24.

Bombardieri et al. 2018 L. Bombardieri – C. Scirè Calabrisotto – F. Chelazzi – M. Amadio, Little Big Data. On-going Archaeological Science-based Researches at Bronze Age Erimi-Laonin tou Porakou, Archaeologia Cypria 7, 2018, 69–94.

Buikstra 1977 J. E. Buikstra, Biocultural Dimensions of Archaeological Study: A Regional Perspective, in: R. L. Blakely (ed.), Biocultural Adaptation in Prehistoric America, Southern Anthropological Society Proceedings 11 (Athens, GA 1977) 67–84.

Buikstra – Beck 2006 J. E. Buikstra – L. A. Beck (eds.), Bioarchaeology: The Contextual Analysis of Human Remains (Burlington 2006).

Chrysostomou – Violaris 2018 P. Chrysostomou – Y. Violaris, Palaeodemographic Analysis of a Byzantine-Medieval Neighbourhood in Nicosia-Palaion Demarcheion (›Old Municipality‹) 2002–2004, Archaeologia Cypria 7, 2018, 135–162.

Fox 2005 S. C. Fox, Health in Hellenistic and Roman Times: The case studies of Paphos, Cyprus and Corinth, Greece, in: H. King (ed.), Health in Antiquity (London 2005) 59–82.

Goude et al. 2018 G. Goude – J. Clarke – J. M. Webb – D. Frankel – G. Georgiou – E. Herrscher – K. O. Lorentz, Exploring the potential of human bone and teeth collagen from Prehistoric Cyprus for isotopic analysis, JASc Reports 22, 2018, 115–122.

Harper 2008 N. K. Harper, Short Skulls, Long Skulls, and Thalassemia: J. Lawrence Angel and the Development of Cypriot Anthropology, Near Eastern Archaeology 71, 2008, 111–119.

Harper 2010 N. K. Harper, From Typology to Population Genetics: Biodistance in Cyprus, in: S. Christodoulou – A. Satraki (eds.), POCA 2007: Postgraduate Cypriot Archaeology Conference (Cambridge 2010) 1–38.

Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent Research in Cypriot Bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.

Harter-Lailheugue et al. 2005 S. Harter-Lailheugue – F. Le Mort – J.-D. Vigne – J. Guilane – A. Le Brun – F. Bouchet, Premières données parasitologiques sur les populations humaines précéramiques chypriotes (VIIIe et VIIe millénaires av. J. C.), Paléorient 31, 2005, 43–54.

Ktori – Baranhan 2018 M. Ktori – G. Baranhan, Development and future perspectives of a humanitarian forensic programme: the committee on missing persons in Cyprus example, Egyptian Journal of Forensic Sciences 8/25, 2018.

Larsen 1997 C. S. Larsen, Bioarchaeology. Interpreting Behavior from the Human Skeleton, Cambridge Studies in Biological Anthropology 21 (Cambridge 1997).

Larsen – Walker 2010 C. S. Larsen – P. L. Walker, Bioarchaeology: Health, lifestyle, and society in recent human evolution, in: C. S. Larsen (ed.), A companion to biological anthropology (Chichester 2010) 379–394.

Le Mort 2000 F. Le Mort, The Neolithic Subadult Skeletons From Khirokitia (Cyprus): Taphonomy and Infant Mortality, Anthropologie 38/1, 2000, 63–70.

Le Mort 2007 F. Le Mort, Artificial Cranial Deformation in the Aceramic Neolithic Near East: Evidence from Cyprus, in: M. Faerman (ed.), Faces from the Past. Diachronic Patterns in the Biology of Human Populations from the Eastern Mediterranean. Papers in Honor of Patricia Smith, BARIntSer 1603 (Oxford 2007) 151–158.

Le Mort 2008 F. Le Mort, Infant Burials in Pre-Pottery Neolithic Cyprus. Evidence from Khirokitia, in: K. Bacvarov (ed.), Babies reborn: Infant/child burials in pre- and protohistory. Actes du XV^e^ congrès de l'UISPP Lisbonne 4–9 septembre 2006, BARIntSer 1832 (Oxford 2008) 23–32.

Lorentz 2006 K. O. Lorentz, Headshaping at Marki and Its Socio-Cultural Significance, in: D. Frankel – J. M. Webb (eds.), Marki Alonia. An Early and Middle Bronze Age Settlement in Cyprus. Excavations 1995–2000, SIMA 123/2 (Sävedalen 2006) 297–303.

Lorentz 2008a K. O. Lorentz, Crafting the Head: The Human Body as Art?, in: J. Córdoba Zoilo – M. Molist – C. Pérez Aparicio – I. Rubio de Miguel – S. Martínez Lillo (eds.), Proceedings of the Fifth International Congress on the Archaeology of the Ancient Near East, Madrid, April 3–8 2006, II (Madrid 2008) 415–432.

Lorentz 2008b K. O. Lorentz, From Bodies to Bones and Back: Theory and Human Bioarchaeology, in: H. Schutkowski (ed.), Between Biology and Culture (Cambridge 2008) 273–303.

Lorentz 2008c K. O. Lorentz, From Life Course to longue durée: Headshaping as Gendered Capital?, in: D. Bolger (ed.), Gender through Time in the Ancient Near East (Lanham, MD 2008) 281–311.

Lorentz 2009 K. O. Lorentz, The Malleable Body: Headshaping in Greece and the Surrounding Regions, in: L. A. Schepartz – S. C. Fox – C. Bourbou (eds.), New Directions in the Skeletal Biology of Greece, Hesperia Suppl. 43 = Occasional Wiener Laboratory series 1 (Princeton, NJ 2009) 75–98.

Lorentz 2010 K. O. Lorentz, Parts to a whole: Manipulations of the body in prehistoric Eastern Mediterranean, in: K. Rebay-Salisbury – M. L. S. Sørensen – J. Hughes (eds.), Body parts and bodies whole: Changing relations and meanings (Oxford 2010) 20–29.

Lorentz 2011 K. O. Lorentz, Cyprus, in: N. Márquez-Grant – L. Fibiger (eds.), The Routledge Handbook of archaeological human remains and legislation. An international guide to laws and practice in the excavation and treatment of archaeological human remains (Abingdon 2011) 99–111.

Lorentz et al. 2020 K. O. Lorentz – W. de Nolf – M. Cotte – G. Ioannou – F. Foruzanfar – M. R. Zaruri – S. M. S. Sajjadi, Synchrotron radiation micro X-Ray Fluorescence (SR-μXRF) elemental mapping of ancient hair: Metals and health at 3rd millennium BCE Shahr-i Sokhta, Iran, JASc 120, 2020, 105–193.

Parras 2004 Z. Parras, The Biological Affinities of the Eastern Mediterranean in the Chalcolithic and Bronze Age. A Regional Dental Non-metric Approach, BARIntSer 1305 (Oxford 2004).

Parras 2006 Z. Parras, Looking for Immigrants at Kissonerga-Mosphilia in the Late Chalcolithic. A Dental Non-metric Perspective of Chalcolithic and Early Bronze Age Southwest Cyprus, in: A. P. McCarthy (ed.), Island Dialogues. Cyprus in the Mediterranean Network, Archaeology Occasional Paper 21 (Edinburgh 2006) 63–74.

Roberts 2006 C. A. Roberts, A view from afar: bioarchaeology in Britain, in: Buikstra – Beck 2006, 417–439.

Roberts 2010 C. A. Roberts, Adaptation of populations to changing environments: Bioarchaeological perspectives on health for the past, present and future, Bulletins et Mémoires de la Société d'Anthropologie de Paris 22, 2010, 38–46.

Scirè Calabrisotto et al. 2012 C. Scirè Calabrisotto – M. E. Fedi – L. Caforio – L. Bombardieri, Erimi-Laoni tou Porakou (Limassol, Cyprus). Radiocarbon Analyses of the Bronze Age Cemetery and Workshop Complex, Radiocarbon 54/3–4, 2012, 475–482.

Scirè Calabrisotto et al. 2013 C. Scirè Calabrisotto – M. E. Fedi – L. Caforio – L. Bombardieri – P. A. Mandò, Collagen Quality Indicators for Radiocarbon Dating of Bones. New Data on Bronze Age Cyprus, Radiocarbon 55/2–3, 2013, 472–480.

Scirè Calabrisotto 2017 C. Scirè Calabrisotto, Palaeodiet Reconstruction, in: L. Bombardieri (ed.), Erimi Laonin tou Porakou. A Middle Bronze Age Community in Cyprus. Excavations 2008–2014, SIMA 145 (Uppsala 2017) 301–304.

Scirè Calabrisotto – Fedi 2017 C. Scirè Calabrisotto – M. E. Fedi, Radiocarbon Dating, in: L. Bombardieri (ed.), Erimi Laonin tou Porakou. A Middle Bronze Age Community in Cyprus. Excavations 2008–2014, SIMA 145 (Uppsala 2017) 293–300.

Excavating and Studying Skeletal Remains in Cyprus

The Role and Work of the Cyprus Department of Antiquities

Demetra Aristotelous

Abstract

Human skeletal material is becoming a central aspect of research into past populations. In Cyprus, the sole governmental body in charge of managing archaeological heritage is the Department of Antiquities (DoA) of the Ministry of Transport, Communication and Works. The DoA collaborates extensively with local and international research institutes to promote human osteological studies on the island, with their primary focus on the preservation and protection of all heritage material. In order to facilitate this, and encourage systematic excavation of human skeletal material, the DoA has created a standard operating procedure for handling osteological collections and a simplified exhumation recording document for use in the field. Moreover, the DoA is currently implementing storage upgrades for osteological material, building a new museum with up-to-date scientific laboratories, and setting up a synthetic database for all heritage materials within its vast collections. This paper is meant to provide a detailed checklist of how to apply for a study permit for taking samples and conducting research on skeletal remains, which should be used by all researchers looking to work on Cypriot collections.

Bioarchaeology studies in Cyprus have had a long tradition, associated with the work of many renowned scientists through the last century. This paper is meant to present the significant developments in the field of bioarchaeology in Cyprus during the last decade, particularly regarding the increase of local expertise and the key role of the Department of Antiquities (DoA) in safeguarding the valuable osteological material, as the sole governmental body responsible of managing the archaeological heritage of Cyprus.

Cyprus presents exceptional opportunities for archaeological research, not only due to its rich history, central location in the Eastern Mediterranean, and numerous excavated sites with resulting remarkable material culture, but also due to the significant work of local and international experts in many related subdomains. The DoA has long invited and provided opportunities to foreign excavation teams to conduct systematic excavations on the island – given that the provisions stated in the Antiquities Law[1] are met – and numerous renowned institutions have answered this call with fruitful results. Depending on the type of excavation and anticipated findings, field directors are encouraged to include relevant specialists in their teams or arrange for the post-excavation analysis of their finds by accredited scientists. As a direct result of this multi-variant site analysis, many bioarchaeologists have long been working on Cypriot skeletal collections adding valuable and core information to site interpretations.

The previously reported absence of qualified local personnel[2] in all related subfields of bioarchaeology has begun to decrease since the beginning of the century, with many Cypriot young scientists now finding themselves pioneering in their respective fields of interest. A variety of factors seems to have influenced and directed this long-anticipated development. With the establishment of the Archaeological Research Unit (ARU) of the University of Cyprus in 1991, and the inauguration of the Science and Technology in Archaeology and Culture Research Center (STARC) of The Cyprus Institute (CyI) in 2007, the DoA has found powerful allies in conducting

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1 The Antiquities (Amendment) Law of 2014.
2 Harper – Fox 2008.

advanced research, promoting knowledge and encouraging young scientists to pursue innovative multi-disciplinary approaches in their studies. Local and international academic institutions have inspired the development of many bioarchaeology subdisciplines and promoted young scientists to explore their research questions in the rapidly expanding fields of palaeogenetics, palaeodiet, etc. In addition to the worldwide development and expansion of the academic discipline, the modern political situation on the island with the events that ultimately led to the establishment of the Committee of Missing Persons in Cyprus (CMP) in 1981 and the repetitive since call for the employment of young human bioarchaeology scientists of Cypriot origin[3] – especially amid the last economic crisis – to work on the identification of the individuals that went missing during the tragic events of 1963/1964 and 1974, shouldn't be overlooked. With reasons ranging from pure scientific curiosity and academic development, to ethical or a sociopolitical sense of duty in a post-war country, or simply because bioarchaeology found itself in the public's spotlight with references in screen and popular literature, a significant number of Cypriot archaeologists are choosing to specialize in bioarchaeological sciences.

The DoA has since 2011 recruited two university accredited bioarchaeologists as Archaeological Officers, providing expertise in a growing field of interest. In addition to supporting the DoA's mission objectives, the specialists are assigned with the organization and management of the skeletal collections, providing assistance to osteology researchers during their study periods, and have been collaborating, when necessary, with other governmental bodies such as the Crime Combating Department of the Cyprus Police and the Missing Persons Department of the Cyprus Commissioner to the Presidency, either by participating in exhumations or providing counselling to modern police cases involving skeletal remains.

Towards a Standardization of Procedures

As methodological approaches evolve and the technological tools available in research are being constantly re-calibrated, the traditional archaeological approach has now progressed to the point of plausibly reconstructing past population lifeways and unlocking aspects previously unreachable, such as patterns of migration, social status through nutrition and stress, genetics and epidemics. As a result, analyses conducted in the past are often revisited by specialists who request to re-examine and re-evaluate osteological collections by implementing the latest methodologies or testing innovative interdisciplinary approaches. The records and statistics held by the Department of Antiquities, document a rapid increase of interest by bioarchaeology specialists (fig. 1), whereas reports on the analysis of skeletal collections excavated in Cyprus are being upgraded to chapters as opposed to previously being limited to short appendices in publications. Unfortunately, even though the local archaeological scene has greatly benefited from re-evaluations and innovative interpretations, this unprecedented wave of research has managed to yield even more questions to the scientific community, adding more stress to the physical condition of the already degraded collections.

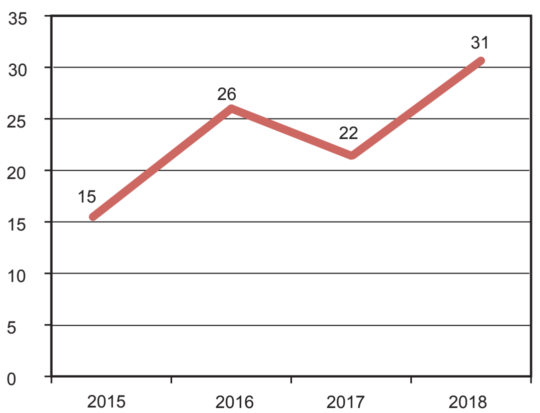

Fig. 1 Line chart showing increase of applications to access osteological collections between the years 2015–2018; Osteology Database (© Department of Antiquities, Cyprus)

3 CMP Terms of reference and mandate <http://www.cmp-cyprus.org/content/partners-and-cooperation> (17.05.2019).

While it cannot be disputed that the Department of Antiquities actively supports and promotes research, its primary mission is to ultimately protect the archaeological record, ensuring that current studies will not damage, limit in any way the collection or affect future advanced approaches. In order to achieve an equilibrium, efforts are made to moderate and control all destructive analyses and over-examinations, maximizing future opportunities for access to information. The recent unprecedented accumulation of study and research applications deemed the need for standardization of procedures and protocols as imperative to ensure that the fragile archaeological record will be minimally disturbed. The Department's »Standard Operating Procedures for Handling Osteological Collections« – currently being finalized – aim to create consistency for everyone dealing with the osteological collections, ensuring efficiency, maximum collection of information with minimized handling, and a complete set of documentation. Special provisions include key notes on excavation methods, guidelines on transfer and packaging, post-excavation handling, conservation and treatment, storage, analysis documentation and sampling procedures.

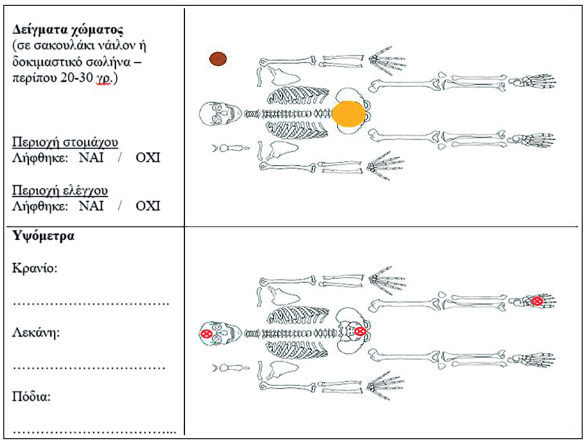

Fig. 2 Skeletal diagrams showing locations of soil samples and elevation levels to be recorded during excavation; Exhumation Inventory (© Department of Antiquities, Cyprus)

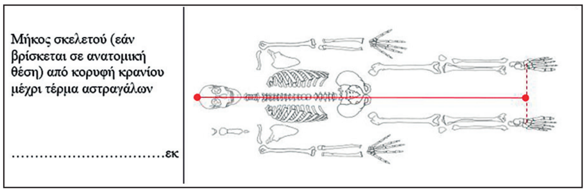

Fig. 3 Skeletal diagram showing measurements to be taken *in situ* during excavation; Exhumation Inventory (© Department of Antiquities, Cyprus)

A user-friendly exhumation inventory has been designed, encouraging its use during Department-lead excavations. This document aims to collect the maximum available information on-site in the minimum amount of time, even from excavators who are not accustomed to specific skeletal terminology or not experienced in the excavation of skeletal remains. Given the tight time constraints of a rescue excavation, this inventory mainly consists of schematic drawings (figs. 2. 3) and simple code charts that encourage immediate actions, acting as a reference point and establishing a uniformity of information collection in all skeletal assemblages. As research progresses, the charts are meant to be updated regularly, incorporating new techniques or resources (i.e., soil sample locations). Whenever possible, traditional field recording methods are supported by geophysical technology (i.e., ground penetrating radar), aerial photography and digital photogrammetry in order to 3D reconstruct and accurately document burial settings.

Matters of Preservation

In Cyprus, the Department's osteological collections consist of human and faunal remains, complete or near-complete skeletons, commingled secondary burial depositions, cremations, and worked bones. The degree of bone preservation depends on a multi-variate combination of intrinsic and extrinsic factors including chemistry, size, shape, structure and density of bone – any pathological changes that affected the body before death, the application of any preservation techniques to the body before inhumation, the funerary rituals involved, the burial type, as well as the geology and acidity of the burial environment. Moreover, the climate conditions and human activity are critical factors in bone degradation and the physical stirring of the skeletal remains[4]. The majority of osteological collections in Cyprus depict a moderate to low preservation status, even though notable exceptions are being recorded. Dealing with badly preserved samples is an issue that especially troubles molecular scientists, who are required to adjust their methodological approaches accordingly by seeking answers in more robust and better-preserved samples (e.g. petrous part of the temporal bone, dentition, etc.).

One of the biggest challenges the Department of Antiquities currently faces is securing adequate storage facilities for the continuously expanding archaeological record. The storage limitations that trouble the museums are being dealt with through the re-design and upgrade of buildings and the acquisition of new storage facilities through various means (i.e., change of ownership status, vacant public buildings, etc.). Improvements and upgrades to the existing storage facilities are being promoted, gradually expanding to all of the Department's buildings. This aims to ensure stable and suitable environmental conditions and prevent further deterioration of the organic material[5]. Old boxes used for the storage of skeletal collections, and unsuitable packaging materials are gradually being replaced by lidded rigid cardboard boxes and polyethylene zip-lock bags with acid-free paper. Additionally, random condition checks are scheduled monthly in the organic collections to assess, prevent, and treat any damage from microorganism attacks.

Simultaneously with the efforts to upgrade storage conditions in its existing facilities, the DoA has been initiating several construction projects, the most notable of which has been that of the New Cyprus Museum. Following the announcement of the museum's architectural proposal in 2017, the construction of the state-of-the-art new National Museum has already been set in motion and is scheduled to be completed in the coming years. The new museum's vast laboratory area will include a dedicated osteology laboratory, serving a core necessity of the institution that will be dedicated to the conservation, study and handling of Cypriot osteological collections. The laboratory will include provisions to host a minimum of four specialists, and adequate space will be assigned to the preparation and sampling of osteological specimens. The laboratory will also house the Department's human and faunal reference collections and provide further support to visiting specialists and researchers.

Since 2018, efforts to better organize and preserve the general condition of the collections led to the creation of a database management system containing information on all the recorded osteological collections, and since updated continuously with data on in-coming study requests and projects, type of analyses, number and type of requested samples per project, laboratories and scientific collaborators, success rates per type of analysis, publication references and more. As well as providing control over information, this database offers a means of moderating overlapping analyses and limiting repeated sampling on the same collections. Fulfilling the Department's mission to safeguard the archaeological record for future generations, over-examination will generally not be approved unless the applicants address different research questions and demonstrate a novel and innovative approach. Additionally, secondary means of controlling the collections are being applied by filling in data log documents that physically accompany each skeletal collection, where updated records of the researchers who access the collection and the samples that have been taken (or returned) are noted.

Guidelines on Submitting a Study Request

An integral part of the Department's procedural reform, concerning the handling of skeletal collections, is the consolidation of all guidelines and requirements in a published document, available to anyone who wishes to obtain a study license. By following a strict plan of actions, the Department ensures that all requirements are met, documentation is appropriately archived, and the application process is further strengthened.

4 Karr – Outram 2015; Pinhasi – Bourbou 2008; Wills et al. 2014.

5 Buś – Allen 2014.

Prior to submitting an application to access or analyze a skeletal collection, the applicant is expected to assemble and submit the following information to the Director of the Department of Antiquities:

1. A *curriculum vitae* of the main applicant, together with a list of publications and previous collaboration (if any) with the Department of Antiquities.
2. A written research proposal of 200–400 words, focusing on the objectives and desirable outcomes, including the primary methodology to be followed and list of all institutions and laboratories that will be involved in the analyses.
3. An official permission by the primary excavator. Upon deciding on the skeletal collections that best fits the research's objectives, the applicant should contact the respective field director(s) in order to obtain their written permission to proceed with studying the particular assemblages, in order to avoid any conflicts of interest. In cases where the principal investigator is deceased, permission should be sought from the assigned lead investigator/person in charge of the site publication and the Director of the DoA.
4. A minimum number of bone samples (if required) needed for the research questions to be statistically addressed and a list of proposed osteological collections that based on their size and preservation best fit the research objectives. The Department's bioarchaeologists will then access the proposed collections and advise the researchers accordingly on the availability of preferable target samples. A collection might be deemed unsuitable for research due to preservation matters (i.e. where there is fragmented or limited representation of skeletal elements, severe degradation due to weathering or burial conditions, etc.) or reported over-sampling. The Department holds the right to deny an analysis or control the proposed number of samples to ensure the safeguarding of evidence for future research.
5. Whenever research applications involve sampling (i.e., destructive analyses), the skeletal remains from which the samples originate will have to be previously recorded and fully inventoried by an accredited bioarchaeologist. Sampling permissions in non-inventoried collections will be withheld. Essentially, researchers either are encouraged to target samples from previously recorded collections, or collaborate with accredited bioarchaeologists in analyzing unpublished collections.

Upon submitting an application, the Department's specialists are directed to assess the overall condition of the requested collections and report to the Director on whether or not the proposed actions will significantly burden the skeletal assemblages. The Director of the DoA then evaluates all information and decides accordingly on whether or not to grant permission to proceed with the proposed research. The final decision will be based on the researcher's established credibility with the Department, previous experience in the methodology and type of research proposed, the significance of the research's outcomes for Cypriot archaeology, and the commitment that reliable and notable new data will be delivered back to the Department of Antiquities.

Studying and Sampling Osteological Collections

Once the above requirements are met, the applicant will be notified of the Department's decision (i.e., whether or not the proposed research is deemed accepted) via formal correspondence. Analyses are generally instructed to take place on the Department's premises unless otherwise permitted by the Director, and it is expected that researchers will make adequate provisions to secure clean and stable surfaces for their study, following international recommendations for stabilization and proper use of recording instruments, so as to avoid any damage to the bones. Any attempts to conserve or treat, in any way, skeletal remains are to be avoided unless they are considered imperative to address specific research questions. Moreover, researchers should seek advice from the Department's bioarchaeologists and conservators regarding the proposed methodology of conservation and its proper documentation prior to and following the treatment.

When a permit to proceed with sampling skeletal material is granted, the applicant is expected to arrange a meeting with the Department's bioarchaeologists and proceed with a preliminary selection of samples. To avoid unnecessary destruction of information, the Department has instituted a set of parameters to guide the selection. Notably, the number of samples will be restricted to the minimum needed to fulfill the purpose of the research, and the accessibility of samples will be analogous to the size of the collection, its overall condition and preservation, taphonomic alterations, and the availability of targeted samples. In cases involving large groups of samples, applicants are strongly encouraged to conduct a preliminary screening on a small number of samples, and depending on the nature of the results obtained, proceed with the remaining samples or abort the process accordingly. Furthermore, sampling pathological lesions or skeletal landmarks should be avoided unless driven by the research objectives or unavailability of other options, in which case researchers are expected to proceed with 3D scanning, cast replicas, or high-resolution photographs, as well as full set of measurements prior to sampling. The same parameters apply to dental samples.

Once the preliminary selection of samples is completed, the researcher must submit a table catalogue to the Director of the DoA that will include a description, high-resolution photographs (various angles) and precise measurements for each sample. This information will then be archived in the electronic Osteology Database and in hard-copy data logs that will accompany the physical collections. Final permission to proceed with the sampling will be formally issued by the Director.

The export of samples to either European or International laboratories follow different procedures, and different time frames are required for their processing. Once the sampling process has been completed, the district museums are responsible for the secure packaging and transfer of the samples to the Cyprus Museum[6], where if they are to be exported to an EU laboratory, the applicant is required to sign an export license accepting responsibility for their safe delivery and analysis. If a third-country laboratory is involved, according to the »Export of Cultural Goods Law«[7], the applicant must fill in and submit to the Department of Antiquities a cover letter elaborating on the necessity to export samples in a third country, a standardized application form (available online), and proof of payment of a fee of 256 euros to the Treasury of the Republic. A six-member interdepartmental export committee is then scheduled to assemble and decide accordingly on the permit, as per the current legislation. Finally, researchers are obliged to sign an »Undertaking document« binding them to return any unused or remaining bone fragments to the Department following the analyses and in a pre-specified time frame of usually one year.

Once the study period is completed, researchers are expected to report on their results by submitting to the Director of the DoA copies of their data collection (e.g., inventories, measurements, etc.) within a time frame of six months. Furthermore, copies of the final products (i.e., dissertations, research papers, publications, etc.) are expected to be submitted to the library of the Department of Antiquities within a two-month period following their publication.

Concluding Remarks

The Department of Antiquities has had the opportunity to officially initiate its bioarchaeology program through significant leaps in updating and regulating its procedures in internal expertise, managing, and processing the osteological collections during the last decade. Dedicated to research, it has actively participated in large-scale funded bioarchaeology projects (e.g., »Introduction of Osteological and Molecular Methods in Cypriot Archaeology – revival of Byzantine/

6 Circular to the directors of the Archaeological Missions in Cyprus, Department of Antiquities, 8th September 2010.

7 Export of Cultural Goods Law, No 182 (1) of 2002.

Medieval Nicosia«; »Face to Face: Meet an Ancient Cypriot«, etc.) and has committed to promoting the archaeological science through its public outreach programs (e.g. school presentations, annual events) and special educative events (e.g., annual participation in the »European Researchers' Night«).

Needless to add, more reform is to be expected, and as the field expands, improvements in the way the collections are being handled and stored should be re-addressed. Even though two human bioarchaeologists are currently employed at the DoA, it is still lacking the expert contribution of zooarchaeologists. With the construction of the new National Museum and the creation of the Osteology Laboratory, its vision is to ultimately develop a strong bioarchaeological presence on the island, setting collaborative and successful partnerships with academic institutions and researchers from Cyprus and abroad.

Bibliography

Buś – Allen 2014 M. M. Buś – M. Allen, Collecting and Preserving Biological Samples from Challenging Environments for DNA Analysis, Biopreservation and Biobanking 12/1, 2014, 17–22.

Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent Research in Cypriot Bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.

Karr – Outram 2015 L. P. Karr – A. K. Outram, Bone degradation and environment: Understanding, accessing and conducting archaeological experiments using modern animal bones, International Journal of Osteoarchaeology 25/2, 2015, 201–212.

Pinhasi – Bourbou 2008 R. Pinhasi – C. Bourbou, How Representative are Human Skeletal Assemblages for Population Analysis?, in: R. Pinhasi – S. Mays (eds.), Advances in Human Palaeopathology (Chichester 2008) 31–44.

Wills et al. 2014 B. Wills – C. Ward – V. Sáiz Gómez, Conservation of Human Remains from Archaeological Contexts, in: A. Fletcher – D. Antoine – J. D. Hill (eds.), Regarding the Dead: Human Remains in the British Museum (London 2014) 49–73.

The Osteological Dataset for Bronze Age Cyprus (Philia–LCIA)

Sarah Douglas

Abstract

Until recent years, the limitations to osteological data obtained from the Bronze Age mortuary arena in Cyprus, have prevented any large-scale interpretations of the funerary population. Mortuary analyses of the period have predominantly focused on the rich grave good assemblages of copper-based tools and weapons, and ceramic vessels that begin to feature in large quantities in graves from the transitional Philia facies. This paper considers skeletal material from 17 large-scale cemeteries/burial locales and a further six rescue/smaller burial excavations in order to offer a broad overview of the osteological dataset that exists at present for the Philia–LCIA period (ca. 2500–1550 B.C.). Emerging patterns in minimum numbers of individuals (MNI), burial demography in relation to age and sex, evidence for activity markers or degenerative joint disease and violent trauma will be highlighted. Whilst more abundant than ever before, this paper underlines the need for continued osteological analyses for this time period, alongside meticulous scientific excavation of human skeletal material.

Introduction

The difficulties of the Bronze Age burial record in Cyprus have been well documented. Until recent years, limitations to the body of osteological data obtained from the mortuary arena have prevented any large-scale interpretations of the funerary population. Mortuary analyses of the period[1] have predominantly focused on the rich grave good assemblages of copper-based tools and weapons, and ceramic vessels that begin to feature in large quantities in graves from the transitional Philia facies. In recent years, the implementation of scientific excavation methods and the re-analysis of previously excavated skeletal material has significantly increased the amount of osteological data available. In response, this paper will offer a broad overview of the osteological dataset that exists at present for the Philia–LCIA (ca. 2500–1550 B.C.) (table 1) and emerging patterns. The distribution of burial locales with osteological data across the island will be discussed in order to demonstrate the varying extent of information available. Within this, key cemeteries and bodies of research will be highlighted and emerging evidence for burial MNI (minimum number of individuals), age and sex, activity and trauma of the buried individuals will be considered. Presenting an exhaustive review of Bronze Age bioarchaeology is beyond the remit of this paper[2]. However, it aims to provide a record of the osteological data currently available for the period, from which avenues for future research may be identified.

1 E.g., Keswani 2004.

2 See Harper – Fox 2008 for a broad overview of bioarchaeology in Cyprus.

Table 1 Cypriot Chronology for the period studied with abbreviations (from Manning 2014, 215 refined chronology using synthesised radiocarbon dates; see also Manning 2013; Knapp 2013, 27)

Period		Dates (B.C.)
Philia		2500/2400–2200
Early Cypriot (ECI–III)	(EC)	2200–2100/2050
Middle Cypriot (MCI–III)	(MC)	2100/2050–1690/1650
MCIII–LCIB		1700/1650–1450
Late Cypriot (LCIIA–IIIA)	(LC)	1450/1300–1100

Limitations to the Cypriot Burial Record

The main problems associated with the burial record in Cyprus are broadly related to three central issues of preservation, disturbance, and past approaches to excavation. Rock-cut chamber tombs, which were the favoured tomb type for the period, have caused persistent issues for preservation as a result of the chemical composition of the bedrock they are cut into, as well as their architectural features. Whilst the alkaline bedrock of havara or kafkalla itself provides a difficult environment for human bone preservation, the repeated seasonal flooding of some tombs has also hindered preservation, and disturbed skeletal remains and grave good assemblages[3].

Frequent looting of tombs, which has occurred from antiquity and into the present day has had a similar effect on the preservation of bodies and grave goods *in situ*, as well as creating an extensive number of unprovenanced artefacts which are now held in private collections[4]. Looters have damaged the vast majority of settlements and cemeteries in Cyprus, although some cemeteries, such as those in the vicinity of Marki-*Alonia*, have been pillaged more thoroughly than others[5]. Furthermore, the Bronze Age Cypriot preference for burying multiple individuals in the same tomb chamber, often pushing aside previous interments and their grave goods to make way for new ones, also makes it difficult to reconstruct individual assemblages with commingled human remains and artefacts[6]. Further damage to Bronze Age graves has been caused by construction and development, particularly in urban areas. For example, the Kalavasos village cemetery which is located beneath the modern settlement[7].

Lastly, a large number of excavations were undertaken in Cyprus before the second half of the 20th century when fine objects were frequently valued over human remains[8]. Whilst skulls were sometimes preserved and taken care of, post-cranial skeletal material was often discarded and poorly excavated and recorded[9]. Also, while skeletal material was indicated on the plan drawings of tombs from some sites, limited attention was paid to human remains overall[10].

3 Harper – Fox 2008, 2.
4 Sneddon 2002, 5.
5 Sneddon 2002.
6 Keswani 2004, 23 f.
7 Todd 1986; Todd 2007.
8 Crewe et al. 2005, 2; Harper – Fox 2008, 2.
9 Crewe et al. 2005, 2.
10 E.g. Gjerstad et al. 1934; Stewart – Stewart 1950. Skeletal material was drawn on plans at both Lapithos and Bellapais-*Vounous*.

Overview of Sites with Osteological Data

In light of these issues, it is not surprising that the osteological record has been relatively scarce until recent years. The overall lack of analysed skeletal assemblages has posed a persistent problem for interpretations of the funerary record and was brought to attention in the last major overviews of mortuary practice[11]. According to P. Davies in 1995, two decades ago, only 32 chambers had any information pertaining to the sex of the skeletons. More recently, N. K. Harper and S. C. Fox[12] estimated that only 36 % of EC–MC cemeteries (nine in total) have undergone sufficient osteological analysis. As a result, P. Keswani[13] listed meticulous excavation and osteological analysis of all skeletal remains as the primary recommendation for future research on Bronze Age burials in her study. Promisingly, since these stark estimations, the body of osteological data for the prehistoric Bronze Age on Cyprus is steadily growing. This is owed in part to the rigorous implementation of scientific excavation methods, as well as doctoral studies that are re-visiting previously excavated material[14].

At present, skeletal material has now been osteologically analysed from 17 large-scale sites/burial locales and a further six rescue/smaller tomb excavations for the Philia–LCIA period[15] (fig. 1; tables 2. 3). In total, osteological information pertaining to a minimum of 329 individuals from 149 tomb chambers exists for this period (fig. 2). The majority of these sites lie south of the island's ›Green Line‹, which was implemented following the Turkish occupation of the north of the island in 1974 (fig. 1).

The amount of skeletal material analysed from larger EC–MC sites and cemeteries is variable and there are few in which all excavated human remains have been assessed in full (table 2). Only

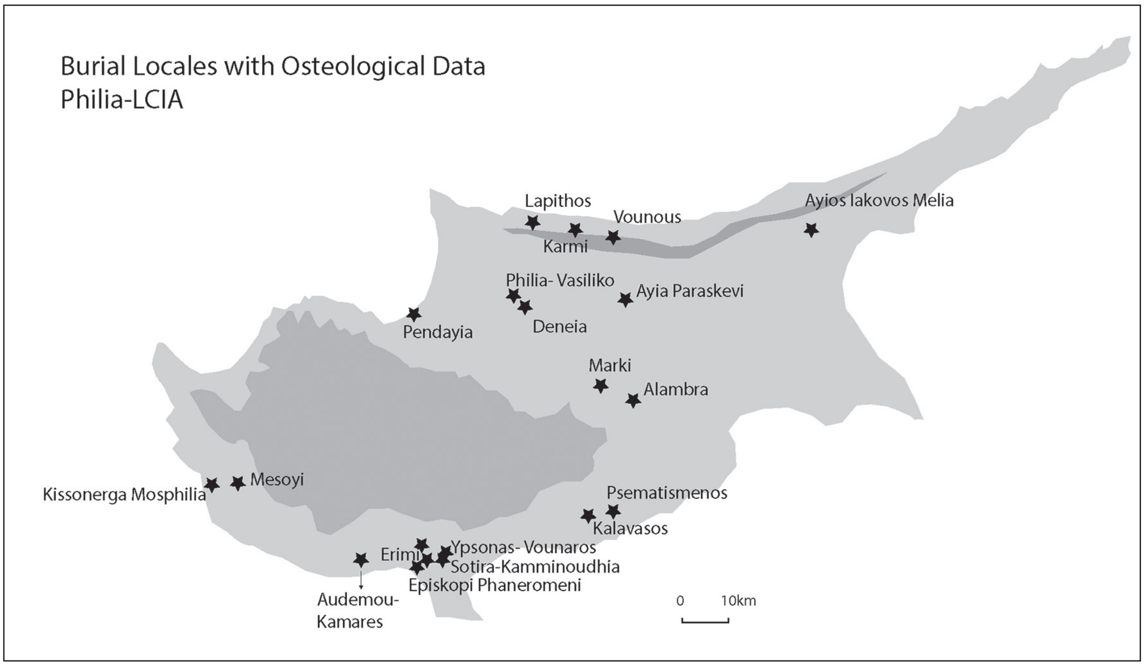

Fig. 1 Map of Cyprus: Burial locales with osteological data, Philia–LCIA (map adapted by S. Douglas)

11 Davies 1995; Keswani 2004. Davies' unpublished MA thesis and Keswani's 2004 publication is based on her PhD thesis from 1989.

12 Harper – Fox 2008, 2. 23.

13 Keswani 1989; Keswani 2004, 161.

14 E.g. Gamble 2011; Osterholtz 2015; M. Monaco, this volume.

15 There are additional LC sites with osteologically analysed remains from graves in use in LCIA that have been omitted from this paper due to the longevity of tomb use during this period and difficulties in separating material from later phases of use. See Harper – Fox 2008, 23 for a list of LC osteological reports.

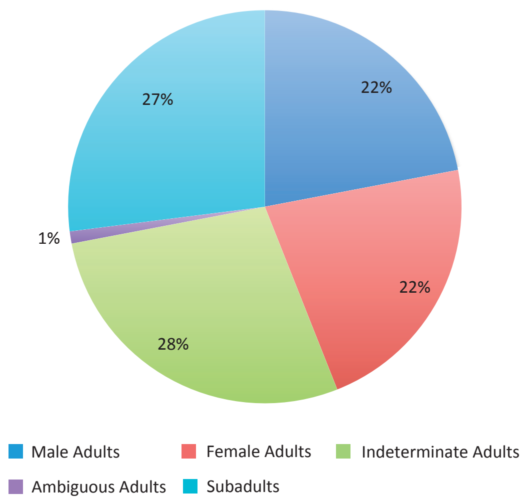

Fig. 2 Breakdown of EC–LCIA individuals by sex/age (329 total) (© S. Douglas)

a select sample of material (skulls only) has been officially studied from the northern sites of Bellapais-*Vounous* (*Vounous* hereafter) and Lapithos-*Vrysi tou Barba* (Lapithos hereafter), which are undoubtedly the richest cemeteries excavated so far for the period[16]. The largest assemblage of assessed human remains derives from the Kalavasos village cemetery (predominantly ECIII–MCI–II) (fig. 1; table 2)[17]. Skeletal material from this site was examined by C. Schulte-Campbell and C. J. Moyer[18] in the original site reports, and later in A. J. Osterholtz's[19] doctoral thesis. The EC necropolis of Psematismenos-*Trelloukas* also has a fully analysed skeletal assemblage, despite the poor preservation of human remains in this cemetery[20]. Emerging patterns from this collated sample of analysed skeletal remains will now be considered[21].

Table 2 Philia–LCIA. Larger-scale sites/cemeteries with osteological data

Burial site	Chronology	Level of osteological information	Osteological reference/s	Number of graves with osteologically analysed remains
Kissonerga-*Mosphilia*	MChal–Philia	all human remains studied	Lunt et al. 1998 Gamble 2011	10 with Philia attributes
Philia-*Vasiliko*	Philia	skulls from selected tombs analysed	Fischer 1986	2
Sotira-*Kamminoudhia*	Philia–EC	all human remains studied	Schulte-Campbell 2003 Osterholtz 2015	9
Nicosia-*Ayia Paraskevi*	Philia–EC	limited analysis of material held in Australia	Frankel et al. 2010 (Pardoe conducting analysis)	2
Bellapais-*Vounous*	EC–MC	skulls from selected tombs analysed	Rix 1950 Fischer 1986	6
Lapithos-*Vrysi tou Barba*	EC–MC	skulls from selected tombs analysed	Fürst 1933 Hjortsjö 1947 Fischer 1986	6

16 A small amount of material was analysed from *Vounous* by Fürst 1933; Hjortsjö 1947; Rix 1950. The Lapithos material was analysed by Fürst 1933 and Fischer 1986. Similar results were gleaned from earlier and later analyses.
17 Todd 1989; Todd 2007.
18 Schulte-Campbell 1989; Moyer 2007.
19 Osterholtz 2015.
20 Georgiou et al. 2011; Lorentz 2011.
21 This collective body of data was collated and analysed as part of the author's doctoral research into burial practices and identity on Bronze Age Cyprus: Douglas 2019.

Burial site	Chronology	Level of osteological information	Osteological reference/s	Number of graves with osteologically analysed remains
Marki-*Alonia*	Philia, EC–MC	all human remains studied	Moyer 1997 Moyer 2006 Fox 2006 Lorentz 2006	7
Marki-*Davari*	Philia–EC	remains from tomb 7 studied	Lorentz 2006	1
Psematismenos-*Trelloukas*	EC	all human remains studied	Lorentz 2011	29
Kalavasos village	EC–LCIA (burials mainly dating from ECIII–MCI–II)	all human remains studied* (largest complete sample size for the whole period)	Schulte-Campbell 1986 Moyer 2007 Osterholtz 2015	38
Karmi-*Paleolona*	EC–MC	retained skeletal material from Stewart's excavations from selected tombs studied	Pardoe 2009 studied material stored in Australia; Lorentz 2009 studied material stored in Cyprus	8
Karmi-*Lapatsa*	EC–MC	retained skeletal material from Stewart's excavations from selected tombs studied	Pardoe 2009 studied material stored in Australia; Lorentz 2009 studied material stored in Cyprus	4
Alambra-*Mouttes*	EC–MC	osteological analysis of all tombs published in Coleman 1996; full osteological report	Domurad 1996	6
Erimi-*Laonin Tou Pourakou*	MC	all human remains studied	Albertini – Monaco 2017	7
Episkopi-*Phaneromeni*	MC	analysis by Osterholtz 2015, but tombs not fully published	Osterholtz 2015	11
Deneia	MC	all skeletal material from tomb 789 analysed	Tucker – Clegget 2007	1
Aios Iakovos-*Melia*	MC–LC	skulls from selected tombs analysed	Fischer 1986	1* additional post-LCI tombs also studied

Table 3 Philia–LCIA. Rescue excavation tombs with osteological data

Burial site	Chronology	Osteological reference/s	Number of graves with osteologically analysed remains
Ypsonas-*Vounaros*	EC	Christofi et al. 2015	1
Audemou-*Kamares*	EC–MC	Vavouranakis et al. 2004	3
Mesoyi-*Katarraktis*	MC	Herrscher – Fox 1993	1
Psematismenos-*Koliokremmos* PK/99	MC	Fox 2007	1
Psematiosmenos-*Trelloukas* T.1/99	MC	Georgiou 2000 Lorentz 2011	1
Psematismenos-*Trelloukas* T.1/82	MC	Moyer 1985	1

Minimum Number of Individuals

Collective burials with sequential and/or contemporary interments became the standard in Cyprus from the onset of the Philia facies[22]. Prior to this, multiple burial practices were also favoured in the Chalcolithic at the Souskiou cemeteries of *Laona* and *Vathyrkakas*[23]. Without complete analysis of all recovered skeletal material at *Vounous* and Lapithos, secure minimum numbers of individuals (MNI's) for the EC–MC have not been obtainable at these sites. In these cemeteries, the number of tomb occupants was estimated based on the counting of skulls, articulated remains and the excavator's assumptions. Whilst the number of tomb occupants as published in full by P. Keswani[24] offer a rough guide to collective mortuary practices at these sites, secure osteological analysis of frequently fragmentary and commingled material is now providing a much more accurate insight into MNI's in Bronze Age graves at other sites at this time.

Osteologically derived MNI's from all sites combined, support the view that there was an increasing preference for collective burials from the Philia–LCIA, although burials with fewer individuals also continue to occur. From the Philia–ECIII, people were often buried alone, in pairs or groups of three (table 4). In the Kalavasos village cemetery, the majority of graves contained one or two bodies, with a maximum number of six interments (table 5)[25]. At EC Psematismenos-*Trelloukas*, the majority of graves also contained single interments[26]. Table 4 shows a similar pattern until the MCIII–LCIA transition, when higher numbers of individuals appear in the ›mass graves‹ associated with this period, which are characterised by high numbers of interments and very few grave goods[27].

Table 4 Philia–LCIA. MNI based on current, secure osteological data (after Douglas 2019, 104)

Period	Mean MNI	Standard deviation
Philia	1.5	0.836
ECI–III	1.89	1.68
MCI–MCIII	3.4	7.5
LCIA–LCIIB	5.07	5.789

Table 5 Kalavasos village. MNI based on current, secure osteological data (after Douglas 2019, 104)

Mean MNI	Standard deviation
1.9	1.34

Age and Sex

The estimation of age-at-death and sex using skeletal markers frequently hampers palaeodemographic analysis and this is one of the most prominent issues within the Cypriot skeletal samples for the Bronze Age[28]. Categorising remains by sex is particularly difficult and within the Philia–LCIA assemblage of analysed remains, over a third have been categorised as indeterminate based on a lack of preserved diagnostic skeletal features (fig. 2). Despite this, much more meaningful

22 Keswani 2004, 51.
23 Peltenburg 2006; Peltenburg et al. 2019.
24 Keswani 2004, 197–213 tables 4.7 a–c; 4.11 a–c.
25 Tomb 36 and Tomb 67 contained six individuals each according to Osterholtz 2015, 145 f.
26 Based on Lorentz 2011, 332 f.
27 Steel 2014, 574.
28 Harper – Fox 2008, 15.

patterns can now be gleaned from the current body of osteologically analysed individuals.

As with MNI, the Kalavasos village cemetery offers the most robust insight into age-at-death for the period (see table 6 for commonly used age categories) due to the complete analysis of all skeletal remains from this site. Based on the original analysis by C. J. Moyer[29], the average age-at-death within this cemetery was 33.6 years, out of a range of 17.5–50+ years. Adult age-at-death ranges can also be collected from four much smaller skeletal samples from cemeteries spanning the Philia – early LC. At the Philia–EC cemetery of Sotira, of the five adults for who an age estimate could be provided, the majority died between the ages of 20–30 years, however there is a much smaller overall age-at-death range for adults than at the Kalavasos village cemetery (16–37 years)[30]. At MC Erimi-*Laonin tou Porakou*, of the adults for who an age category could be specifically provided (as opposed to a general ›adult‹ only assessment), four died in what the osteologists determined as the middle adult range and five in the young adult range, with no old adults visible in the sample[31]. At MC Alambra, of the eight adult individuals studied, four died between the ages of 30–35 years, one at 20–30 years, and another at 55+ years. Given the small size of these skeletal samples, average ages-at-death should be used with caution but are important for indicating overall ranges. The combined data suggests that Bronze Age individuals could live relatively long lives, evidenced by several individuals dying at 55+ years, but that, overall, people died at a younger age.

The exclusion of subadults with adults in the EC–MC has been argued as one of the most noteworthy departures from preceding Chalcolithic funerary practice[32]. However, whilst occurring less frequently than adults, it was not wholly uncommon for adolescents, children, and infants to be buried alongside adults. For example, in the Kalavasos village cemetery, eight out of 38 burials contained adults and subadults[33]. Figure 4 shows that of all burial locales with adequate demographic data, eleven contained subadult/adolescent remains. Mass burial 789 at Deneia contained the highest number of subadults from any cemetery[34]. Both tomb 789 at Deneia and the cemetery of Psematismenos-*Trelloukas* have offered substantial evidence in recent years for the inclusion of subadults in mortuary spaces prior to the LC[35]. Other noteworthy examples are the EC–MC *intra-mural* burials at Marki-*Alonia* where at least three graves contained subadults[36].

In the majority of cases, subadults were buried in the same chambers as adults and rarely recovered as single interments. However, single interments of subadults have been identified in EC burials at Psematismenos-*Trelloukas*, Karmi-*Paleolona* and later at Episkopi-*Phaneromeni*[37]. Interments of subadults in pithoi also occurred in the Philia, with two examples from Kissonerga-*Mosphilia* and one from Marki-*Alonia*[38]. Adolescents may have also been awarded separate burial treatment in three graves at Psematismenos-*Trelloukas*, an *intra-mural* grave at Marki-*Alonia* and two graves in the Kalavasos village cemetery[39]. Adolescents were also interred with adults in two graves at Kalavasos village and in one tomb at Erimi-*Laonin tou Porakou*[40].

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29 Moyer 2007, 309.

30 Schulte-Campbell 2003.

31 Albertini – Monaco 2017, 319 f.

32 Keswani 2004, 52.

33 Osterholtz 2015, 145 f.

34 Tucker – Clegget 2007, 131–136.

35 Georgiou et al. 2011; Lorentz 2011.

36 Frankel – Webb 1996, 90.

37 Tomb 10b Karmi-*Paleolona* grave had been previously used and cleared in antiquity (Webb et al. 2009, 141–149. 258–261); Psematismenos-*Trelloukas* T.89, T.92, T.114, T.119, T.121, T.126 (Lorentz 2011, 313–336); T. 23b Episkopi-*Phaneromeni* (note that the site is not fully published, Osterholtz 2015, 111).

38 Frankel – Webb 2006, 283–285. 290–297.

39 Marki XCVIII-3 Context 1910, T.1/99, T.81 and T.80 Psematismenos-*Trelloukas* remains categorised as adolescents/young adults in these graves, T.53 and T. 61 Kalavasos village. See Moyer 1997, 111–118; Georgiou 2000, 60 f.; Lorentz 2011, 332 f.; Osterholtz 2015, 145 f.

40 See Osterholtz 2015, 111. 145 f. for Kalavasos village, T.60 and T.67; see Albertini – Monaco 2017, 307–318 for Erimi-*Laonin tou Porakou.*

In terms of sex-based patterns in tomb occupancy, adult males and females were often buried together. Once again, Kalavasos village provides the most complete sample for understanding the grouping of the dead by sex. Here, single burials of adults make up a large proportion of the sample (19 of 38 burials) based on the latest analysis[41]. From the individuals for whom sex could be determined, males and females were often buried alone at this site or in mixed-sex pairs (three graves). Female only tombs appear twice, and mixed burials of more than two males and females were common (five graves). Overall, based on the full body of osteological data available for Philia–LCI graves, single burials occur 56 times within the total sample of adult only graves (86), there are 16 burials of two adults of which eight contained a male and a female, as well as 14 mixed-sex burials containing more than two adults (fig. 3)[42].

Table 6 Age categories frequently employed by osteologists (after Osterholtz 2015, 73)

Age category	Developmental age
Preterm	Fetal
Perinatal	Birth – 2 months
Infant	Birth – 2 years
Child	2–12 years
Adolescent	12–18 years
Subadult	< 18 years
Young adult	18–35 years
Middle adult	35–50 years
Adult	18+ years

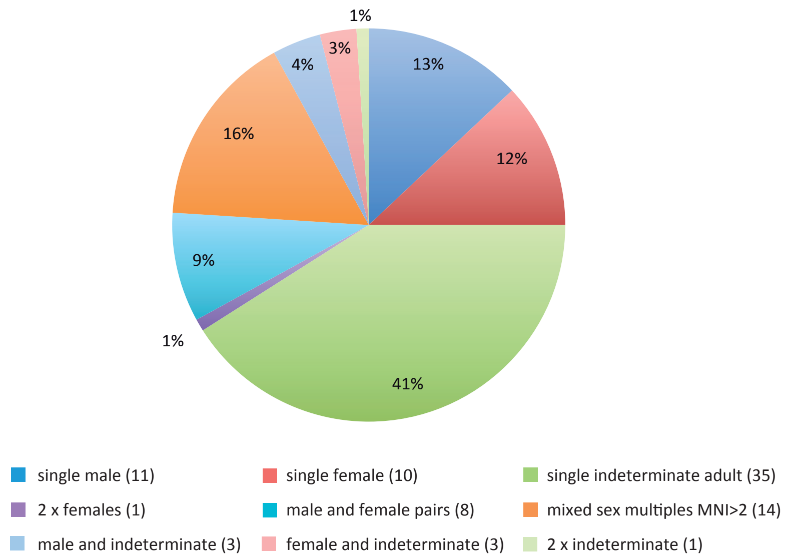

Fig. 3 Adult tomb demography (86 tombs total) (© S. Douglas)

41 Osterholtz 2015, 146.

42 Fig. 3 includes burials from the Karmi cemeteries, Alambra-*Mouttes,* Marki-*Alonia,* Episkopi-*Phaneromeni,* Sotira-*Kamminoudhia,* Nicosia-*Ayia Paraskevi,* Psematismenos-*Trelloukas,* Erimi-*Laonin tou Porakou,* Mesoyi-*Katarraktis,* Philia-*Vasiliko*, Ypsonas-*Vounaros.*

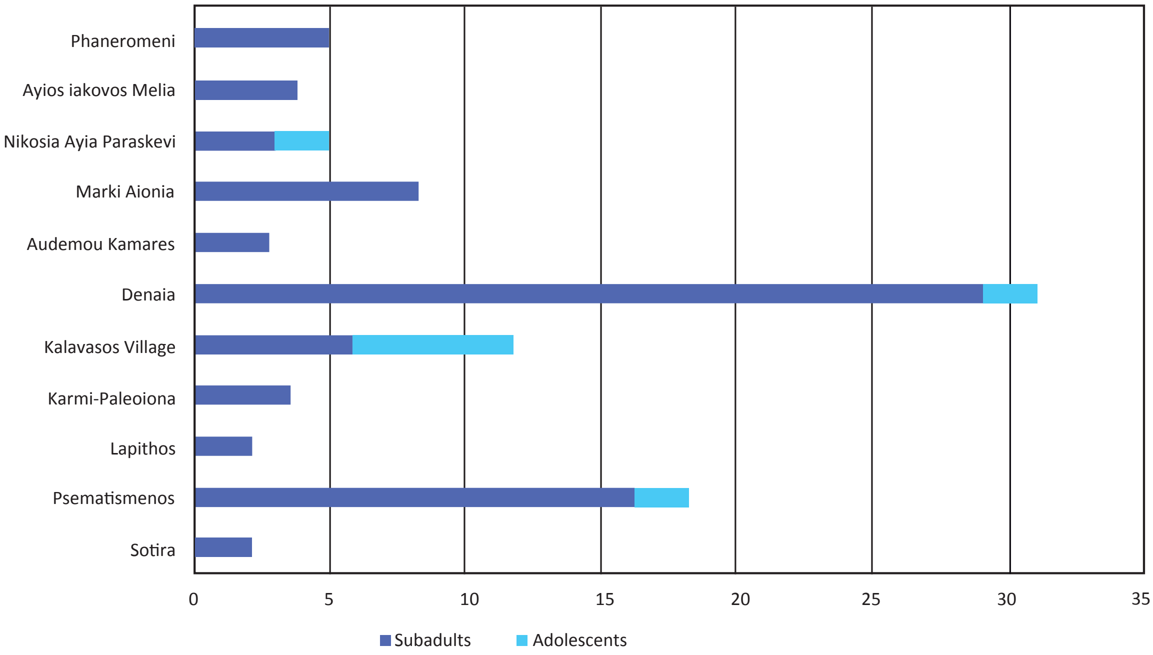

Fig. 4 Total numbers of subadults and adolescents per site (© S. Douglas)

Activity Markers

Aside from MNI, sex and age, the growing body of osteological data is also shedding new light on health and trauma in the Bronze Age population of Cyprus. As more detailed analyses are taking place, information related to activity in the population is growing. Activity markers or occupational stress markers are changes to human bone that have occurred due to repetitive movements[43]. Specific changes are observable when areas of muscle attachment (entheses) become enlarged because of concentrated stress through movement, in areas where tendons and ligaments are attached to bone[44]. A number of instances of possible stress markers on the upper and lower limbs are recorded in osteological reports for the period[45]. This includes pronounced linea aspera of the femur, which indicates strong adductor muscles[46]. In the upper body, humeri have displayed enlarged entheses at the deltoid tuberosity. This relates to the deltoid muscle[47]. Other individuals present with evidence for repeated squatting on the bones of the feet and prolonged use of the calf muscles[48].

Arthritic changes or degenerative joint diseases (DJD) are also able to offer an insight into potential occupational stresses on the human skeletal system. Whilst DJD is a normal part of the ageing process, it can also be exacerbated or present at specific sites due to repeated activity[49]. It is categorised by cartilage destruction and the formation of bony spurs called osteophytes around the joint edges[50]. Presence of arthritic changes in different areas of the skeleton have been argued to indicate different activity patterns. In the Kalavasos village cemetery arthritic changes

43 Kennedy 1989; Capasso et al. 1999.
44 Benjamin et al. 2006.
45 T.11, T.15, T.6 at Sotira; tombs 101–106 at Alambra-*Mouttes*; T.228, T.248 at Erimi-*Laonin tou Porakou*. See Domurad 1996, 515–517; Schulte-Campbell 2003, 420. 429 f.; Albertini – Monaco 2017, 307–318.
46 White – Folkens 2005, 257; Molleson 2007, 28.
47 White – Folkens 2005, 207.
48 Audemou-*Kamares* T.17 and T.228 Erimi-*Laonin tou Porakou*. See Vavouranakis et al. 2004, 49–108; Albertini – Monaco 2017, 307.
49 White – Folkens 2005, 327.
50 White – Folkens 2005, 325.

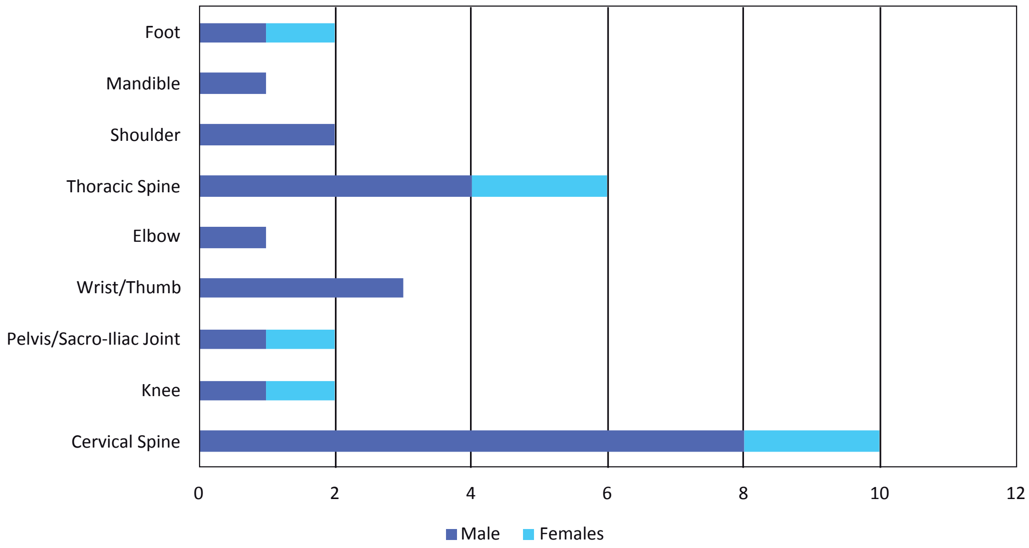

Fig. 5 Incidences of DJD in 16 sexed individuals from Kalavasos Village T.52–79 by joint based on analysis by J. Moyer 2007 (© S. Douglas)

to the feet, thoracic spine, pelvis and cervical spine affected both males and females. DJD of the shoulder, jaw, elbow and wrists/thumb was only observed on males (fig. 5). C. J. Moyer has argued that the evidence for DJD overall, shows that the inhabitants of this cemetery lived active lives[51]. It is important to note that only one female aged 50+ years-at-death was present within this sample compared to four males, and this should be taken into consideration when arguing for a disparity in the number of males and females affected by DJD. Cases of arthritic changes to joints have also been recorded at Alambra-*Mouttes*[52]. Specific occupations cannot be assigned based on the skeletal evidence presented above alone. However, these cases importantly highlight the breadth of skeletal evidence for activity that is being gleaned thorough osteological analyses of the Cypriot Bronze Age population.

Another notable case of skeletal pathology has emerged from K. O. Lorentz's analysis of an individual from MC T.11b at Karmi-*Paleolona*, evocatively labelled as the »tomb of the seafarer« by J. R. Stewart[53]. This mature adult male individual, interred alone with a large spear and a Minoan Kamares ware cup, has been identified as to have been living with extensive spinal pathologies and congenital anomalies that would have substantially impaired his mobility[54]. Thus, palaeopathological analysis is shedding light on the lived experience and lifeways of Bronze Age people in Cyprus.

Violent Trauma

The prevalence of interpersonal violence in EC–MC society has been questioned in recent years and interpretations have been largely based on deposits of weapons, which begin to feature in increasing numbers in EC–MC graves, particularly on the north coast[55]. Whilst the MCIII/LCIA transition has been previously interpreted as a period of possible »violent upheaval«[56], it has been suggested that prior to this, violent interactions may have occurred less frequently and even

51 Moyer 2007, 315.
52 T.106; see Domurad 1996, 517.
53 Stewart 1963; Lorentz 2009, 272.
54 Lorentz 2009, 272.
55 Webb 2016, 60.
56 This has been based on the emergence of ›mass‹ graves and increasing fortifications at this time, see Åström 1972, 764; Steel 2014, 574. Alternatively, these graves have been interpreted by Keswani 2004, 91 f. 157 as instances of large-scale collective burial/secondary treatment.

been viewed as anti-social and unacceptable[57]. In light of this, a number of recently identified cases of violent trauma on skeletons are able to shed new light on social interactions on Bronze Age Cyprus at this time. Positive identifications of traumatic injuries are now viewed as vital components in understanding identity and violence in the past in wider literature[58].

It can be difficult to separate traumatic injuries caused by interpersonal aggression from accidental ones however, there are a number of trauma types that are considered as reliable indicators of interpersonal violence in forensic anthropology. Cranial depression fractures located above the ›hat brim‹ line of the skull are considered as one of the most secure locations to indicate evidence of interpersonal violence involving a weapon[59]. In total, 14 individuals from Philia–LCIA graves have been identified as displaying these types of fractures[60]. The majority of cases were identified in A. J. Osterholtz's re-analysis of the Kalavasos village material, as well as in earlier analyses of material from the Karmi cemeteries, *Vounous*, Lapithos and Nicosia-*Ayia Paraskevi*. Three burials at the Kalavasos village cemetery contained two individuals with cranial depression fractures[61].

Within the Kalavasos village sample of nine individuals with cranial depression fractures, A. J. Osterholtz observes that the size and depth of fractures does not differ greatly, which indicates that similar levels of force and/or weapons were used to inflict the injuries[62]. The only notable difference in the size of the injury was observed on the skull of a male, skeleton 1 from tomb 36, who displayed fractures on both the frontal and parietal regions. One of these fractures was significantly larger in size than the injuries present on the other skeletons[63]. All of the Kalavasos village injuries were non-fatal traumas that had healed at the time of death[64], which indicates the prevalence of violent interactions as opposed to mass killings seen in larger-scale conflict[65]. In addition to the skull traumas, there are a number of post-cranial traumas evident within the skeletal population of the Kalavasos village cemetery. Tomb 58 contained multiple adults with injuries to the skull, lower limbs and chest. Two adults, one male and one female had sustained skull fractures. An additional adult, sexed as male by J. Moyer, had a kneecap injury that may have been caused by trauma from a sharp object and another male adult had broken ribs and toes that had healed at the time of death[66]. Ribs are frequently injured during interpersonal conflict and therefore a violent origin for this injury is plausible[67]. Of the Kalavasos village skeletons displaying skull trauma, one indeterminate adult buried in LCIA tomb 51, referred to as the »tomb of the unknown soldier« was found interred in close association with a cast hilt sword[68]. Whilst damaged by corrosion, the sword shows signs of wear on the blade indicating that it was likely used as a weapon prior to burial as a grave good[69]. This tantalising osteobiography provides important skeletal and material evidence for violence at the transition to the Late Bronze Age.

Higher frequencies of non-fatal injuries have been interpreted elsewhere as evidence for low-scale, intergroup conflict[70]. Thus, this emerging evidence for violent trauma from the osteologi-

57 Sneddon 2014, 63.
58 See Matić – Jensen 2017.
59 Guyomarc'h et al. 2010; Kremer – Sauvageau 2009; Kremer et al. 2008; Lovell 1997; Walker 1989.
60 T.36, T.40, T.51, T.65, T.67, T.77, T.58 Kalavasos village. T.69 *Vounous*. T.4 Karmi-*Lapatsa*. T.141/29 Lapithos. See Fischer 1986, 14 f.; Pardoe 2009; Frankel et al. 2010; Moyer 2007, 316; Osterholtz 2015, 161–167.
61 T.36, T67 and T.58; see Osterholtz 2015, 162.
62 Osterholtz 2015, 162.
63 Osterholtz 2015, 163.
64 Osterholtz 2015, 161–167.
65 Fibiger et al. 2013, 200.
66 Moyer 2007, 316; Osterholtz 2015, 162.
67 Brickley – Smith 2006.
68 Pearlman 1985; sexed as indeterminate by Osterholtz 2015.
69 See Pearlman 1985; Douglas 2019, 207.
70 E.g. Owens 2007; Fibiger et al. 2013; Smith 2014.

cal record may indicate that violent interactions played a more frequent role in the daily life of EC–MC Bronze Age Cypriots than has previously been considered[71].

Conclusions

This short paper has demonstrated that despite a number of longstanding issues with the preservation, disturbance and recording of human remains, the Bronze Age osteological dataset of Cyprus is a growing resource, from which meaningful patterns can now be explored. Much progress has been made since the last major overviews and reviews of mortuary practice and bioarchaeology on the island[72]. Thus, collated data from osteological reports related to a wider number of sites are now able to offer a far more robust insight into funerary practices through the analysis of secure MNI's, as well as palaeodemographical information related to age and sex. Beyond these broad patterns, osteological analysis is also shedding light on individual lived lives including the active nature of daily life and the prevalence of interpersonal violence. In turn, the osteological record is an increasingly valuable tool for investigating the social world of Bronze Age Cyprus. However, P. Keswani's[73] call for meticulous recording and analysis of all human remains from Bronze Age graves must still be echoed in the present in order for this valuable resource to keep on growing.

Bibliography

Albertini – Monaco 2017 E. Albertini – M. Monaco, Human Remains, in: L. Bombardieri (ed.), Erimi Laonin tou Porakou. A Middle Bronze Age Community in Cyprus. Excavations 2008–2014, SIMA 145 (Uppsala 2017) 305–319.

Åström 1972 P. Åström, Finds and results of the excavation in Cyprus, 1927–1931. The Middle Cypriot Bronze Age, SCE 4, 1, B (Lund 1972).

Benjamin et al. 2006 M. Benjamin – H. Toumi – J. R. Ralphs – G. Bydder – T. M. Best – S. Milz, Where tendons and ligaments meet bone: attachment sites (›entheses‹) in relation to exercise and/or mechanical load, Journal of Anatomy 208/4, 2006, 471–490.

Brickley – Smith 2006 M. Brickley – M. Smith, Culturally determined patterns of violence: biological anthropological investigations at a historic urban cemetery, American Anthropologist 108/1, 2006, 163–177.

Capasso et al. 1999 L. Capasso – K. A. R. Kennedy – C. A. Wilczak, Atlas of occupational markers in human remains (Teramo 1999).

Christofi et al. 2015 P. Christofi – E. Stefani – L. Bombardieri, Bridging the gap: long-term use and reuse of Bronze Age funerary areas at Ypsonas-Vounaros and Erimi-Laonin tou Porakou, in: H. Matthäus – C. Vonhoff (eds.), PoCA: Postgraduate Cypriot Archaeology (Cambridge 2015) 130–169.

Coleman 1996 J. E. Coleman (ed.), Alambra: A Middle Bronze Age Settlement in Cyprus. Archaeological Investigations by Cornell University 1974–1985, SIMA 118 (Jonsered 1996).

Crewe et al. 2005 L. Crewe – K. O. Lorentz – E. Peltenburg – S. Spanou, Treatments of the Dead: Preliminary Report of Investigations at Souskiou-Laona Chalcolithic Cemetery, 2001–2004, RDAC 2005, 41–67.

Davies 1995 P. Davies, Mortuary Patterning and Social Complexity in Prehistoric Bronze Age Cyprus (MA thesis University of Melbourne 1995).

Domurad 1996 M. R. Domurad, The Human Remains from Alambra, in: Coleman 1996, 515–518.

Douglas 2019 S. Douglas, Beyond Gender and Status: Rethinking the Burial Record of Bronze Age Cyprus (2500–1340 BC) (PhD thesis University of Manchester 2019).

Fibiger et al. 2013 L. Fibiger – T. Ahlström – P. Bennike – R. J. Schulting, Patterns of violence-related skull trauma in Neolithic Southern Scandinavia, American Journal of Physical Anthropology 150/2, 2013, 190–202.

71 Douglas 2019.
72 Davies 1995; Keswani 2004; Harper – Fox 2008.
73 Keswani 2004, 161.

Fischer 1986 P. M. Fischer, Prehistoric Cypriot Skulls: A medico-anthropological, archaeological and micro-analytical investigation, SIMA 75 (Göteborg 1986).
Fox 2006 S. C. Fox, Human skeletal remains from the 1991 and 1998 seasons, in: Frankel – Webb 2006, 290–291.
Fox 2007 S. C. Fox, The human remains from Psematismenos-Koliokremmos/Palia, in: J. M. Webb, Psematismenos-Koliokremmos/Palia Tomb PKK/94, RDAC 2007, 104–132.
Frankel – Webb 1996 D. Frankel – J. M. Webb, Marki Alonia: An Early and Middle Bronze Age Town in Cyprus. Excavations 1990–1994, SIMA 123, 1 (Jonsered 1996).
Frankel – Webb 2006 D. Frankel – J. M. Webb, Marki Alonia: An Early and Middle Bronze Age Settlement in Cyprus. Excavations 1995–2000, SIMA 123, 2 (Sävedalen 2006).
Frankel et al. 2010 D. Frankel – J. M. Webb – C. Pardoe, A note on human remains from Lefkosia-Agia Paraskevi, RDAC 2010, 177–182.
Fürst 1933 C. Fürst, Zur Kenntnis der Anthropologie der prähistorischen Bevölkerung der Insel Cypern, Lunds Universitets Årsskrift 29/6, 1933, 1–106.
Gamble 2011 M. Gamble, Health and Disease in Chalcolithic Cyprus: A problem-oriented Paleopathological Study of the Human Remains (PhD thesis University of Newcastle 2011).
Georgiou 2000 G. Georgiou, An Early Bronze Age Tomb at Psematismenos-Trelloukas, RDAC 2000, 47–63.
Georgiou et al. 2011 G. Georgiou – J. M. Webb – D. Frankel, Psematismenos-Trelloukkas: An Early Bronze Age Cemetery in Cyprus (Nicosia 2011).
Gjerstad et al. 1934 E. Gjerstad – J. Lindos – E. Sjoqvist – A. Westholm, The Swedish Cyprus Expedition: finds and results of the excavations in Cyprus 1927–1931, SCE 1 (Lund 1934).
Guyomarc'h et al. 2010 P. Guyomarc'h – M. Campagna-Vaillancourt – C. Kremer – A. Sauvageau, Discrimination of Falls and Blows in Blunt Head Trauma: A Multi-Criteria Approach, Journal of Forensic Sciences 55/2, 2010, 423–427.
Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent Research in Cypriot Bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.
Herrscher – Fox 1993 E. Herrscher – S. C. Fox, A Middle Bronze Age Tomb from Western Cyprus, RDAC 1993, 69–80.
Hjortsjö 1947 C.-H. Hjortsjö, To the Knowledge of the Prehistoric Craniology of Cyprus (Lund 1947).
Kennedy 1989 K. A. R. Kennedy, Skeletal markers of occupational stress, in: M. Y. İşcan – K. A. R. Kennedy (eds.), Reconstruction of life from the skeleton (New York 1989) 129–160.
Keswani 1989 P. S. Keswani, Mortuary Ritual and Social Hierarchy in Bronze Age Cyprus (PhD thesis University of Michigan 1989).
Keswani 2004 P. S. Keswani, Mortuary Ritual and Society in Bronze Age Cyprus, Monographs in Mediterranean Archaeology 9 (London 2004).
Knapp 2013 A. B. Knapp, The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age (Cambridge 2013).
Kremer – Sauvageau 2009 C. Kremer – A. Sauvageau, Discrimination of Falls and Blows in Blunt Head Trauma: Assessment of Predictability Through Combined Criteria, Journal of Forensic Sciences 54, 2009, 923–926.
Kremer et al. 2008 C. Kremer – S. Racette – C.-A. Dionne – A. Sauvageau, Discrimination of Falls and Blows in Blunt Head Trauma: Systematic Study of the Hat Brim Line Rule in Relation to Skull Fractures, Journal of Forensic Sciences 53/3, 2008, 716–719.
Lorentz 2006 K. O. Lorentz, Human skeletal remains from the 1999 and 2000 seasons, in: Frankel – Webb 2006, 293–297.
Lorentz 2009 K. O. Lorentz, Human remains in the Cyprus Museum, in: Webb et al. 2009, 265–281.
Lorentz 2011 K. O. Lorentz, The Human Remains, in: Georgiou et al. 2011, 313–336.
Lovell 1997 N. C. Lovell, Trauma analysis in paleopathology, American Journal of Physical Anthropology 104, 1997, 139–170.
Lunt et al. 1998 D. A. Lunt – E. J. Peltenburg – M. E. Watt, Mortuary Practices, in: E. J. Peltenburg – D. Bolger – P. Croft – E. Goring – B. Irving – D. A. Lunt – S. W. Manning – M. A. Murray – C. McCartney – J. S. Ridout-Sharpe – G. Thomas – M. E. Watt – C. Elliott-Xenophontos, Excavations at Kissonerga-Mosphilia 1979–1992, Lemba Archaeological Project 2, 1, A. B, SIMA 70, 2 (Jonsered 1998) 65–92.
Manning 2013 S. W. Manning, A New Radiocarbon Chronology for Prehistoric and Protohistoric Cyprus, ca. 11000–1050 Cal BC, in: B. Knapp, The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age (Cambridge 2013) 485–535.
Manning 2014 S. W. Manning, A Radiocarbon-Based Chronology for the Chalcolithic through Middle Bronze Age of Cyprus (as of AD 2012), in: F. Höflmayer – R. Eichmann (eds.), Egypt and the Southern Levant in the Early Bronze Age, OrA 31 (Rahden 2014) 207–240.

Matić – Jensen 2017 U. Matić – B. Jensen, Archaeologies of Gender and Violence (Oxford 2017).

Molleson 2007 T. Molleson, A method for the study of activity related skeletal morphologies, Bioarchaeology of the Near East 1, 2007, 5–33.

Moyer 1985 C. J. Moyer, The Human Skeletal Remains, in: I. A. Todd, A Middle Bronze Age Tomb at Psematismenos-Trelloukkas, RDAC 1985, 72–77.

Moyer 1997 C. J. Moyer, Human Remains from Marki-Alonia, Cyprus, RDAC 1997, 111–118.

Moyer 2006 C. J. Moyer, Human Remains from LVII-1, Context 963, in: Frankel – Webb 2006, 286–289.

Moyer 2007 C. J. Moyer, Human Skeletal Remains, in: Todd 2007, 262–332.

Osterholtz 2015 A. J. Osterholtz, Bodies in Motion: A Bioarchaeological Analysis of Migration and Identity in Bronze Age Cyprus (2400–1100 BC) (PhD thesis University of Nevada 2015).

Owens 2007 L. S. Owens, Craniofacial trauma in the prehispanic Canary Islands, International Journal of Osteoarchaeology 17, 2007, 465–478.

Pardoe 2009 C. Pardoe, Human Remains in the Nicholson Museum, in: Webb et al. 2009, 255–264.

Pearlman 1985 D. Pearlman, Kalavasos Village Tomb 51: Tomb of an Unknown Soldier, RDAC 1985, 164–179.

Peltenburg 2006 E. Peltenburg, The Chalcolilthic Cemetery of Souskiou-Vathyrkakas, Cyprus. Investigations of Four Missions from 1950 to 1997 (Nicosia 2006).

Peltenburg et al. 2019 E. Peltenburg – D. Bolger – L. Crewe (eds.), Figurine Makers of Prehistoric Cyprus. Settlement and Cemeteries at Souskiou (Oxford 2019).

Rix 1950 M. M. Rix, Cranial measurements, in: Stewart – Stewart 1950, 373.

Schulte-Campbell 1986 C. Schulte-Campbell, Human Skeletal Remains, in: Todd 1986, 168–179.

Schulte-Campbell 2003 C. Schulte-Campbell, The Human Skeletal Remains, in: S. Swiny – G. Rapp – E. Herrscher (eds.), Sotira Kaminoudhia. An Early Bronze Age Site in Cyprus, Cyprus American Archaeological Research Institute, Monograph Series 4 = American School of Oriental Research, Archaeological Reports 8 (Boston 2003) 413–438.

Smith 2014 M. J. Smith, The war to begin all wars? Contextualizing violence in Neolithic Britain, in: C. Knüsel – M. J. Smith (eds.), The Routledge Handbook of the Bioarchaeology of Human Conflict (Abingdon 2014) 109–126.

Sneddon 2002 A. Sneddon, The Cemeteries at Marki. Using a looted landscape to investigate Prehistoric Bronze Age Cyprus, BARIntSer 1028 (Oxford 2002).

Sneddon 2014 A. Sneddon, Making love not war? An archaeology of violence and some lessons for the study of Prehistoric Bronze Age Cyprus, in: J. M. Webb (ed.), Structure, Measurement and Meaning: Studies on Prehistoric Cyprus in Honour of David Frankel, SIMA 143 (Uppsala 2014) 57–67.

Steel 2014 L. Steel, Cyprus during the Late Bronze Age, in: M. L. Steiner – A. E. Killebrew (eds.), The Oxford Handbook of the Archaeology of the Levant, c. 8000–332 BCE (Oxford 2014) 577–594.

Stewart 1963 J. R. Stewart, The Tomb of the Seafarer at Karmi in Cyprus, OpAth 4, 1963, 197–204.

Stewart – Stewart 1950 E. Stewart – J. R. Stewart, Vounous 1937–1938. Field Report of the Excavations sponsored by the British School at Athens (Lund 1950).

Todd 1986 I. A. Todd (ed.), The Bronze Age Cemetery in Kalavasos village, Vasilikos Valley Project 1, SIMA 71, 1 (Göteborg 1986).

Todd 2007 I. A. Todd (ed.), Kalavasos village, Tombs 52–79, Vasilikos Valley Project 11, SIMA 71, 11 (Sävedalen 2007).

Tucker – Cleggett 2007 K. Tucker – S. Cleggett, Human Remains from Tomb 789, in: D. Frankel – J. M. Webb, The Bronze Age Cemeteries of Deneia in Cyprus, SIMA 135 (Sävedalen 2007) 131–136.

Vavouranakis et al. 2004 G. Vavouranakis – L. Karali – G. Manginis – A. Tsaliki, The Tombs at the Site of Audemou-Kamares. The Contribution of Salavage Excavation in the understanding of Material Culture and of Historical-Social Acts in Prehistoric Cyprus, RDAC 2004, 149–168.

Walker 1989 P. L. Walker, Cranial Injuries as Evidence of Violence in Prehistoric Southern California, American Journal of Physical Anthropology 80, 1989, 313–323.

Webb et al. 2009 J. M. Webb – D. Frankel – K. O. Eriksson (eds.), The Bronze Age Cemeteries at Karmi Paleolona and Lapatsa in Cyprus (Sävedalen 2009).

Webb 2016 J. M. Webb, Lapithos revisited: a fresh look at a key Middle Bronze Age site in Cyprus, in: G. Bourogiannis – C. Mühlenbock (eds.), Ancient Cyprus Today: Museum Collections and New Research, SIMA Pocket Book 184 (Uppsala 2016) 57–67.

White – Folkens 2005 T. D. White – P. A. Folkens, The Human Bone Manual (San Diego, CA 2005).

Bioarchaeological Investigations of Three Hellenistic to Early Christian Tombs from the Ayioi Omoloyites Neighborhood in Lefkosia

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Abstract

The primary goal of the »Ayioi Omoloyites Bioarchaeological Project« (AOBP) is to document and interpret the commingled human skeletal remains recovered from three Hellenistic to Early Christian rock-cut tombs located south-southwest of the old city walls of Lefkosia, Cyprus. The tomb cluster in the Ayioi Omoloyites neighborhood has been the focus of archaeological investigations by the Department of Antiquities for over 100 years. Commingled human skeletal remains recovered from all three tombs present interpretive challenges. Recent laboratory research over the past five years have focused on the inventory, assessment, and contextualization of the Ayioi Omoloyites skeletal remains employing several recent methodological and theoretical advances concerning commingled burial assemblages. While similar in condition and context to other archaeological sites in the broader region, the remains from the Ayioi Omoloyites tombs represent an extreme example of commingling and fragmentation. The following bioarchaeological report summarizes the various methods used to analyze this complicated dataset, while providing for thorough interpretation of the skeletal evidence from these tombs.

Introduction

The »Ayioi Omoloyites Bioarchaeological Project« (AOBP) is focused on the documentation and interpretation of the commingled human skeletal remains recovered from three Hellenistic (312–58 B.C.) to Early Christian (A.D. 395 – mid 7th century[1]) rock-cut tombs located south-southwest of the old city walls of Lefkosia, Cyprus. The tomb cluster in the Ayioi Omoloyites neighborhood represents one of numerous Hellenistic to Early Christian mortuary complexes across Cyprus and in Lefkosia[2]. Rock-cut tombs are highly varied across the island[3] and those examined in this study are roughly of similar size but differ in configuration (fig. 1 a. b). Commingled human skeletal remains present methodological and interpretive challenges for skeletal biologists. Recent research on commingled human remains from archaeological and forensic contexts has focused on advancing methodological and theoretical approaches[4]. Laboratory research over the past five years has focused on the inventory, assessment, and contextualization of the Ayioi Omoloyites skeletal remains employing several of these methodological and theoretical advances. While similar in condition and context to other archaeological sites in the broader region, the human skeletal remains from the Ayioi Omoloyites tombs are extremely fragmented and commingled with well over 140 kg of human bone collected during salvage excavations in 2006. The following summary puts forth various methods to analyze such complicated datasets, while providing for thorough interpretation of the skeletal and cultural material.

1 Dates from the Department of Antiquities Chronological Table <http://www.mcw.gov.cy/MCW/DA/DA.NSF/DMLchtable_en/DMLchtable_en?OpenDocument> (01.05.2019).
2 Pilides 2009.
3 Carstens 2009.
4 Adams – Byrd 2008; Osterholtz et al. 2014; Fox-Leonard – Marklein 2014.

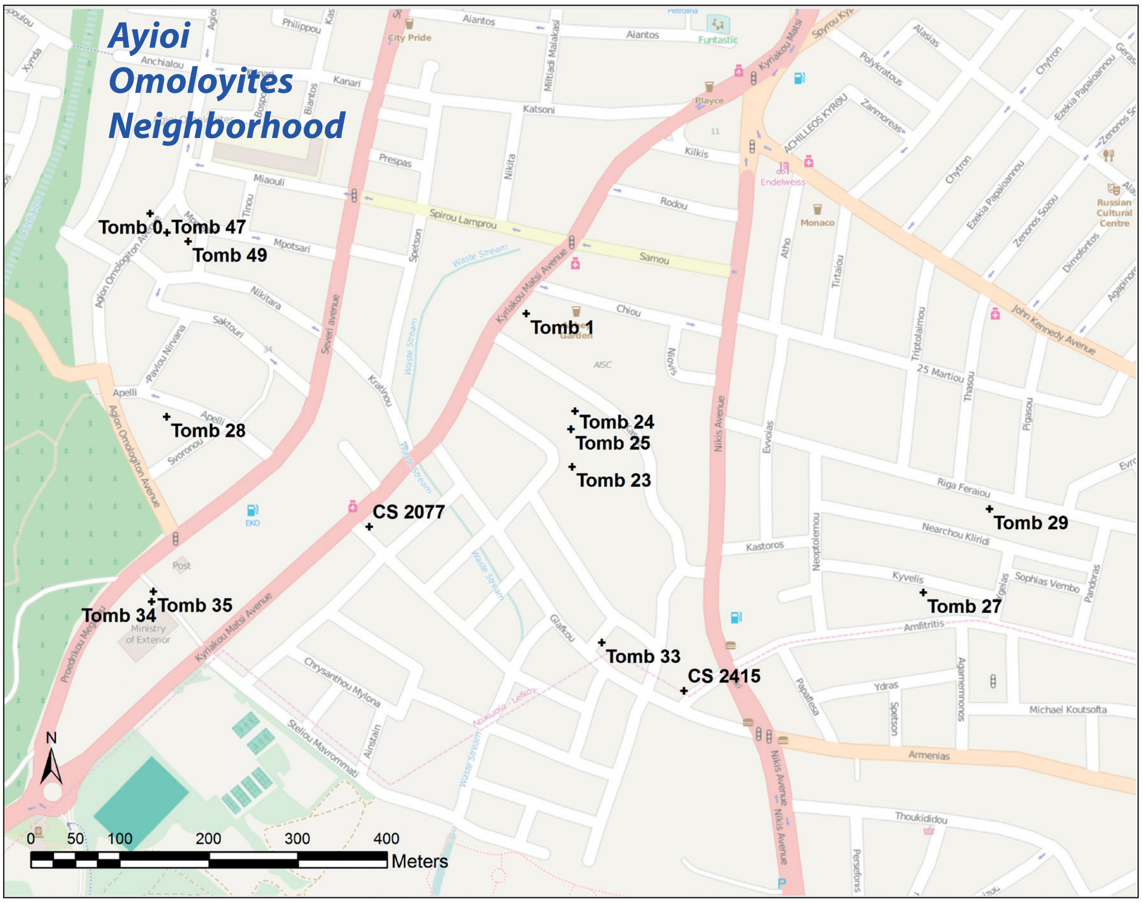

Fig. 1 a Ayioi Omoloyites neighborhood in Lefkosia with the tomb locations published in the Reports of the Department of Antiquities, Cyprus (Flourentzos 1986; Hadjicosti 1993) (NB: Tombs 47 and 48 are plotted together)

In collaboration with the Republic of Cyprus' Department of Antiquities, the goals of AOBP are to provide the Department with a summary of the human remains resulting in a comparative dataset relative to contemporaneous burial samples from across the island as well as the excavations on the Hill of Agios Georgios, directed by D. Pilides, just north of the Ayioi Omoloyites neighborhood. This chapter provides a summary of analyses of three Ayioi Omoloyites tombs (47, 48, and 49) excavated by Y. Violaris with the Department in 2006 and will be published by Y. Violaris and D. Pilides. This summary details the methodological approach used to document the commingled sample, highlights the chronology of the tombs based on radiocarbon dates derived from human bone samples, describes the general demographic structure of the tombs based on the osteological analysis, and provides examples of health assessments of adult and non-adult individuals through the comparison of paleopathological data to contemporaneous samples from Cyprus and in the Eastern Mediterranean.

The structure of this chapter is as follows: First, we detail the methods used for the study highlighting the adaption of several approaches into a cohesive and concise analytical database. Next, the chronology of the tombs is described, illustrating the research potential for tombs near Lefkosia and more broadly, the island and region as a whole. This is especially important given the oft-fragmentary and commingled nature of human skeletal remains from archaeological sites in Cyprus and the Eastern Mediterranean. We then detail the skeletal sample demography using a modified zonal element coding system[5] incorporated in the cohesive analytical database mentioned above. Lastly, data from three commonly examined indicators of community health

[5] Knüsel – Outram 2004.

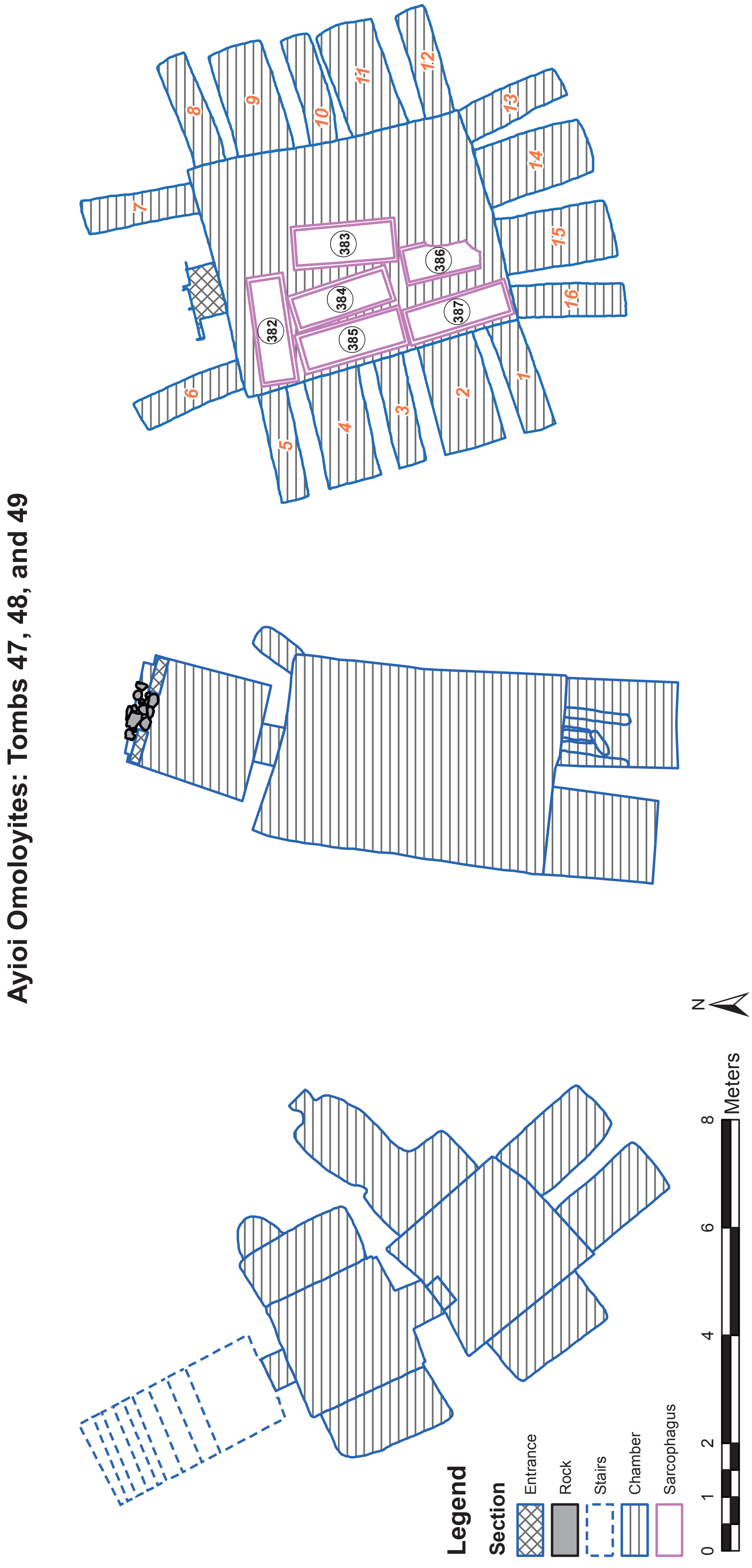

Fig. 1 b Plan maps of the three tombs (scaled equally) (modified from plan and section maps provided by the Department of Antiquities of Cyprus) are presented and discussed. These indicators include degenerative joint disease, trauma and fractures, and adult and non-adult periostitis. Combined, these analyses present a thorough example of data collection and interpretation in face of the extreme preservation issues researchers face across the region.

Methods

To facilitate the analysis of the Ayioi Omoloyites human skeletal remains, a custom relational database was developed in Filemaker®, which incorporated a variety of experiences of the first author dealing with commingled samples from Greece and North America. The data structure includes the contextual information from the Department of Antiquities salvage excavation efforts and basic osteological and dental observations critical for the assessment of the burial sample. The contextual data tied to the osseous samples varied by tomb with Tomb 49 providing more specific locations. During excavation, human bone was retained by stratigraphic level within the main chamber of Tomb 49 or was specified by a side chamber (theke) or sarcophagi. We did not want to ignore this critical information in our analysis, so the context page built into the database included all tag and box information. In addition to the tag transcriptions, initial photographs of each box or tray of remains were incorporated into the database. The osteological analysis proceeded by context within each tomb with Tomb 49 providing greater resolution. Detailed contextual data was limited to tomb identification for Tombs 47 and 48. Although multiple boxes and trays were processed for these two tombs, these containers simply stated the tomb number and the excavation date.

Each box/tray from all tombs was sorted, organized by element, side, and general age (adult and non-adult), and then coded into the database. During the coding process, all observations were recorded including bone and dental morphology, paleopathology, epiphyseal fusion, dental development, and adult age and sex markers when possible. In general, this data collection follows the Osteoware coding scheme[6]. The commingled skeletal inventory followed a modified zooarchaeological zonal system developed by C. J. Knüsel and A. K. Outram[7]. Additional zones were added to the cranial elements in order to highlight specific regions (petrous temporal and the orbital plates of the frontal) critical for quantification of minimum number of elements (MNE) values and paleopathological assessments. Post-cranial zones followed the original zonal codes except in a few instances where letter codes were converted to numbers, or in one instance, zones were combined (fibula shaft). These zones allow the authors to summarize each element and zone combination to a count by tomb or general age group.

In order to visualize these data, a custom skeletal homunculus shapefile was developed incorporating the skeletal zones defined in the database. Summarized data is joined to the shapefile and percentages or counts can be visualized through the symbology function of the associate Geographic Information System (GIS) software. Given the skeletal data is not projected, we consider this to be an Osteological Information System (OIS) linking our element-level skeletal data to summarized visualizations.

The radiometric assays were analyzed by the Oxford Radiocarbon Accelerator Unit. These samples consisted of five proximal femoral shaft sections from Tomb 49, two left complete third metacarpals from Tomb 48, and two right complete second metatarsals from Tomb 47. Three of the Tomb 49 samples failed to produce collagen yields, so only two dates were derived from each tomb. Within OxCal[8], the radiocarbon dates for each tomb were combined and probability densities generated with 95 % ranges identified. The probability distributions were then compared

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6 Buikstra – Ubelaker 1994; <https://osteoware.si.edu/> (07.01.2018).

7 Knüsel – Outram 2004.

8 Bronk Ramsey 2017; Reimer et al. 2013.

to the Department of Antiquities' chronological table for the island to determine the period of use. The chronological table is available on the Department's website[9].

Results

Demography and Dating

A total of 7,272 skeletal elements have been examined from the three tombs with 540, 457, and 6,275 elements documented from Tomb 47, 48, and 49, respectively. Minimum number of individuals (MNI) estimates based on minimum number of skeletal elements (MNE) zonal scores and demographic parameters suggest varied uses of the tombs (table 1; fig. 2) with MNI estimates of 22, 23, and 247 for the three tombs starting with Tomb 47. Clearly, the remains from Tomb 49 make up most of the analyzed skeletal material. The burial samples from Tombs 47 and 48 are small but consist of adults and non-adults.

Table 1 Demographic distribution of the Ayioi Omoloyites tombs

Age group	**Tomb 47**	**Tomb 48**	**Tomb 49**	**Total**
Infant (0–3)	1	2	44	**47**
Child (3–12)	3	5	30	**38**
Adolescent (12–18)	1	2	8	**11**
Subadult	2	1	14	**17**
Adult	17	14	165	**196**
Young adult (18–35)	2	1	17	**20**
Middle adult (35–50)	1	1	9	**11**
Older adult (50+)	0	1	5	**6**
Total	**22**	**23**	**247**	**292**

* rows in italics not counted in total

The six radiocarbon dates provide evidence to support this conclusion. The results of the radiocarbon dates are presented in table 2. As shown in table 2 and figure 3, the combined probability for Tomb 49 dates much later than Tombs 47 and 48. These two tombs clearly fall within the Hellenistic period and in each case, there is a low probability that they may in fact date to the Classical period (3.3 % for Tomb 48 and 23.9 % for Tomb 47). Tomb 49 on the other hand is much later and dates to the Early Christian period with less than a 1 % chance that it dates to the late Roman period. Clearly, the two Hellenistic Tombs have much smaller burial samples as compared to Tomb 49, the Early Christian tomb. It is likely Tombs 47 and 48 represent family or kin-based household mortuary facilities. Whereas, Tomb 49 is far more complex and likely had been repurposed as an ossuary for the larger community given the radiocarbon dates for the burial samples from each tomb and the number of individuals included in Tomb 49 as compared to Tombs 47 and 48. Future work will investigate the ancient DNA and the variety of dental and cranial morphological traits to better understand the genetic/biological diversity of each tomb's burial sample.

9 <http://www.mcw.gov.cy/mcw/da/da.nsf> (07.01.2018).

Table 2 Uncalibrated radiometric assays from the three Ayioi Omoloyites tombs

Tomb Bone	**Sample**	**Date and error (BP)**			**Yield**	**%Yld**	**Excess**	**%C**	**CN**
Tomb 47									
BID1983	OxA-37450	2212	±	28	54.00	6.8	46.5	44.4	3.2
BID1988	OxA-37451	2256	±	28	60.02	7.6	52.8	45.8	3.2
Tomb 48									
BID0852	OxA-37448	2105	±	28	49.83	6.5	42.6	44.0	3.2
BID0850	OxA-37449	2145	±	28	63.28	8.3	55.5	44.9	3.2
Tomb 49									
BID0395	OxA-34993	1563	±	30	21.95	2.4	16.8	28.6	3.2
BID0396	OxA-34994	1559	±	36	15.90	1.4	11.0	8.7	3.4

Table 3 Siler model parameters for Tomb 49 from Ayioi Omoloyites and Ulpian's Table (by Pflaumer 2015)

Siler model parameter	**Ayioi Omoloyites**	**Low CI**	**High CI**	**Ulpian's Table †**
α1	0.10767	0.06406	0.16593	0.68898
β1	0.22141	0.13679	0.36827	1.00889
α2*	0.00000	0.00000	0.00000	0.00827
α3	0.00300	0.00165	0.00524	0.00077
β3	0.05247	0.04146	0.06573	0.07633

* α2 not estimated for the Ayioi Omoloyites samples. The residual risk parameter is often difficult to estimate, and it is constant across the entire life span.
† Pflaumer 2015, tab. 3, α1 = B, β1 = g, α2 = C, α3 = A, and β3 = k

In an effort to understand if Tomb 49 was serving the entire community, the demographic structure was modeled using the non-adult and adult age estimates. A five-parameter Siler model was estimated using the mle software[10] (table 3). Non-adult ages were based on dental development[11] from digital radiographs taken of the available mandibles and femoral bone metrics using KidStats[12]. Adult ages are estimated from available pelvic indicators processed in the ADBOU Age Estimation Software (Version 2.1)[13]. The two datasets were merged and modeled in mle producing the four parameters shown in table 3 (the residual risk was not modeled for Ayioi Omoloyites). The fit line, as well as the upper and lower 95 % confidence intervals for Tomb 49 are shown in figure 4. In addition to the fit line, the Ulpian's Table model survivorship is depicted[14]. The Ulpian's Table dates to approximately A.D. 230 and has been interpreted as an ancient Roman annuities table, possibly for enslaved or formerly enslaved individuals. Clear differences are evident in the two models, but the adult parameters match well. Life expectancy at birth for Tomb 49 is 31.1 (22.7 to 44.8) and Ulpian's Table is 21.8 years. P. Pflaumer suggests that survivorship from 0 to 20 in the Ulpian's model may be underestimated resulting in higher infant mortality and a lower life expectancy[15]. He presents more nuanced analysis of this early life span and the resulting models produced life expectancies ranging from 25.6 and 30.1 years. These values match well with the Ayioi Omoloyites life expectancy values. It is also possible that non-adults are underrepresented in Tomb 49 for various reasons ranging from preservation to non-inclusion of these age groups individuals in the tomb.

[10] Holman 2003.
[11] Kamnikar et al. 2018.
[12] Stull et al. 2014.
[13] Milner – Boldsen 2012.
[14] Pflaumer 2015.
[15] Pflaumer 2015.

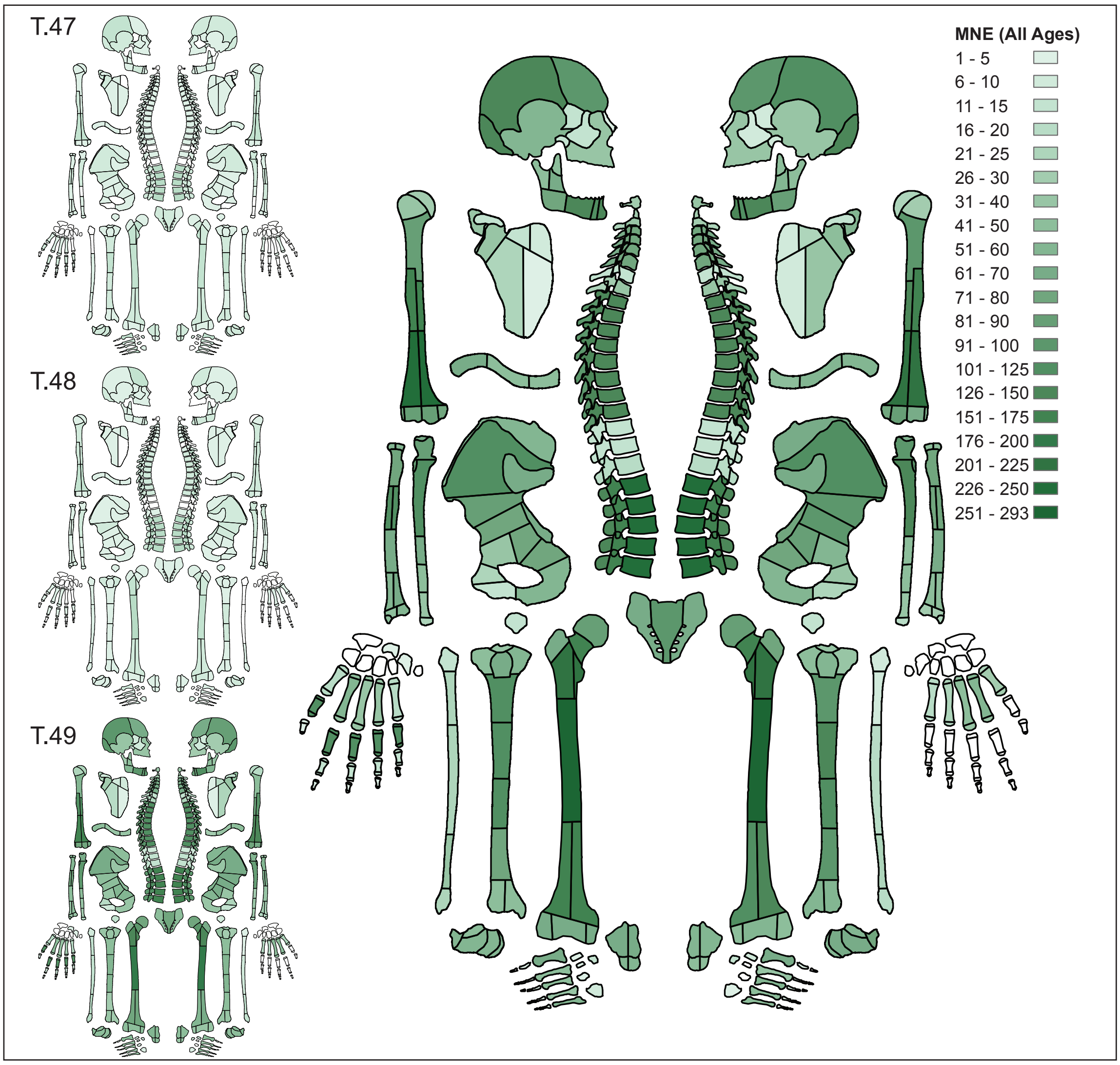

Fig. 2 Summary zonal MNE values for the entire sample and the individual tombs (© N. Herrmann)

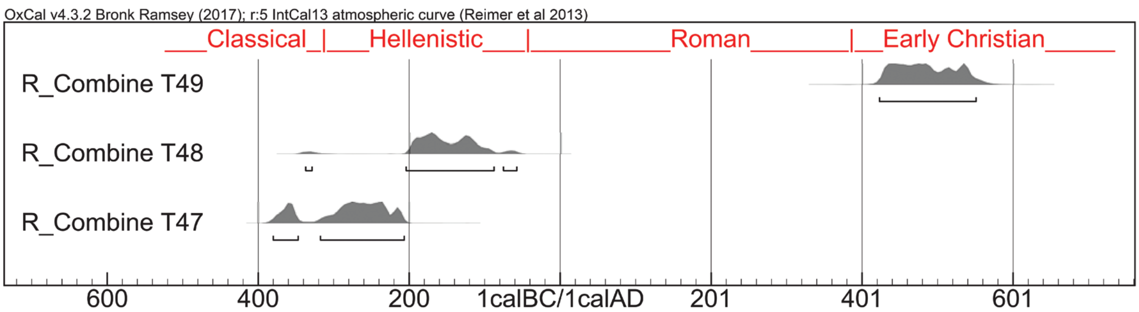

Fig. 3 Calibrated radiocarbon dates (CalBC/CalAD) with the Department of Antiquities cultural chronology in red at the top of the figure (© N. Herrmann)

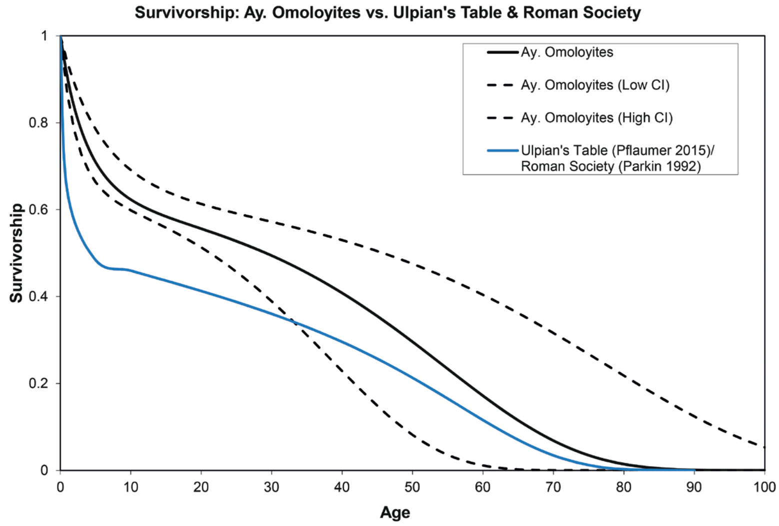

Fig. 4 Survivorship for Tomb 49 with the Ulpian's Table survivorship estimate added for comparison (© N. Herrmann)

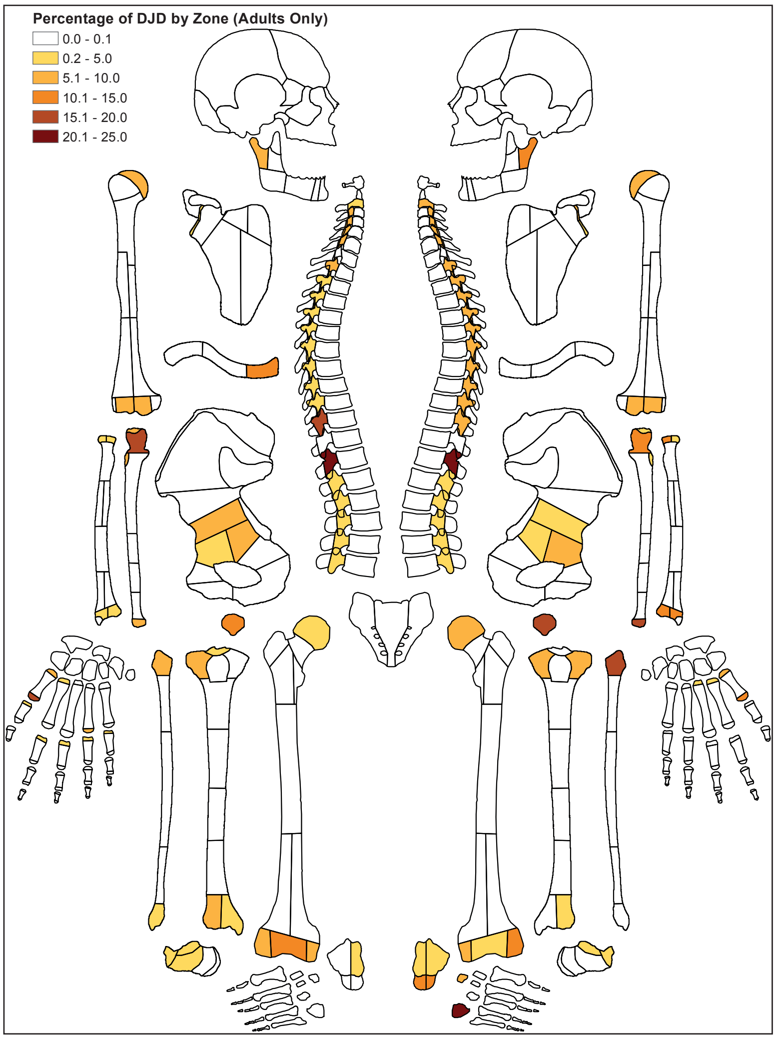

Fig. 5 Summary of joint DJD by percentage of zonal MNE values for the entire sample (© N. Herrmann)

Pathology

Due to the fragmentary and commingled nature of the Ayioi Omoloyites remains, pathological conditions and lesions had to be summarized by zone and zonal frequencies calculated. For burial samples with individual inhumations, prevalence is often reported as an individual rate not an element or zonal rate, so comparisons were made where possible. Otherwise, the individual prevalence is compared to the elemental or zonal rate.

Degenerative Joint Disease (DJD)

Over half of the pathological lesions (60 %, n = 519) are related to DJD (joint or vertebral). Degenerative joint disease provides us with evidence of the lived experiences of the individuals under study. The lesions testify to the activity levels of the individuals and the pattern of disease can inform our interpretations of the workloads performed by the population. The distribution of synovial joint degenerative lesions is depicted in figure 5 as a percentage of joint zones with DJD. The rates of vertebral centra lesions are not included in this figure because they are markedly higher than the synovial joint pattern. The maximum synovial frequency is 25 % of joint surfaces, whereas the vertebral centra rate ranges from roughly 40 % to over 90 % in the case of the lower thoracic vertebrae. If the centra rates were included in the figure, then the more nuance patterns of the synovial joints would not be evident. The pattern of appendicular DJD is consistent with the distribution recorded on the Hellenistic and Roman burials from Paphos by S. C. Fox[16]. However, the vertebral involvement including Schmorl's node and osteophyte formation is higher in the Ayioi Omoloyites sample as compared to that from Paphos[17].

Fractures and Trauma

Fractures and skeletal trauma observed in human burials provide a variety of clues as to the level of interpersonal violence, warfare, labor, accidents, and even terrain[18]. A total of 37 antemortem fractures are evident in the Ayioi Omoloyites sample. These are depicted on the skeletal diagram as simple counts (fig. 6). These range from rib fractures (n = 6, which are not depicted in the figure), comminuted clavicle fractures, and joint fusion of the left ankle of one individual. Based on the age distribution presented in table 1, 18.9 % of the adults present fractures, which is significantly higher ($X^2 = 8.02$, $p = 0.0046$) than the rate for Paphos at 9.9 % of 191 adults[19]. It may be that the Early Christian period in Lefkosia presented more risks for injury than Hellenistic Paphos. For example, the distal radius and ulna presents evidence of multiple fractures spanning several zones. Such fractures are commonly associated with accidental falls, injuries, or osteoporosis[20]. In addition to the post-cranial fractures, six cranial fractures are recorded. Four of the six fractures are recorded on the frontal and three are on the left frontal squama. Such fractures may be indicative of interpersonal violence in the Ayioi Omoloyites community as they have been interpreted in other burial samples by various researchers[21] or they could re-enforce the argument that the Ayioi Omoloyites community faced elevated risks of injury if these are accidental in origin.

Bone Formation and Periostitis

Nearly one-third of the pathological lesions (27 %, n = 232) relate to bone formation (periostitis, ossified connective tissue, or specific bony structures). Skeletal lesions associated with bone formation is especially interesting and informative in that they provide evidence of non-specific

16 Fox-Leonard 1997.
17 Fox-Leonard 1997.
18 Martin et al. 2012; Kilgore et al. 1997.
19 Fox-Leonard 1997.
20 Riggs et al. 2006.
21 Baustian et al. 2012.

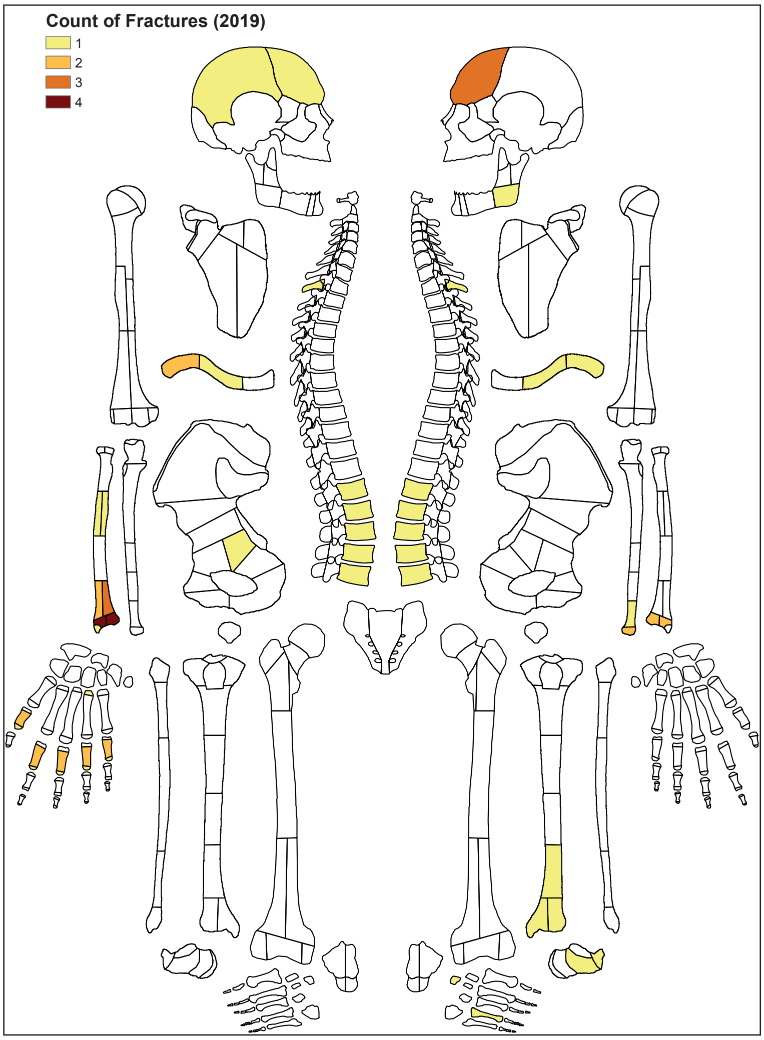

Fig. 6 Fracture frequency and distribution for the Ayioi Omoloyites sample by zone (© N. Herrmann)

infections, systemic diseases, and injuries. Given the differences in stress and diseases faced by adult and subadult individuals, periosteal lesions are divided between these two demographic groups and are represented in figure 7. Adult periosteal lesions are evident on 95 elements and are primarily focused on the lower leg and the maxillary sinuses (fig. 7, A). These lesions are consistent with maxillary sinusitis in the case of the maxillary atriums and non-specific infections, which tend to be expressed as lesions of the lower limb[22]. The lower leg shows extensive coverage of the fibular and tibial shafts. Periosteal lesions in subadults are evident on 28 elements and are also focused on the lower leg (fig. 7, B). Lesions in subadults are also present on endocranial surfaces in high frequencies, unlike adults, and likely relate to non-specific infections, possibly meningitis[23]. Overall, the median periostitis percentage for the Ayioi Omoloyites subadult samples is 5.1 % by zone, which is identical to the prevalence of 5.1 % for Paphos[24]. The adult rate is much lower with a median value of 2.5 %.

22 Roberts 2019.
23 Lewis 2004.
24 Fox-Leonard 1997.

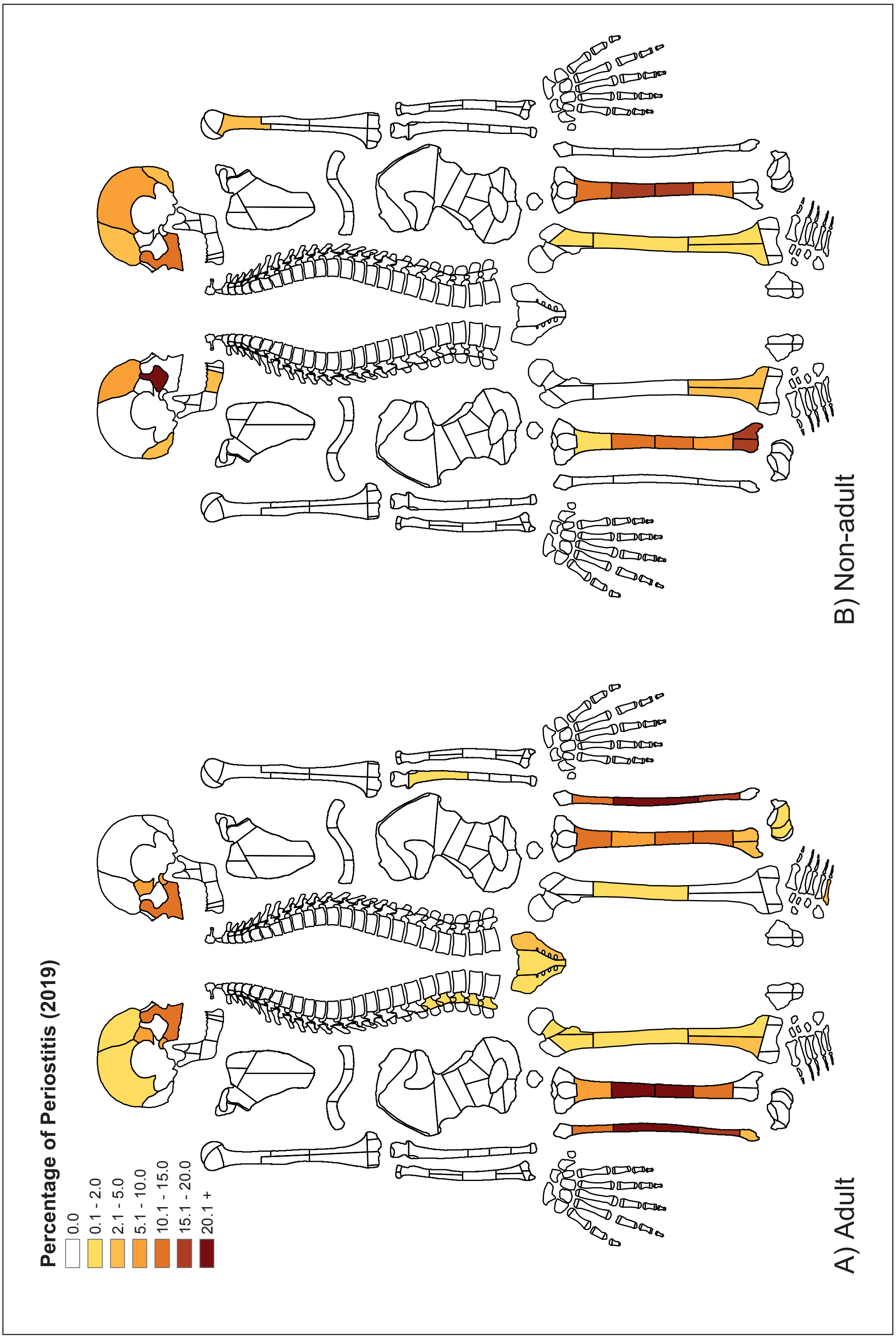

Fig. 7 (A) The percentage of periosteal lesions in non-adults by zone; (B) the percentage of periosteal lesions in adults by zone (© N. Herrmann)

Discussion and Conclusion

The analysis of the Ayioi Omoloyites sample is time consuming simply given the fact that the remains are fragmentary and commingled. Refitting of elements proved to be limited, if not impossible, with only a few bone fragments able to be reconstructed within a single context and no cross-context refits identified at this point in the project. Therefore, the analysis has proceeded at an elemental and contextual level, potentially inflating the MNE estimates from the zonal approach. As is evident in the MNE plots (fig. 2), only the midshaft and proximal femur zones (Femur Zone 6) reach the peak MNE values (293). The remaining zones are all below 225. This is an inherent problem of zonal or portion coding systems[25].

Dating of the tombs from Ayioi Omoloyites has helped resolve the temporal relationship of these three tombs and represent the first radiometric assessments of any tomb from this neighborhood in Lefkosia. These three tombs are on the western edge of the Ayioi Omoloyites neighborhood and are three of the most western tombs in the tomb complex. The fact that two appear to be Hellenistic and one is Early Christian is important for future interpretations of the burials and comparison of Tomb 49 relative to Tombs 47 and 48. For the present work, we simply look at the data in aggregate for broad skeletal comparisons. However, once the analysis of Tomb 49 is complete, we will separate the data into Hellenistic and Early Christian samples.

The picture presented by the remains thus far suggests a diverse community, similar in demographic structure as compared to other Hellenistic to Early Christian communities of coastal Cyprus and the Eastern Mediterranean. The predominately Early Christian sample from Ayioi Omoloyites does present an elevated risk of injury as evidenced by the higher number of fractures as compared to Paphos. The rates of periosteal reactions are consistent for the non-adult individuals between Ayioi Omoloyites and Paphos as well. Degenerative joint disease is also consistent for the synovial joints and the pattern suggests an active population with high degenerative changes evident in the arms and hands. Vertebral osteophytosis is elevated compared to Paphos, but the distribution of pathological changes is consistent across the vertebral units (cervical, thoracic, and lumbar vertebrae) which may suggest that the daily lives of early Lefkosians did not dramatically change from Hellenistic times to Early Christian period.

The demographic reconstruction is on-going and limited by the fragmentary nature of the collection. The use of ADBOU and the non-adult dental and diaphyseal data does produce a compelling age-at-death reconstruction, which appears consistent with the historical and regional evidence[26]. As new methods for aging specific elements of the skeleton are introduced (like Transition Analysis 3 [TA3])[27], these will be employed to improve our understanding of adult mortality in these complex deposits.

Our preliminary analysis indicates that the Hellenistic and Roman tombs in Lefkosia offer a wealth of data about the early inhabitants of the Cypriot capital. The osteological and contextual data will provide an excellent comparison to the Hellenistic and Roman remains at Kourion, Kopetra, and Paphos[28]. Future research will examine diets of these early Lefkosians through the analysis of skeletal and dental isotopic profiles. It is possible that the two communities, represented by Tombs 47/48 and Tomb 49 respectively, will present different isotopic profiles which would be indicate individuals with contrasting diets. Ultimately, the comparison of Ayioi Omoloyites to the other contemporaneous coastal sites of Cyprus and beyond will give insight into the level of integration and social interaction of early Lefkosia within the broader Cypriot Hellenistic to Early Christian world.

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25 Lyman 1994a; Lyman 1994b.
26 Pflaumer 2015; Pilides 2009.
27 Ousley – Milner 2019.
28 Fox-Leonard – Marklein 2014.

Bibliography

Adams – Byrd 2008 B. J. Adams – J. E. Byrd (eds.), Recovery, Analysis, and Identification of Commingled Human Remains (New York 2008).

Baustian et al. 2012 K. M. Baustian – R. P. Harrod – A. J. Osterholtz – D. L. Martin, Battered and abused: Analysis of trauma at Grasshopper Pueblo (AD 1275–1400), International Journal of Paleopathology 2/2, 2012, 102–111.

Bronk Ramsey 2017 C. Bronk Ramsey, Methods for Summarizing Radiocarbon Datasets, Radiocarbon 59/6, 2017, 1809–1833.

Buikstra – Ubelaker 1994 J. E. Buikstra – D. H. Ubelaker (eds.), Standards for Data Collection from Human Skeletal Remains. Proceedings of a seminar at the Field Museum of Natural History, Research Series 44 (Fayetteville, AR 1994).

Carstens 2009 A. M. Carstens, Cypriot built chamber tombs – evidence of multiculturalism?, in: S. Houby-Nielsen (ed.), Finds and Results from the Swedish Cyprus Expedition 1927–1931: A Gender Perspective, Medelhavsmuseet, Focus on the Mediterranean 5 (Stockholm 2009) 89–97.

Flourentzos 1986 P. Flourentzos, Tomb groups from the necropolis of Ay. Omologites, Nicosia, RDAC 1986, 150–163.

Fox-Leonard 1997 S. C. Fox-Leonard, Comparing Health from Paleopathological Analysis of the Human Skeletal Remains Dating to the Hellenistic and Roman Periods, from Paphos, Cyprus and Corinth, Greece (PhD thesis University of Arizona, Ann Arbor, MI 1997).

Fox-Leonard – Marklein 2014 S. C. Fox-Leonard – K. Marklein, Primary and Secondary Burials with Commingled Remains from Archaeological Contexts in Cyprus, Greece, and Turkey, in: Osterholtz et al. 2014, 193–211.

Hadjicosti 1993 M. Hadjicosti, The Late Archaic and Classical Cemetery of Agioi Omologites, Nicosia, in the Light of New Evidence, RDAC 1993, 173–193.

Holman 2003 D. J. Holman, mle. A Programming Language for Building Likelihood Models. Version 2.1. User's Manual (Seattle, WA 2003) <http://faculty.washington.edu/~djholman/mle> (07.01.2018).

Kamnikar et al. 2018 K. R. Kamnikar – N. P. Herrmann – A. M. Plemons, New Approaches to Juvenile Age Estimation in Forensics: Application of Transition Analysis via the Shackelford et al. Method to a Diverse Modern Subadult Sample, Human Biology 90/1, 2018, 11–30.

Kilgore et al. 1997 L. Kilgore – R. Jurmain – D. Van Gerven, Palaeoepidemiological Patterns of Trauma in a Medieval Nubian Skeletal Population, International Journal of Osteoarchaeology 7/2, 1997, 103–114.

Knüsel – Outram 2004 C. J. Knüsel – A. K. Outram, Fragmentation: The Zonation Method Applied to Fragmented Human Remains from Archaeological and Forensic Contexts, Environmental Archaeology 9, 2004, 85–97.

Lewis 2004 M. E. Lewis, Endocranial lesions in non-adult skeletons: understanding their aetiology, International Journal of Osteoarchaeology 14/2, 2004, 82–97.

Lyman 1994a R. Lyman, Quantitative Units and Terminology in Zooarchaeology, American Antiquity 59/1, 1994, 36–71.

Lyman 1994b R. Lyman, Vertebrate Taphonomy, Cambridge Manuals in Archaeology (Cambridge 1994).

Martin et al. 2012 D. L. Martin – R. P. Harrod – V. R. Pérez, The Bioarchaeology of Violence (Gainesville, FL 2012).

Milner – Boldsen 2012 G. R. Milner – J. L. Boldsen, Transition analysis. A validation study with known-age modern American skeletons, American Journal of Physical Anthropology 148/1, 2012, 98–110.

Osterholtz et al. 2014 J. A. Osterholtz – M. K. Baustian – L. D. Martin (eds.), Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data (New York 2014).

Ousley – Milner 2019 S. D. Ousley – G. R. Milner, Adult Skeletal Age Estimation: Transition Analysis Using the Entire Skeleton. Workshop (W24), American Academy of Forensic Sciences (Baltimore, MD 2019).

Pflaumer 2015 P. Pflaumer, Estimations of the Roman Life Expectancy using Ulpian's Table, JSM Proceedings, Social Statistics Section. Alexandria, VA: American Statistical Association, 2015, 2666–2680.

Pilides 2009 D. Pilides, Evidence for the Hellenistic period in Nicosia: The settlement at the Hill of Agios Georgios and the cemetery at Agii Omologites, Cahiers du Centre d'Etudes Chypriotes 39, 2009, 49–67.

Reimer et al. 2013 P. J. Reimer – E. Bard – A. Bayliss – J. W. Beck – P. G. Blackwell – C. Bronk Ramsey – C. E. Buck – H. Cheng – R. L. Edwards – M. Friedrich – P. M. Grootes – T. P. Guilderson – H. Haflidason – I. Hajdas – C. Hatté – T. J. Heaton – D. L. Hoffmann – A. G. Hogg – K. A. Hughen – K. F. Kaiser – B. Kromer – S. W. Manning – M. Niu – R. W. Reimer – D. A. Richards – E. M. Scott – J. R. Southon – R. A. Staff – C. S. M. Turney – J. van der Plicht, IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP, Radiocarbon 55/4, 2013, 1869–1887.

Riggs et al. 2006 B. L. Riggs – L. J. Melton – R. A. Robb – J. J. Camp – E. J. Atkinson – A. L. Oberg – P. A. Rouleau – C. H. McCollough – S. Khosla – M. L. Bouxsein, Population-Based Analysis of the Relationship of Whole Bone Strength Indices and Fall-Related Loads to Age- and Sex-Specific Patterns of Hip and Wrist Fractures, Journal of Bone and Mineral Research 21/2, 2006, 315–323.

Roberts 2019 C. A. Roberts, Infectious Disease: Introduction, Periostosis, Periostitis, Osteomyelitis, and Septic Arthritis, in: J. E. Buikstra (ed.), Ortner's Identification of Pathological Conditions in Human Skeletal Remains [3](London 2019) 285–319.

Stull et al. 2014 K. E. Stull – E. N. L'abbe – S. D. Ousley, Using multivariate adaptive regression splines to estimate subadult age from diaphyseal dimensions, American Journal of Physical Anthropology 154/3, 2014, 376–386.

Anemias in Prehistoric Cyprus

Insights from Khirokitia

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Abstract

The site of Khirokitia, which illustrates the last phase of the Aceramic Neolithic in Cyprus, yielded a large series of human remains (MNI = 243) showing an unusual age distribution. The juvenile sample includes a high proportion of infants less than one year old, mostly perinates. Furthermore, porotic bone lesions, that might suggest anemia have been frequently observed on the juvenile sample. Taking into account the ancient origin of some ß-thalassemias in the Mediterranean Basin, the hypothesis of prehistoric thalassemia in the Eastern Mediterranean, put forward by J. L. Angel in the 1960s, can be reconsidered, using the data from Khirokitia. For this purpose, we have undertaken an innovative interdisciplinary study combining anthropological and paleopathological analyses, digital imaging and isotopic studies. Promising preliminary results, regarding the microstructural analysis of bones through digital imaging techniques support the hemoglobinopathy hypothesis.

Introduction

Anemia is a major public health issue in many countries. It can be considered as »a general term for a variety of abnormalities of red blood cells that affect the ability of the circulatory system to exchange oxygen«[1]. It is the result of a wide variety of causes, mainly iron-deficiency, although other conditions such as micronutrient deficiencies, chronic inflammation, parasitic infections or inherited disorders can all cause anemia. Anemia can occur at any age of life, but its highest prevalence is observed in preschool age children (0–4.99 years)[2].

In Cyprus, anemia prevalence in children aged 6–59 months was estimated at 19 % on average in 2011[3]. The island is known to have one of the highest prevalence rates of thalassemias in the world and was one of the first countries to develop, 40 years ago, a successful population-wide prevention program[4].

According to J. L. Angel, who put forward the hypothesis of prehistoric thalassemia in the Eastern Mediterranean based on the frequency of porotic hyperostosis in Neolithic skeletal remains from this region, the mutations responsible for thalassemias might have been present in the Eastern Mediterranean since the 7th millennium B.C. Porotic hyperostosis is described by J. L. Angel as »an overgrowth of the spongy marrow space of the skull«, with the possibility that other bones are affected in children[5]. The diagnostic value of such bone modifications has

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1 Ortner 2003.
2 WHO 2008.
3 WHO 2015.
4 Kountouris et al. 2016.
5 Angel 1966.

since been debated[6] but analysis of the genetic background of thalassemias mutations indicates the ancient origin of some ß-thalassemias in the Mediterranean Basin[7].

Given the development of imaging techniques, allowing microstructural analysis of bones and advances in isotopic biogeochemistry, it is now possible to reconsider J. L. Angel's hypothesis, using a combined set of methods consisting of anthropological and paleopathological analyses, digital imaging and isotopic studies. The anthropological and paleopathological peculiarities observed at the Neolithic site of Khirokitia in Cyprus[8], which strongly suggest the presence of one or more forms of haemoglobinopathies and possibly of iron-deficiency-anemia, provide an excellent opportunity to undertake this type of study, the preliminary results of which are presented here.

Materials and Methods

The Site of Khirokitia

The site of Khirokitia, situated on a hill, about 6 km as the crow flies from the present southern coast of the island, was first excavated by P. Dikaios between 1936 and 1946[9]. After a few soundings[10], the excavations, directed by A. Le Brun, were renewed in 1977 and completed in 2009. The occupation of the site, which illustrates the last phase of the Aceramic Neolithic of Cyprus, took place during the 7th and early 6th millennium cal. B.C. The settlement area was determined to be approximately 3 ha, of which only a part has been explored. The village consists of houses composed of several round-shape buildings. It is divided into two sectors, east and west. During the course of recent excavations, nine stratigraphical levels have been recognized in the east sector (A to H, J) and three (I to III) in the west sector; it also appears that the boundaries of the village fluctuated during its occupation[11].

The Burials

Many burials were discovered at the site, all of which are primary burials. The bodies lie in a contracted position in burial pits that were dug into the floors of houses while those houses were occupied (fig. 1). The dead are all buried in the same way, whatever their age-at-death. Most of the buildings yielded at least one, and as many as 18 burials, belonging either to the same or to various stratigraphical levels. Burials of a single age-at-death group (adults, infants or older juveniles[12]) may be found in one building; whilst in other cases, adult burials were found together with infant burials and/or older juveniles. There is no evidence that a special part of the house was reserved for graves. The buildings where infant burials have been found are distributed all over the investigated area[13]. Contrary to what is commonly observed in ancient populations[14], no specific funeral treatment was devoted to infants who had been stillborn or had died shortly

6 E.g. Stuart-Macadam 1985; Stuart-Macadam 1987; Stuart-Macadam 1991; Ascenzi et al. 1991; Hershkovitz et al. 1997; Holland – O'Brien 1997; Wapler 1998; Schultz 2001; Walker et al. 2009.
7 Filon et al. 1995; Le Mort et al. 2006; Cherry et al. 2016; Vigano et al. 2017.
8 Le Mort 2000; Le Mort 2003; Le Mort 2008.
9 Dikaios 1953.
10 Stanley Price – Christou 1973; Le Brun – Stanley Price 1977.
11 Le Brun 1984; Le Brun 1989a; Le Brun 1994; Le Brun – Daune-Le Brun 2003; Le Brun – Daune-Le Brun 2009.
12 In this text, the term »juvenile« is used for any stage of life that is not truly adult (until the final fusion of long bones epiphyses), according to the definition provided by Scheuer and Black (2000); the term infant is also used according to the definition recommended by these authors (from birth to the age of one year).
13 Dikaios 1953; Le Brun 1984; Le Brun 1989a; Le Brun 1989b; Le Brun 1994; Le Mort 1994; Le Mort 2003.
14 E.g. Dedet et al. 1991; Duday et al. 1995; Coqueugniot et al. 1998; Alpe 2008.

after birth and no reserved funeral area for these very young individuals seem to have existed at Khirokitia[15].

Within the territory explored by P. Dikaios, burials are distributed across all excavated areas[16]. In the recently excavated area, burials were found in all levels except for the oldest three (levels G, H, J), but it has to be noted that these levels have only been explored in a limited area[17]. It is difficult to establish the exact number of graves found during the older excavations for two reasons: first, some of them have not been published in the final report[18]; and second, the analysis of the published data leads to the hypothesis that the few burials considered by P. Dikaios to include more than one individual correspond to superimposed single burials[19]. Therefore, the total number of individuals recovered from the Dikaios excavations is estimated to be 146 based on his published descriptions. During the soundings carried out in 1972 in the part of the site previously investigated by P. Dikaios, some new human remains were found but their burial treatment is not clear[20]. Recent excavations (since 1977) have yielded at least 107 more individuals, resulting in a total burial sample of at least 253.

Fig. 1 Khirokitia. Infant burial 830, structure 122, level C, east sector (© French Archaeological Mission at Khirokitia)

Skeletal Sample

The material from P. Dikaios' excavations was partly analyzed by J. L. Angel[21] and then by G. Kurth[22] and R. P. Charles[23]. The few remains found during the soundings were briefly reported on[24]. A reappraisal of all accessible human remains has been carried out, in parallel to the study of the skeletons from recent excavations. A portion of the human remains unearthed by P. Dikaios are now missing and could not, therefore, be reconsidered. The reappraisal of the skeletons uncovered during the old excavations, and from the soundings, and the study of the human remains from recent excavations allowed us to identify at least 243 individuals[25], of which 135 are juveniles.

15 Le Mort 2000; Le Mort 2008.
16 Dikaios 1953.
17 Le Brun 1984; Le Brun 1989a; Le Brun 1994, as well as personal communication; Le Mort 1994.
18 Niklasson 1991.
19 Le Mort 2003.
20 Stanley Price – Christou 1973.
21 Angel 1953.
22 Kurth 1958.
23 Charles 1962.
24 Stanley Price – Christou 1973.
25 In a few cases, when bones from several burials uncovered during P. Dikaios' excavations were mixed together, it was necessary to estimate the minimum number of individuals.

Bone Preservation

At Khirokitia, there is a difference in preservation amongst burials. The preservation generally, is rather good in regard to the relative completeness of the skeleton. On the other hand, the bones themselves are often in a bad condition. Most of them are broken into numerous pieces and many are partial and/or eroded; but, in general, the remains of very young infants are well preserved. Nearly all the remains are covered with concretions that could be partly dissolved in acid[26].

Estimation of Age-at-Death of Juvenile Individuals

For juvenile individuals, age-at-death was estimated according to dental development, applying the methods developed by C. Moorrees et al.[27] when the required teeth could be observed, or the chart of D. H. Ubelaker[28] in the other cases. For perinatal individuals, the bone size was, in many cases, the only available indicator of age-at-death; there, age-at-death was thus estimated by measuring the length of limb bones[29]. Because of the individual and inter-population variability, these estimates should be considered with caution. That is the reason why we include in the perinate category fetuses more than six lunar months old, stillborns and infants under one month of age[30].

Lesion Recording and 3D Imaging

All skeletal remains were examined macroscopically for porotic hyperostosis, cribra orbitalia and any abnormal porosity. Unfortunately, the state of preservation of the remains, the alterations due to taphonomic process, the concretions and the plaster used for reconstruction of skulls from P. Dikaios' excavations, greatly limited macroscopical paleopathological observations. In order to have access to the inner structure of the skulls showing porosities, micro-computed tomography (μ-CT) imaging techniques, which permits non-destructive study of pathologies[31], were applied to a selected set of five individuals. The bones were μ-CT scanned with a GE v|tome|x S at a resolution from 9.7 to 12 μm (acquisition parameters: 120 kV, 120 μA, 2550 projections, 360, 500 ms, frame averaging of 3, 0.1 mm copper filter).

Results

Age Distribution

The studied skeletal sample consists of 110 infants less than one year old, 25 other juveniles and 108 adults. The juveniles/adults ratio (56 %) appears to be consistent with an ancient population[32]. On the other hand, the age distribution of juveniles is quite unusual[33]; it reveals a high proportion of infants less than one year old (45 % of the total sample and 81 % of the juveniles), most of them (95 %) deceased during the perinatal period, as well as a low proportion of juveniles more than one year old (fig. 2).

26 Most of the skeletons unearthed in the course of P. Dikaios' excavations are still partly or totally covered with concretions; the way they were cleaned at the time of their discovery is unknown.
27 Moorrees et al. 1963a; Moorrees et al. 1963b.
28 Ubelaker 1978.
29 Fazekas – Kosa 1978; Scheuer – Black 2000.
30 According to paediatricians, the term perinatal means from 24 weeks gestation to 7 postnatal days and stillborn refers to an infant born after gestational period of 24 weeks who shows no sign of life; Scheuer – Black 2000.
31 Coqueugniot et al. 2010; Coqueugniot et al. 2015.
32 Ledermann 1969; Sellier 1996.
33 Le Mort 2000.

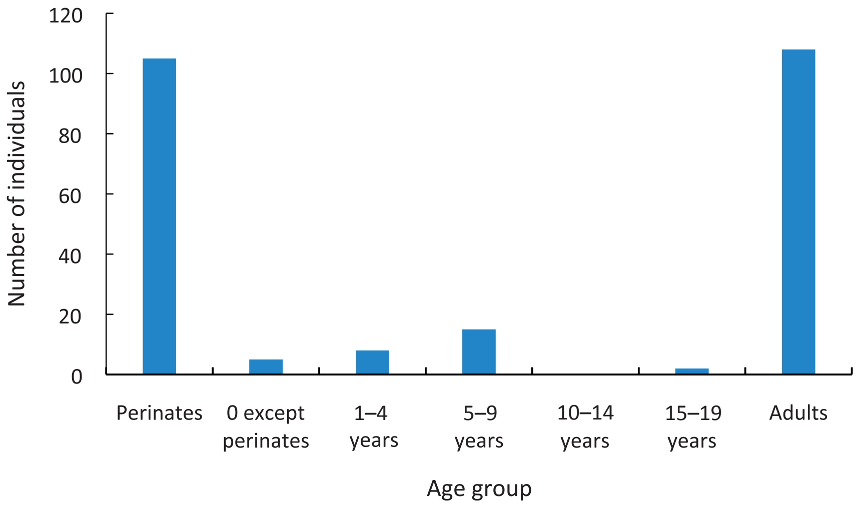

Fig. 2 Age distribution of the juvenile skeletal sample from Khirokitia (© F. Le Mort)

Bone Lesions

Cribra orbitalia (figs. 3 a. b) is the most prevalent pathology observed in the juveniles who did not die during the perinatal period, with a frequency of 78 % in observable individuals (9); it was also identified in three adult individuals. Porotic hyperostosis involves pitting and porosity of the external surface of the cranial vault usually associated with a thickening of the diploë[34]. Despite the alterations, the concretions and the plaster, porosities (figs. 4 a; 5 a) have been observed on the cranial vault of at least 21 juvenile individuals including perinates; a frequent thickening of the vault, up to 12 mm, was also noticed for the adults.

The study of these porosities using µ-CT, performed on selected samples, confirmed changes in cranial vault microstructure suggested by the appearance of the ectocranial surface. The µ-CT slice of a piece of occipital bone from a child, aged between 4.5 and 7 years-at-death, (locus 639, east sector, level A) showing porous lesions allows us to observe the widening of the diploë which presents large medullary sinuses, some of which are open on the external surface of the outer table as porosities (fig. 4 b). This trait indicates marrow hypertrophy very likely linked to anemia. This child also exhibits cribra orbitalia. The inner structure of a fragment of the right half of a frontal bone from a perinate (locus 434, west sector, level III) shows a vermiculated reorganization of the medullary space; locally the sinuses are oriented perpendicular to the outer table and are open at the external surface as numerous porosities (fig. 5 b). This pattern is highly suggestive of porotic hyperostosis resulting from anemia.

Discussion

The juvenile age distribution observed at Khirokitia is quite unusual. The proportion of infants who died before one year of age, as well as the proportion of perinates among the infants is very high. Historical demographic data reflects that the normal perinates/infants less than one year old frequency in pre-industrial populations ranges between 43 % and 52 % of the population[35]. No infant remains have been reported from other Cypriot sites dating to the 7th or early 6th millennium B.C. Earlier Neolithic Cypriot sites, Kalavasos-*Tenta*, Kissonerga-*Mylouthkia* and Parekklishia-*Shillourokambos*, yielded a small number of individuals (up to 27 individuals

34 Stuart-Macadam 1985.

35 Dupâquier 1979.

Fig. 3 a Cribra orbitalia on a child aged between 6.5 and 10 years (locus 277, west sector, level I) (photo by B. Chamel)

Fig. 3 b Cribra orbitalia on a young adult (locus 638, east sector, level A) (photo by B. Chamel)

Fig. 4 a Piece of occipital bone from a child aged between 4.5 and 7 years (locus 639, east sector, level A) showing porous lesions (photo by B. Chamel)

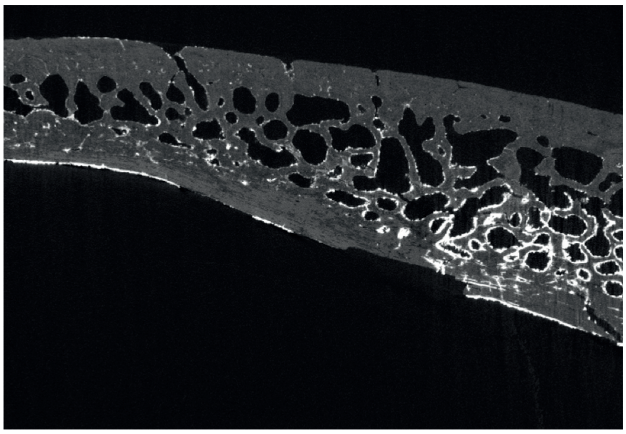

Fig. 4 b µ-CT slice (resolution: 12 µm) revealing the widening of the diploë which presents large medullary sinuses, some of which are opened at the surface of external table as porosities. This pattern reflects *hyperostosis spongiosa cranii* (© H. Coqueugniot)

Fig. 5 a Piece of the right half of the frontal bone of a perinate (locus 434, west sector, level III) exhibiting porosities (photo by B. Chamel)

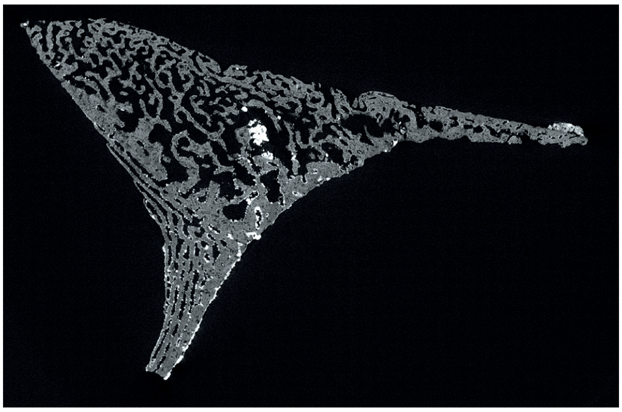

Fig. 5 b μ-CT slice (resolution: 9.7 μm) showing a vermiculated reorganization of the medullary space; locally the sinuses are oriented perpendicular to the external table, with opening at the external surface as numerous porosities. This pattern reflects *hyperostosis spongiosa cranii* (© H. Coqueugniot)

at *Shillourokambos*) which included very few perinates[36]. However, it is interesting to notice that a high proportion of the infant age group was also noted for the small skeletal series from the site of Kalavasos-*Tenta* located not far from Khirokitia: at this site, infants make up 44 % of the total population (MNI = 18)[37]. Comparisons with Neolithic Near Eastern sites dating from the 9th to the 7th millennium B.C. (Early Pre-Pottery Neolithic B [PPNB] to Pottery Neolithic) also point out the exceptionality of the age distribution of the juveniles at Khirokitia (table 1).

Table 1 Mortality patterns at Khirokitia compared to earlier Cypriot sites and some Syrian Neolithic sites

Site	Period	MNI	Proportion of juveniles	Proportion of infants among juveniles	Proportion of perinates among infants	References
Khirokitia (Cyprus)	7th–early 6th mill.	243	56 %	81 %	95 %	–
Kalavasos-*Tenta* (Cyprus)	8th–7th mill.	18	55.5 %	80 %	–	Moyer 2005
Kissonerga-*Mylouthkia* (Cyprus)	8th mill.	6	50 %	33 %	100 %	Fox et al. 2003
Shillourokambos (Cyprus)	8th mill.	27	29.6 %	37.5 %	66.7 %	Le Mort et al. 2021b
Kerkh (Syria), Pottery Neolithic levels	7th mill.	89	41.5 %	21.6 %	75 %	Chamel 2014
Abu Hureyra (Syria), phases 2A and 2B	9th–7th mill.	167	42.5 %	19.7 %	71.4 %	Chamel 2014
Dja’de el Mughara (Syria), Early PPNB levels	9th mill.	111	54 %	18.3 %	81.8 %	Chamel 2014

36 Fox et al. 2003; Moyer 2005; Le Mort et al. 2011; Le Mort et al. 2021a; Le Mort et al. 2021b.
37 Moyer 2005.

Several hypotheses could account for the very high proportion of infants deceased as perinates at Khirokitia. Firstly, it may be that this age distribution results from archaeological sampling bias. Nevertheless, when the remains from old excavations are compared to those from recent excavations in different areas of the site, or between the remains from the East and West sectors, a quite consistent picture appears: the perinatal group is over-represented in each case[38].

Another possibility could be the existence of age-related mortuary practices; it may be that the inhabitants of Khirokitia provided a specific treatment to the perinatal individuals leading to better preservation of their skeletal remains and allowing for the frequent discovery of their burials while excavating the houses. A consequence of this different treatment of perinatal individuals would mean that the other juvenile burials would be rare in the excavated portion, and imply that they were possibly buried in a, as yet, undiscovered location. Taking into account the homogeneity of mortuary practices at Khirokitia[39], such a hypothesis looks unlikely.

In a skeletal assemblage, a high number of perinates, in relation to other juveniles, can indicate infanticide[40]; this hypothesis has been formulated to explain the high number of perinates uncovered at some archaeological sites[41]. Further evidence for the sex ratio of the infant sample, and/or possible specific age-related mortuary practices, is yet needed to prove such a practice[42]. At Khirokitia, infanticide seems very improbable, taking into account again the homogeneity of mortuary practices at the site.

The high proportion of perinates at Khirokitia coupled with the high frequency of porotic bone lesions in the juvenile sample may suggest poor maternal/fetal health. A number of etiologies, such as anemias (both inherited and nutritional), scurvy, rickets, infections, etc. might induce porotic bone lesions of the skull[43]. 3D imaging techniques has allowed us to show that, at least in some cases, the porosities observed on the cranial vault of the juveniles from Khirokitia were associated with an enlargement of the diploë, as well as with changes in its microstructure, including sinuses merging at the external table, which is highly suggestive of anemia. According to P. L. Walker et al.[44], the iron-deficiency-anemia hypothesis, which has been largely accepted during the past decades, cannot explain the marrow hypertrophy that produces porotic hyperostosis (including cribra orbitalia). These pathologies would be most likely caused by hemolytic anemias and megaloblastic anemias, mainly due to vitamin B12 deficiency or folate deficiency. In possible conjunction with this, in the island of Cyprus there is a high prevalence of β-thalassemia and also high frequencies of Hemoglobin H disease (--/-α) causing severe anemia and serious health problems[45].

Conclusion and Perspectives

The very high perinatal mortality and the bone modifications observed at Khirokitia might be consistent with a hereditary anemia such as thalassemia. During the 7th millennium B.C., the inhabitants of the island of Cyprus develop an original culture, indicating a relative isolation from the mainland. It seems that the island was inhabited by a homogeneous population whose traits (i.e. brachycrany, practice of cranial deformation, funeral practices) already existed at sites of the 8th millennium B.C.[46]. This population, which is likely to have resulted from the local evo-

38 Le Mort 2000.
39 Dikaios 1953; Le Brun 1984; Le Brun 1989a; Le Brun 1989b; Le Brun 1994; Le Mort 1994; Le Mort 2003.
40 Molleson 1991.
41 E.g. Faerman et al. 1998; Mays – Eyers 2011.
42 Faerman et al. 1998.
43 E.g. Ortner 2003; Lewis 2018.
44 Walker et al. 2009.
45 Kountouris et al. 2016.
46 Le Mort 2003; Le Mort 2017.

lution of communities that arrived much earlier on the island, might have favored endogamy, leading to increased risk of autosomal diseases.

To explore, in-depth, the anemia hypothesis, we are performing a multi-factoral approach, combining micro-computed tomography and isotopic analysis at a large scale in order to reconstruct the diet and health status of the population of Khirokitia, alongside the previously completed anthropological analyses. In total, 248 bone samples, including pieces with and without porous lesions from all age categories, have been collected. Within this ongoing study, carbon, nitrogen and calcium isotopic analyses are in progress and preliminary results are promising. This project could, further, be extended to other Neolithic populations from Cyprus and the Near East in order to contribute to a more complete understanding of the early history of anemia from the Neolithic period onwards.

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Bibliography

Alpe 2008 — L. Alpe, Les tombes d'enfants à Chypre à l'époque des royaumes: bilan et perspectives, Cahiers du Centre d'Etudes Chypriotes 38, 2008, 143–159.

Angel 1953 — J. L. Angel, The Human Remains from Khirokitia, in: Dikaios 1953, 416–430.

Angel 1966 — J. L. Angel, Porotic Hyperostosis, Anemias, Malarias, and Marshes in the Prehistoric Eastern Mediterranean, Science 153, 1966, 760–763.

Ascenzi et al. 1991 — A. Ascenzi – A. Bellelli – A. B. Brunori – G. Citro – R. Ippoliti – E. Lendaro – R. Zito, Diagnosis of Thalassemia in Ancient Bones: Problems and Prospects in Pathology, in: D. J. Ortner – A. C. Aufderheide (eds.), Human Paleopathology. Current Syntheses and Future Options (Washington, DC 1991) 73–75.

Chamel 2014 — B. Chamel, Bioanthropologie et pratiques funéraires des populations néolithiques du Proche – Orient: l'impact de la Néolithisation. Étude de sept sites syriens – 9820–6000 cal. BC (PhD thesis University of Lyon 2, Lyon 2014).

Charles 1962 — R. P. Charles, Le peuplement de Chypre dans l'Antiquité. Étude Anthropologique, Études Chypriotes 2 (Paris 1962).

Cherry et al. 2016 — L. Cherry – C. Calo – R. Talmaci – P. Perrin – L. Gavrila, β-Thalassemia Haplotypes in Romania in the Context of Genetic Mixing in the Mediterranean Area, Hemoglobin 40/2, 2016, 85–96.

Coqueugniot et al. 1998 H. Coqueugniot – E. Crubézy – S. Heroin – B. Midant-Reynes, La nécropole nagadienne d'Adaïma. Distribution par âge des sujets du secteur est, BIFAO 98, 1998, 127–137.

Coqueugniot et al. 2010 H. Coqueugniot – P. Desbarats – B. Dutailly – M. Panuel – O. Dutour, Les outils de l'imagerie médicale et de la 3D au service des maladies du passé, in: R. Vergnieux – C. Delevoie (eds.), Virtual Retrospect 2009. Actes du colloque Pessac 18–20 novembre 2009, Collection Archéovision 4 (Bordeaux 2010) 177–180.

Coqueugniot et al. 2015 H. Coqueugniot – B. Dutailly – P. Desbarats – B. Boulestin – I. Pap – I. Szikossy – O. Baker – M. Montaudon – M. Panuel – K. Karlinger – B. Kovács – L. A. Kristóf – G. Pálfi – O. Dutour, Three-dimensional imaging of past skeletal TB: from lesion to process, Tuberculosis 95, 2015, 73–79.

Dedet et al. 1991 B. Dedet – H. Duday – A.-M. Tillier, Inhumations de fœtus, nouveau-nés et nourrissons dans les habitats protohistoriques du Languedoc: l'exemple de Gailhan (Gard), Gallia 48, 1991, 59–108.

Dikaios 1953 P. Dikaios, Khirokitia. Final Report on the Excavation of a Neolithic Settlement in Cyprus on Behalf of the Department of Antiquities, 1936–1946, Monographs of the Department of Antiquities of the Government of Cyprus 1 (London 1953).

Duday et al. 1995 H. Duday – F. Laubenheimer – A.-M. Tillier, Sallèles d'Aude. Nouveau-nés et nourrissons gallo-romains, Centre de Recherches d'Histoire Ancienne 144, série Amphores 3 = Annales Littéraires de l'Université de Besançon 563 (Paris 1995).

Dupâquier 1979 J. Dupâquier, La population rurale du Bassin Parisien à l'époque de Louis XIV, Publications de l'Université de Lille 3 (Paris 1979).

Faerman et al. 1998 M. Faerman – G. Kahila Bar-Gal – D. Filon – C. L. Greenblatt – L. Stager – A. Oppenheim – P. Smith, Determining the sex of infanticide victims from the Late Roman Era through ancient DNA analysis, JASc 25, 1998, 861–865.

Fazekas – Kosa 1978 I. G. Fazekas – F. Kosa, Forensic Foetal Osteology (Budapest 1978).

Filon et al. 1995 D. Filon – M. Faerman – P. Smith – A. Oppenheim, Sequence analysis reveals a ß-thalassaemia mutation in the DNA of skeletal remains from the archaeological site of Akhziv, Israel, Nature Genetics 9, 1995, 365–368.

Fox et al. 2003 S. Fox – D. A. Lunt – M. E. Watt, Human remains, in: E. Peltenburg (ed.), The colonisation and settlement of Cyprus. Investigations at Kissonerga-Mylouthkia, 1976–1996, SIMA 70/4 (Sävedalen 2011) 43–47.

Hershkovitz et al. 1997 I. Hershkovitz – B. M. Rothschild – B. Latimer – O. Dutour – G. Leonettti – C. M. Greenwald – C. Rothschild – L. M. Jellema, Recognition of Sickle Cell Anaemia in Skeletal Remains of Children, American Journal of Physical Anthropology 104/2, 1997, 213–226.

Holland – O'Brien 1997 T. D. Holland – M. J. O'Brien, Parasites, Porotic Hyperostosis, and the Implications of Changing Perspectives, American Antiquity 62/2, 1997, 183–193.

Kountouris et al. 2016 P. Kountouris – I. Kousiappa – T. Papasavva – G. Christopoulos – E. Pavlou – M. Petrou – X. Feleki – E. Karitzie – M. Phylactides – P. Fanis – C. W. Lederer – A. R. Kyrri – E. Kalogerou – C. Makariou – C. Ioannou – L. Kythreotis – G. Hadjilambi – N. Andreou – E. Pangalou – I. Savvidou – M. Angastiniotis – M. Hadjigavriel – M. Sitarou – A. Kolnagou – M. Kleanthous – S. Christou, The molecular spectrum and distribution of haemoglobinopathies in Cyprus: a 20-year retrospective study, Scientific Reports 6, 2016 <https://www.nature.com/articles/srep26371> (25.05.2019).

Kurth 1958 G. Kurth, Zur Stellung der neolithischen Menschenreste von Khirokitia auf Cypern, HOMO Journal of Comparative Human Biology 9, 1958, 20–31.

Le Brun 1984 A. Le Brun, Fouilles récentes à Khirokitia (Chypre), 1977–1981 (Paris 1984).

Le Brun 1989a A. Le Brun, Fouilles récentes à Khirokitia (Chypre), 1983–1986 (Paris 1989).

Le Brun 1989b A. Le Brun, Le traitement des morts et les représentations des vivants à Khirokitia, in: E. Peltenburg (ed.), Early Society in Cyprus (Edinburgh 1989) 71–81.

Le Brun 1994 A. Le Brun, Fouilles récentes à Khirokitia (Chypre), 1988–1991 (Paris 1994).

Le Brun – Daune-Le Brun 2003 A. Le Brun – O. Daune-Le Brun, Deux aspects du Néolithique pré-céramique récent de Chypre: Khirokitia et Cap Andreas-Kastros, in: J. Guilaine – A. Le Brun (eds.), Le Néolithique de Chypre. Actes du colloque international Nicosie 17–19 mai 2001, BCH Suppl. 43 (Athens 2003) 45–59.

Le Brun – Daune-Le Brun 2009 A. Le Brun – O. Daune-Le Brun, Khirokitia (Chypre): la taille et les pulsations de l'établissement néolithique pré-céramique, nouvelles données, Paléorient 35/2, 2009, 69–78.

Le Brun – Stanley Price 1977 A. Le Brun – N. P. Stanley Price, Khirokitia 1976, BCH 101, 1977, 733–736.

Ledermann 1969 S. Ledermann, Nouvelles tables-types de mortalité, Institut National d'Études Démographiques, Travaux et Documents 53 (Paris 1969).

Le Mort 1994 F. Le Mort, Les sépultures, in: Le Brun 1994, 157–198.

Le Mort 2000 F. Le Mort, The Neolithic subadult skeletons from Khirokitia (Cyprus): taphonomy and infant mortality, Anthropologie (Brno) 38/1, 2000, 63–70.

Le Mort 2003 F. Le Mort, Les restes humains de Khirokitia: particularités et interprétations, in: J. Guilaine – A. Le Brun (eds.), Le Néolithique de Chypre. Actes du colloque international Nicosie 17–19 mai 2001, BCH Suppl. 43 (Athens 2003) 313–325.

Le Mort 2008 F. Le Mort, Infant Burials in Pre-Pottery Neolithic Cyprus. Evidence from Khirokitia, in: K. Bacvarov (ed.), Babies reborn: Infant/child burials in pre- and protohistory. Actes du XVe congrès de l'UISPP Lisbonne 4–9 septembre 2006, BARIntSer 1832 (Oxford 2008) 23–32.

Le Mort 2017 F. Le Mort, Chypre et le Levant au Néolithique pré-céramique: évolution des pratiques funéraires et de l'état sanitaire des populations (Habilitation à diriger des recherches Ecole Pratique des Hautes Etudes, Lyon 2017).

Le Mort et al. 2006 F. Le Mort – C. Chataigner – A. N. Basak – H. Özbal – M. Özbek – Y. S. Erdal – L. Zahed – P. Perrin – G. O. Tadmouri, From bone to DNA. The hereditary anaemias in ancient populations of the Near East, in: L. Battini – P. Villard (eds.), Médecine et médecins au Proche Orient ancien. Actes du colloque international Lyon, 8–9 novembre 2002, BARIntSer 1528 (Oxford 2006) 91–101.

Le Mort et al. 2011 F. Le Mort – S. Duchesne – E. Crubézy, Les pratiques funéraires, in: J. Guilaine – F. Briois – J.-D. Vigne (eds.), Shillourokambos, un établissement néolithique précéramique à Chypre. Les fouilles du secteur 1 (Paris 2011) 1093–1117.

Le Mort et al. 2021a F. Le Mort – L. Haye – S. Lenorzer – J.-D. Vigne – S. Rigaud – T. Perrin – F. Briois – I. Carrère – J. Guilaine, Les pratiques funéraires, in: J. Guilaine – F. Briois – J.-D. Vigne (eds.), Shillourokambos, un établissement néolithique précéramique à Chypre. Les fouilles du secteur 3 (Paris 2021) 681–693.

Le Mort et al. 2021b F. Le Mort – S. Harter-Lailheugue – F. Bouchet, Biologie de la population humaine, in: J. Guilaine – F. Briois – J.-D. Vigne (eds.), Shillourokambos, un établissement néolithique précéramique à Chypre. Les fouilles du secteur 3 (Paris 2021) 695–710.

Lewis 2018 M. Lewis, Paleopathology of Children. Identification of Pathological Conditions in the Human Skeletal Remains of Non-Adults (London 2018).

Mays – Eyers 2011 S. Mays – J. Eyers, Perinatal infant death at the Roman Villa Site at Hambleden, Buckinghamshire, England, JASc 38, 2011, 1931–1938.

Molleson 1991 T. Molleson, Demographic implications of the age structure of early English cemetery sample, in: L. Buchet (ed.), Ville et campagne en Europe occidentale, Dossier de Documentation Archéologique 14 (Paris 1991) 113–122.

Moorrees et al. 1963a C. F. A. Moorrees – E. A. Fanning – E. E. Hunt Jr., Formation and resorption of three deciduous teeth in children, American Journal of Physical Anthropology 21/2, 1963, 205–213.

Moorrees et al. 1963b C. F. A. Moorrees – E. A. Fanning – E. E. Hunt Jr., Age variation of formation stages for ten permanent teeth, Journal of Dental Research 42/6, 1963, 1490–1502.

Moyer 2005 C. J. Moyer, Human burials, in: I. A. Todd (ed.), Excavations at Kalavasos-Tenta II, Vassilikos Valley Project 7, SIMA 71, 7 (Jonsered 2005) 1–15.

Niklasson 1991 K. Niklasson, Early Prehistoric Burials in Cyprus, SIMA 96 (Jonsered 1991).

Ortner 2003 D. J. Ortner, Identification of Pathological Conditions in Human Skeletal Remains ^{2}(San Diego, CA 2003).

Scheuer – Black 2000 L. Scheuer – S. M. Black, Developmental Juvenile Osteology (San Diego, CA 2000).

Schultz 2001 M. Schultz, Paleohistopathology of Bone. A New Approach to the Study of Ancient Diseases, Yearbook of Physical Anthropology 44, 2001, 106–147.

Sellier 1996 P. Sellier, La mise en évidence d'anomalies démographiques et leur interprétation: population, recrutement et pratiques funéraires du tumulus de Courtesoult, in: J. F. Piningre (ed.), Nécropoles et société au premier âge du Fer. Le tumulus de Courtesoult (Haute-Saône), Documents d'archéologie française 54 (Paris 1996) 188–202.

Stanley Price – Christou 1973 N. P. Stanley Price – D. Christou, Excavations at Khirokitia, 1972, RDAC 1973, 1–33.

Stuart-Macadam 1985 P. Stuart-Macadam, Porotic Hyperostosis: Representative of a Childhood Condition, American Journal of Physical Anthropology 66/4, 1985, 391–398.

Stuart-Macadam 1987 P. Stuart-Macadam, Porotic Hyperostosis: New Evidence to Support the Anemia Theory, American Journal of Physical Anthropology 74/4, 1987, 521–526.

Stuart-Macadam 1991 P. Stuart-Macadam, Porotic Hyperostosis: Changing Interpretations, in: D. J. Ortner – A. C. Aufderheide (eds.), Human Paleopathology. Current Syntheses and Future Options (Washington, DC 1991) 36–39.

Ubelaker 1978 D. H. Ubelaker, Human Skeletal Remains. Excavation, Analysis, Interpretation (Chicago, IL 1978).

Vigano et al. 2017 C. Vigano – C. Haas – F. J. Rühli – A. Bouwman, 2,000 Year old ß-thalassemia case in Sardinia suggests malaria was endemic by the Roman period, American Journal of Physical Anthropology 164/2, 2017, 362–370.

Walker et al. 2009 P. L. Walker – R. R. Bathurst – R. Richman – T. Gjerdrum – V. A. Andrushko, The Causes of Porotic Hyperostosis and Cribra Orbitalia. A Reappraisal of the Iron-Deficiency-Anemia Hypothesis, American Journal of Physical Anthropology 139/2, 2009, 109–125.

Wapler 1998 U. Wapler, Cribra orbitalia in Anthropobiology: Diagnostic Criterions and Implications in the Study of Ancient Skeletal Populations (PhD thesis University of Bordeaux 1, Bordeaux 1998).

WHO 2008 B. De Benoist – E. McLean – I. Egli – M. Cosgwell (eds.), World Health Organization. Worldwide prevalence of anaemia 1993–2005, WHO Global Database on Anaemia (Geneva 2008) <https://apps.who.int/iris/bitstream/handle/10665/43894/9789241596657_eng.pdf?sequence=1> (25.05.2019).

WHO 2015 World Health Organization, The Global Prevalence of Anaemia in 2011 (Geneva 2015) <https://apps.who.int/iris/bitstream/handle/10665/177094/9789241564960_eng.pdf?ssequenc=1> (25.05.2019).

A Tale of Two (or Three) Chalcolithic Villages

Health, Disease, and Lifeways at Lemba-*Lakkous*, Kissonerga-*Mosphilia*, and Chlorakas-*Palloures*

Michelle Gamble

Abstract

Comprehensive palaeopathological analyses are helpful in determining aspects of social differentiation within and amongst communities, which have shared cultural and economic lifeways. This study provides the first inter-site comparative analysis of pathological markers on the human skeleton in the Middle Chalcolithic period in Cyprus. The settlement sites of Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Chlorakas-*Palloures* are all located in the southwest of Cyprus, and results indicate that, in general, pathological expression is low amongst these populations. The majority of the individuals within these skeletal samples are subadults (under 12 years of age), and the adults are predominantly female. Dental pathologies are the most commonly observed pathologies, followed by osteoarthritic changes, with only a small number of individuals displaying evidence of trauma or a systemic disease or nutritional deficiency. With differences in expression of dental caries, calculus, and the joints effected by osteoarthritic changes based on the sex of the individuals, it can be suggested that, while the pathological expression does not indicate social hierarchy, differential access to foodstuffs and activities could have been based on sex.

Introduction

This study will primarily focus on the results of the palaeopathological analysis of the Chalcolithic settlement sites of Lemba-*Lakkous* and Kissonerga-*Mosphilia*, with additional recent results from the examination of the skeletons from the first three years of excavation at another Chalcolithic settlement site, Chlorakas-*Palloures*. This is a macroscopic palaeopathological analysis of the human skeletal material and is the first comprehensive comparative analysis of health and disease in the Chalcolithic period in Cyprus. While it relies on the standard macroscopic methods of osteological assessment, it highlights some of the issues of working on previously excavated material in Cyprus, and the difficult taphonomic conditions that exist on the island. Given the extremely poor preservation of the human skeletal material on the island, it was for many years considered unsuitable for palaeopathological analyses[1]. However, this work, and others, both within this volume and elsewhere[2], have demonstrated that important information about the past populations in Cyprus can be derived from the human skeletal material when the issues with preservation are considered and mitigated for.

This paper therefore, will begin with a short description of the Chalcolithic period and the settlements from which the human skeletal material is derived. Following the methods used, the results of the macroscopic analyses will be presented for dental disease, osteoarthritic changes, trauma, and evidence of a disease or nutritional deficiency or disorder. This will be followed

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1 Harper – Fox 2008; Lorentz 2016.

2 i.e. B. Baker, this volume; Baker – Bolhofner 2014; Fox-Leonard 1997; G. Ioannou, this volume; Lorentz 2019; M. Monaco, this volume; Osterholtz 2015; Parras 2004.

Fig. 1 Map of Cyprus showing the location of Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Chlorakas-*Palloures* (© OeAW-OeAI, C. Kurtze 2019)

by a discussion of the results and the implications for the lifeways and social organisation of the people living in the southwest of Cyprus during the Middle and Late Chalcolithic periods.

Chalcolithic Cyprus Settlements

The Chalcolithic period in Cyprus (4000/3900–2500/2400 cal. B.C.)[3] was a long and dynamic period when there was, according to E. J. Peltenburg, increasingly complex levels of social organisation[4], reaching its pinnacle in the Middle Chalcolithic[5]. There are at least 125 known Chalcolithic sites[6], with the excavations at Lemba-*Lakkous*, Kissonerga-*Mosphilia*, and Erimi-*Pamboula* dominating our understanding of the nature and material culture of the period[7]. Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Chlorakas-*Palloures* are all in very close proximity to each other in the southwest of Cyprus (fig. 1), and therefore share a similar geography; with all three situated less than a kilometre from the sea, on southwest-facing hillslopes above the coastal plain. The sites have slightly different chronologies, but the burials predominately date to the Middle (3600/3400–2700 B.C.) and Late (2700–2500/2400 B.C.) Chalcolithic periods, and they share similar types of architecture and mortuary features. All three sites reflect settlement occupation with similar archaeological evidence for domestic structures, material culture and variability in burial practice.

During the Chalcolithic period, the people lived in round structures, followed an agro-pastoral lifestyle with a substantial amount of hunting and gathering as well[8]. Kissonerga-*Mosphilia* was considered the largest site in the area until further trial trenches at Chlorakas-*Palloures* in 2018 have indicated that this site is likely even larger[9]. There is no evidence of defensive or enclosure walls around the settlement sites. According to E. J. Peltenburg, aspects of social organisation may be seen in the diversity of site sizes, with densely-inhabited large villages, such as Kissonerga-*Mosphilia* (ca. 12 ha)[10] and smaller, less crowded communities, such as Lemba-*Lakkous* (ca. 3 ha)[11]. The archaeological evidence seems to reflect structural changes, which have been interpreted as increasing social complexity during this period.

The excavations at Lemba-*Lakkous* (1976–1983) were conducted by the University of Edinburgh under the direction of E. J. Peltenburg. Lemba-*Lakkous* is located within the village boundaries of the modern village of Lemba, at the northern end of the Ktima Lowlands in the Paphos District, approximately 4 km from Paphos[12]. Kissonerga-*Mosphilia* was also excavated (1979–1992) by E. J. Peltenburg, and is located 6 km north of Paphos in the Ktima Lowlands, on the coastal plain below the modern village of Kissonerga[13]. Finally, since 2015 Chlorakas-*Palloures* has been excavated by a team from the University of Leiden, directed by B. Düring, initially as a rescue excavation. It is located approximately 3 km from Paphos, just below the modern village of Chlorakas. The site has been badly disturbed by the mid-1970s land consolidation programme; several roads were cut through the site and buildings were constructed on top. To date, seventeen 5 × 10 m trenches have been opened in order to establish the distribution of archaeological strata across the site and locate well-preserved buildings and contexts[14]. Excavations will continue for some years to come as the land has been purchased and scheduled by the government.

3 Knapp 2013, 27.
4 Peltenburg 2002; Bolger 2003, 102–105; Knapp 2013, 195.
5 Knapp 2013, 206.
6 Knapp 2013, 197.
7 Knapp 2013, 195–262.
8 Peltenburg 1998, 239.
9 Düring et al. 2019.
10 Peltenburg et al. 1998, 3; Peltenburg 1991a, 18.
11 Peltenburg 1991c, 17 f.
12 Peltenburg et al. 1985, 4 f.
13 Peltenburg et al. 1985, 1.
14 Düring et al. 2018.

Chalcolithic Burials

All three sites have intra-settlement burials of a portion of their overall populations, as the number of graves found could not represent the totality of the population over time[15]. The majority of the burials tended to be pit graves, or pit graves with capstones, with several exceptions including chamber tombs and two pot burials[16]. In general, there is greater variety in the burial programme at Kissonerga-*Mosphilia* than at Lemba-*Lakkous*, due to the larger size of the site and the longer period of use, which provides the opportunity to observe the chronological changes in burial practice[17]. Given the small number of burials excavated to-date at Chlorakas-*Palloures*, it is not possible to talk about burial programme or variation at this time. All of the dentition from Lemba-*Lakkous* and Kissonerga-*Mosphilia* was previously examined by D. A. Lunt, however, the teeth were re-assessed along with the skeletal material as part of this palaeopathological analysis[18].

Materials

With the permission of the Department of Antiquities of Cyprus and the site directors, the skeletal material from all three sites was examined at the Paphos Museum and the Edgar Peltenburg Archaeological Research Centre. Forty-seven of the 56 recorded graves from Lemba-*Lakkous* were located, 18 from Area I and 29 from Area II. At Kissonerga-*Mosphilia*, 62 of 73 recorded graves were examined[19], and all 15 of the identified and excavated graves from Chlorakas-*Palloures* were investigated. While a small portion of the graves at Kissonerga-*Mosphilia* and Lemba-*Lakkous* were either disturbed through ploughing or ancient intrusions, most are undisturbed primary burials. At Chlorakas-*Palloures*, the term »burial« was given to any human remains identified in the field, so it was only possible to confidently assign 9 of the 15 as primary burials, with two others which may be primary but extremely partial; the rest of the skeletal material likely comes from disturbed or secondary contexts.

Methods

The methods of observation and analysis of the human remains in this paper are in agreement with the recommendations from J. E. Buikstra and D. H. Ubelaker[20]. Observations were recorded for skeletal material from a single context in a detailed inventory recording: bone element, side, the segment of the skeletal element present, the number of fragments or the weight, the completeness score, the level of fragmentation, and the surface preservation level of the skeletal element. The length of the bone is recorded where possible and any evidence of pathologies on the bones or teeth

15 There are several known Chalcolithic period *extra mural* cemeteries, which have been identified across Cyprus, two of which have been excavated. The Souskiou-complex of cemeteries in the southwest of the island, near Kouklia, have been excavated and published by E. J. Peltenburg and team (Peltenburg 2006; Peltenburg et al. 2019). The skeletal material from Souskiou-*Vathyrkakas* was inventoried and presented in the publication, but no further work has been done on the material (Lunt et al. 2006). Souskiou-*Laona* represents one of the best excavated and recorded *extra mural* cemeteries from the prehistoric periods in Cyprus, and the skeletal material has been examined as part of the author's PhD thesis (Gamble 2011; and in Lorentz 2019).

16 Peltenburg et al. 1998, 68–72.

17 Niklasson 1991.

18 Lunt 1985; Lunt et al. 1998; Gamble 2011.

19 The missing graves from Lemba-*Lakkous* and Kissonerga-*Mosphilia* are predominantly those, which did not contain any skeletal material. At Lemba-*Lakkous*, three graves with skeletal material could not be located within the Museum stores, five graves contained no skeletal material, and one was not excavated. At Kissonerga-*Mosphilia*, ten graves contained no skeletal material, and one was located that was not recorded in the publication (Grave 559).

20 Buikstra – Ubelaker 1994.

are described in terms of severity and location. Standard age estimation methods were used based on developmental and degenerative changes for subadult and adult indviduals, respectively[21]. The recommended methods to determine the sex of adult human skeletal remains use the os coxa for the greatest accuracy and precision[22]. This was used in conjunction with sexually dimorphic features of the skull to determine sex[23] and where this was not possible, metric determination using aspects of post-cranial elements was employed[24]. Living stature could not be determined for any individuals due to fragmentation of the long bones, and thus was not included in this analysis.

It must be kept in mind that the indices applied, for age, sex and stature, are not based on prehistoric Cypriot populations and diet and natural variation across populations can affect the precision of estimation. However, as there is currently no chart for prehistoric Cypriot populations the standards were systematically and consistently used to present the best possible result.

Preservation and Minimum Number of Individuals

The assessment of surface preservation is rather subjective but can be very important in aiding with the understanding of age and sex assessment and the discussion of pathologies present. Skeletal preservation depends on a number of factors, including the age and sex of the individual and the size, shape and robusticity of the bone[25]. Taphonomic processes such as the burial environment, excavation and the curation of the skeletal material can also significantly affect the condition of the bones and the amount of the skeleton recovered[26]. Excellent preservation implies that there is no bone surface erosion and clear surface morphology, while extremely poor preservation reflects severe erosion of the bone surface and complete loss of bone surface morphology making it impossible to assess for pathology or other features on the bones.

The minimum number of individuals (MNI) within a burial is calculated, following the standard procedure, by counting all the long bone ends and distinctive bones present, taking side, age and sex into account[27]. The largest number of the same aspect of a skeletal element present is then taken as the MNI. This number is not infallible and does not preclude the possibility that there may actually have been more individuals present.

Palaeopathological Assessment and Limitations

Pathological lesions were recorded where present[28], and represent evidence of physiological stress during life, which has affected the skeleton. Within this paper, dental pathology, osteoarthritic changes, trauma or infection, and lesions representing a disease or disorder will be presented as a basis for discussion on the life and lifeways and social stratigraphy at the settlement sites of Lemba-*Lakkous*, Kissonerga-*Mosphilia* and, to a limited extent, Chlorakas-*Palloures*.

When analysing the prevalence of dental pathologies based on the individual, only those individuals with one or more tooth were included in the analysis[29]. Dental caries is a bacterial disease, which demineralises the inorganic portion of the tooth enamel and destroys the organic

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21 Schaefer et al. 2009; Buikstra – Ubelaker 1994. For the os coxa: Lovejoy et al. 1985; Brooks – Suchey 1990; Todd 1920. For dentition: Miles 1963; Lovejoy 1985.
22 Phrenice 1969; Schwartz 1995.
23 Buikstra – Ubelaker 1994; White – Folkens 2005.
24 As within Bass 1995.
25 Junkins – Carter 2017, 145–151.
26 Junkins – Carter 2017, 145–151.
27 Buikstra – Ubelaker 1994.
28 After the methods of Aufderheide – Rodriguez-Martin 1998; Buikstra – Ubelaker 1994; Ortner 2003 and Waldron 2009.
29 Dental pathologies were also calculated on a tooth-by-tooth basis in Gamble 2011.

portion[30]. Diet, dental hygiene and the pH of the saliva can all have an impact on the occurrence of dental caries in regards to their formation, location and severity[31]. Caries were recorded based on presence or absence followed by their general size and location on the tooth crown. Calculus is mineralised plaque deposits caused by a build-up of microorganisms against the tooth surface[32]. While calculus is a common irritant leading to the erosion of the alveoli in periodontal disease[33], periodontal disease was not assessed in a systematic way within these skeletal samples due to the poor preservation of the alveoli in most cases. Calculus was recorded according to location and severity on the tooth[34]. In general, dental enamel hypoplasias are a deficiency in the amount or thickness of enamel, resulting from a disruption in the secretory/matrix formation phase of amelogensis caused by a physiological stress as the tooth crown forms[35]. Due to the nature of the taphonomic damage to the tooth surfaces within the skeletal samples of this study, it is not possible to assess for hypoplastic pits and only linear defects were recorded. Linear enamel hypoplasia (LEH) is recorded as present or absent, by severity and by location on the tooth. »Although not a dental disease per se, dental wear is the natural result of masticatory stress upon the dentition in the course of both alimentary and technological activities«[36]. There are a number of factors which affect the wear on teeth, however diet, food processing methods, and use of the teeth as a tool in particular can be considered the leading contributing factors to the gradients of tooth wear[37]. ›Heavy attrition‹ is recorded within this study where there is significant loss of crown due to wear. Ante-mortem tooth loss (AMTL) refers to the *in vivo* loss of teeth and has a wide variety of causes. AMTL was recorded based on location within the jaw and the state of healing of the alveolar bone.

Osteoarthritis or degenerative joint disease is characterised by porosity, eburnation (polishing of the articular surface once the cartilage of a joint is destroyed), subchondral bone sclerosis (hardening of the underlying bone once the cartilage of a joint has been destroyed) and osteophytic growth (bony outgrowths typically on joint surfaces or at their margins) at the articular surfaces where the cartilage has broken down and allowed the two bones of a joint to rub together[38]. A diagnosis of osteoarthritis requires that a number of articular surfaces within the skeleton display lesions or changes[39]. Since preservation and skeletal completeness are so poor within the samples examined for this research, there are rarely enough joint surfaces preserved of a discrete skeleton to diagnose osteoarthritis. Therefore, for this study, the term »osteoarthritic changes« is used where there are elements of osteoarthritis expressed such as osteophytic growth and/or porosity and/or remodelling of the articular surface indicating a malarticulation. Osteoarthritic changes were recorded by presence or absence, and then by type of osseous change observed on the articular facet. Analysis of the frequency of osteoarthritic changes was accomplished by bone element and articular surface affected, indicating which joint would have been affected.

Trauma has an impact on a skeleton in four main ways according to D. J. Ortner: »(1) complete break in a bone, (2) an abnormal joint or displacement or dislocation of joints, (3) a disruption in nerve and/or blood supply, and (4) an artificially induced abnormal shape or contour of bone«[40]. Periosteal reactions (periostitis) are often the result of an infection or trauma (though can be a symptom of another systemic disease) which results in a laminar bone development on the surface of a bone[41].

30 Aufderheide – Rodriguez-Martin 1998, 402–404; Hillson 2005, 290–303.
31 Hillson 1996, 276–284.
32 Hillson 1996, 255.
33 Ortner 2003, 593.
34 Hillson 2001.
35 Aufderheide – Rodriguez-Martin 1998, 405.
36 Powell 1985, 308.
37 Roberts – Manchester 2005, 78 f.
38 Aufderheide – Rodriguez-Martin 1998, 93–96; Waldron 2009, 33 f.
39 Waldron 2009, 31–39.
40 Ortner 2003, 119.
41 Ortner 2003, 130.

For this study, the general terms of »disease or disorder« are used to describe limited types of lesions which may relate to osseous changes due to a metabolic disorder such as scurvy, infectious disease such as tuberculosis, or hematopoietic disease such as iron-deficiency-anaemia. Since there is a limited way that the bones can react to an assault, the diagnoses of a particular disease typically requires a number of skeletal elements to be involved to in a particular way and there can be some overlap in the individual expression on a particular bone[42]. The lesions, which are commonly associated with diseases or disorders within an archaeological skeletal sample, include porotic hyperostosis or cribra orbitalia. These appear as porosity on the cranium, and both have non-specific aetiologies, which makes diagnosis of a specific disease or deficiency challenging. Other pathologies recorded include, bowing of long bones, which could be due to cortical thinning of the bone due to vitamin deficiency such as vitamin D.

The principal issue with analysis of the skeletal material from Lemba-*Lakkous* and Kissonerga-*Mosphilia* was the use of consolidant in excavation and conservation. A number of the bones and teeth were treated with consolidant and in some cases a mesh fabric both of which adhered dirt to the bone surface. At Chlorakas-*Palloures* the highly fragmentary nature of the skeletons and poor surface condition were the primary issues. Preservation of the skeletal material in general was a limiting factor in the analysis of pathological lesions.

Results of the Palaeopathological Analysis

Palaeopathological analyses of the human skeletal remains from Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Chlorakas-*Palloures* reflect the nature and prevalence of disease and trauma within the Chalcolithic settlement populations from the Paphos district. The results presented here reflect those of the discrete, separate individuals as they comprise the majority of the skeletal remains observed[43]. Percentages or prevalences of expression of various pathologies are all stated based on only those with those particular skeletal elements present (i.e. prevalence of dental disease based only on those with teeth observed).

Demographic Profile

The demographic profiles across all three sites are similar – with a high percentage of subadults and a higher portion of the adult population being female. With 72 % of the individuals under 21 years of age at death at Lemba-*Lakkous*, 69 % at Kissonerga-*Mosphilia*, and 64 % at Chlorakas-*Palloures*, the mortuary populations from these villages are comparable. This similarity continues with the adult individuals where sex could be established, with a far higher percentage of females present than males. At Chlorakas-*Palloures*, the total number of individuals based on context and age assessment is 17, however, there were only 11 discrete individuals with more that 15 % of the skeleton present. The other six ›individuals‹ were only represented by bone fragments, therefore, this paper will only include those with a minimum of 15 % of the skeleton present. Table 1 shows the age breakdown of the three sites, alongside figure 2 which shows the percentage of each age group within each discrete site. Table 2 presents the number of each sex of adults identified at each site and figure 3 shows the percentage of each sex present at each site.

42 For information on the different ways in which bones react to different diseases or disorders, see for example: Aufderheide – Rodriguez-Martin 1998, 117–246. 305–343. 345–356; Roberts – Manchester 2005, 164–250 and Waldron 2009, 83–136.

43 A portion of this research was conducted as part of the author's PhD research, which included analysis of the human remains from Souskiou-*Laona* cemetery C. For this analysis pathological prevalence was calculated based on crude and true prevalence rates for all the bones by element and by individuals. This was to include the commingled material, primarily from Souskiou-*Laona* (Gamble 2011).

Table 1 Number of individuals by age group from each site

Age	Lemba-*Lakkous*	Kissonerga-*Mosphilia*	Chlorakas-*Palloures*
Foetus (prenatal)	–	2	–
Infant (0–3 years)	15	20	6
Child (4–12 years)	18	19	1
Adolescent (13–20 years)	5	5	1
Young adult (21–35 years)	7	17	2
Adult (36–50 years)	4	4	1
General adult	4	1	–
General subadult	–	3	–
Total	**53**	**71**	**11**

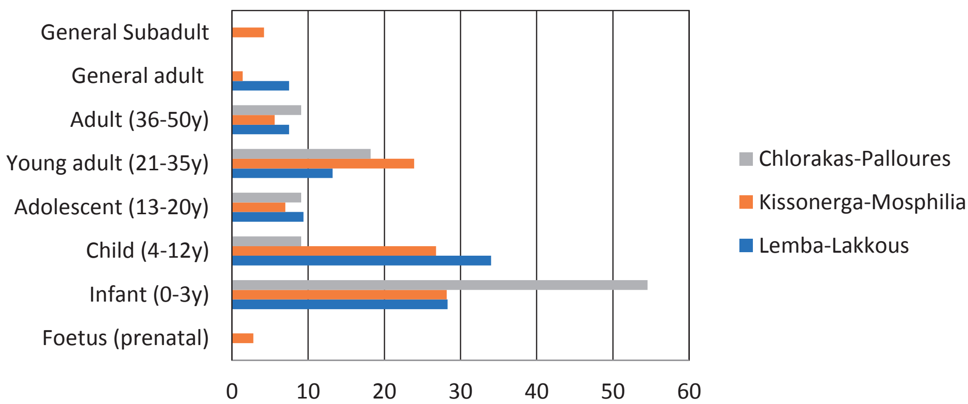

Fig. 2 Percentage of each age group within each site (© M. Gamble)

Table 2 Sex of adult individuals from each site

Sex	Lemba-*Lakkous*	Kissonerga-*Mosphilia*	Chlorakas-*Palloures*
Male	4	6	–
Female	10	13	3
Cannot be assessed (CBA)	5	5	1
Total	**19**	**24**	**4**

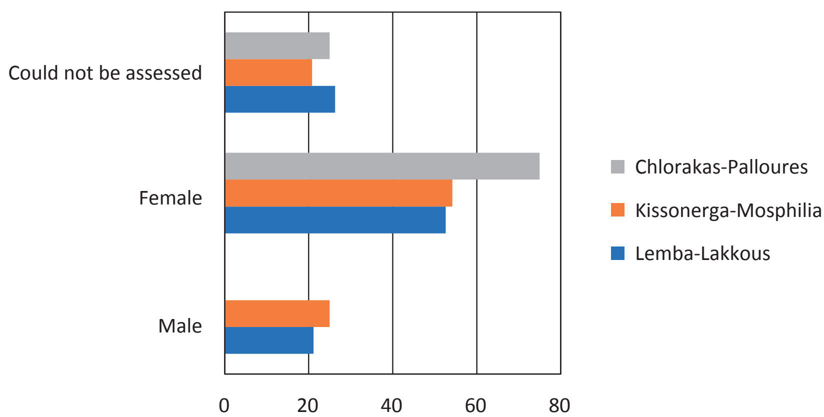

Fig. 3 Percentage of individuals of each sex from each site (© M. Gamble)

Dental Pathologies

Dental caries are the most prevalent dental pathology observed at Lemba-*Lakkous* with all age groups affected and females presenting a higher prevalence than males (tables 3. 6); while at Kissonerga-*Mosphilia* calculus is the most prevalent dental pathology observed, with males displaying a higher prevalence than females (tables 4. 6). Again, at Chlorakas-*Palloures*, calculus is the most prevalent dental pathology (tables 5. 6). Despite females generally displaying a slightly higher prevalence of dental caries at Lemba-*Lakkous* and Kissonerga-*Mosphilia*, there is no significant difference between males and females across the two sites, likely due to the small sample size of males (table 6). The small sample size at Chlorakas-*Palloures* is not significantly different from those of the other two sites.

Table 3 Percentage of each age group with dental pathologies at Lemba-*Lakkous*. * Ante-mortem tooth loss percentages do not include individuals who do not have either maxilla or mandibular fragments to assess

Age group	Calculus	Caries	LEH	AMTL*	Attrition
Infant (n = 12)	–	8.3	–	–	–
Child (n = 18)	–	11.1	–	–	–
Adolescent (n = 5)	40	40	20	25	–
Young adult (n = 7)	42.9	85.7	28.6	14.3	14.3
Adult (n = 4)	75	50	25	75	100
General adult (n = 3)	–	33.3	–	100	66.7
Total	**16.3**	**28.6**	**9.5**	**15.4**	**14.3**

Table 4 Percentage of each age group with dental pathologies at Kissonerga-*Mosphilia*. * Ante-mortem tooth loss percentages do not include individuals who do not have either maxilla or mandibular fragments to assess

Age group	Calculus	Caries	LEH	AMTL*	Attrition
Infant (n = 20)	5	–	–	–	–
Child (n = 19)	10.5	–	15.8	–	10.5
Adolescent (n = 5)	60	–	40	–	–
Young adult (n = 16)	68.8	25	37.5	7.1	12.5
Adult (n = 4)	50	25	25	100	75
General adult (n = 1)	–	–	–	–	–
Total	**29.2**	**7.7**	**18.5**	**4.1**	**10.8**

Table 5 Percentage of each age group with dental pathologies at Chlorakas-*Palloures*. * Ante-mortem tooth loss percentages do not include individuals who do not have either maxilla or mandibular fragments to assess (CBA = Cannot Be Assessed)

Age group	Calculus	Caries	LEH	AMTL*	Attrition
Infant (n = 6)	–	–	–	–	–
Child (n = 1)	–	–	–	–	–
Adolescent (n = 1)	CBA	CBA	CBA	CBA	CBA
Young adult (n = 2)	100	–	50	–	–
Adult (n = 1)	CBA	CBA	CBA	CBA	CBA
General adult (n = 0)	CBA	CBA	CBA	CBA	CBA
Total	**18.2**	**–**	**9.1**	**–**	**–**

Table 6 Percentage of each sex from each site with dentition affected by a pathology * Ante-mortem tooth loss percentages do not include individuals who do not have either maxilla or mandibular fragments to assess (CBA = Cannot Be Assessed)

Site	Sex	Calculus	Caries	LEH	AMTL*	Attrition
Lemba-*Lakkous*	Male (n = 4)	50	50	25	50	75
	Female (n = 10)	40	70	20	33.3	30
	CBA (n = 4)	50	50	25	50	25
Kissonerga-*Mosphilia*	Male (n = 5)	80	20	40	–	–
	Female (n = 13)	46.2	23.1	30.8	20	30.8
	CBA (n = 5)	100	20	40	–	20
Chlorakas-*Palloures*	Male (n = 0)	CBA	CBA	CBA	CBA	CBA
	Female (n = 2)	100	–	50	–	–
	CBA (n = 0)	CBA	CBA	CBA	CBA	CBA

Osteoarthritic Changes

No osteoarthritic changes were observed on the skeletal material from Chlorakas-*Palloures*; this is because of the young age of most of the population, and the extremely poor preservation of the skeletal material with only a small portion of the possible articular surfaces surviving (table 7). Overall, only 21.9 % of the surviving long bones (n = 96) had at least one joint present at Chlorakas-*Palloures* and only 44.8 % of the bones were well enough preserved to be assessed for any pathology (high fragmentation was the primary reason for not being able to assess for pathology). Only one individual from Chlorakas-*Palloures* had vertebrae, which were well enough preserved to be assessed for pathology (Burial 2, Unit 16, Lot 345). This individual did not show osteoarthritic changes, but rather evidence on the cervical vertebrae of degenerative disc disease and changes to the spinous processes of several thoracic vertebrae suggesting tension on the erector spinae muscles.

Table 7 Long bone preservation at Chlorakas-*Palloures* (PE = Proximal Epiphysis; DE = Distal Epiphysis)

Bone	Total number of bones present	Number of preserved PE or DE	Number of bones which could be assessed	Percent of bones which could be assessed
Humerus	15	3	7	46.7
Radius	15	6	8	53.3
Ulna	14	4	8	57.1
Femur	19	4	9	47.4
Tibia	18	2	7	38.9
Fibula	15	2	4	26.7
Total	**96**	**21**	**43**	**44.8**

Preservation was slightly better at Lemba-*Lakkous* and Kissonerga-*Mosphilia* (fig. 4); which meant that 84.2 % of individuals at Lemba-*Lakkous* had one or more joint present for assessment, and 92.3 % of individuals at Kissonerga-*Mosphilia* had one or more joint present. Osteoarthritic changes were observed by joint with the vertebrae displaying the highest prevalence at Lemba-*Lakkous*, while the bones of the feet display the highest prevalence at Kissonerga-*Mosphilia* (tables 8. 9). In regards to the vertebrae, osteoarthritic changes were recorded as present if one or more vertebrae articular facet or vertebral body displayed pathology.

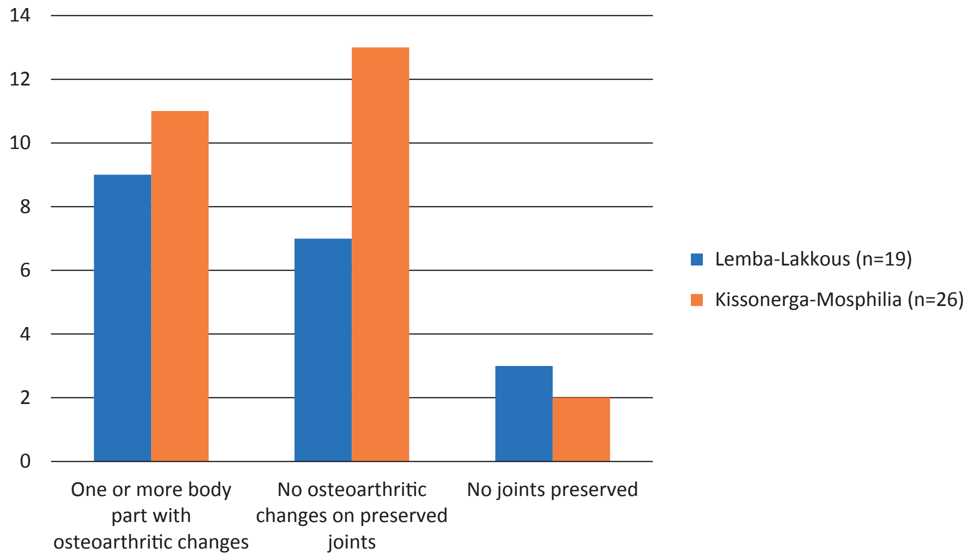

Fig. 4 Preservation of joints of adolescent and adult individuals at Lemba-*Lakkous* and Kissonerga-*Mosphilia* (© M. Gamble)

Table 8 Osteoarthritic changes observed on individuals from Lemba-*Lakkous*

Joint	**Number present**	**Number with osteoarthritic changes**	**Percent of individuals with osteoarthritic changes**	**Number of individuals with osteoarthritic changes and nature of expression**
Vertebrae	16	9	56.3	2 – atlas 2 – axis 2 – atlas and axis 3 – more than one vertebral group
Ribs	13	1	7.7	1 individual
Feet	13	3	23.1	3 – unilaterally
Elbow	9	2	22.2	1 – unilaterally 1 – bilaterally
Ankle	10	–	–	no pathology
Hand	16	1	6.3	1 – unilaterally
Shoulder	10	2	20	2 – bilaterally
Wrist	6	2	33.3	2 – unilaterally
Hip	7	–	–	no pathology
Knee	7	–	–	no pathology

Table 9 Osteoarthritic changes observed on individuals from Kissonerga-*Mosphilia*

Joint	Number present	Number with osteoarthritic changes	Percent of individuals with osteoarthritic changes	Number of individuals with osteoarthritic changes and nature of expression
Vertebrae	23	5	21.7	1 – atlas 2 – axis 2 – more than one vertebral group
Ribs	22	2	9.1	2 individuals
Feet	16	7	43.8	6 – unilaterally 1 – bilaterally
Elbow	12	–	–	no pathology
Ankle	13	1	7.7	1 – unilaterally
Hand	20	1	5	1 – unilaterally
Shoulder	16	1	6.3	1 – unilaterally
Wrist	14	2	14.3	2 – unilaterally
Hip	14	–	–	no pathology
Knee	11	–	–	no pathology

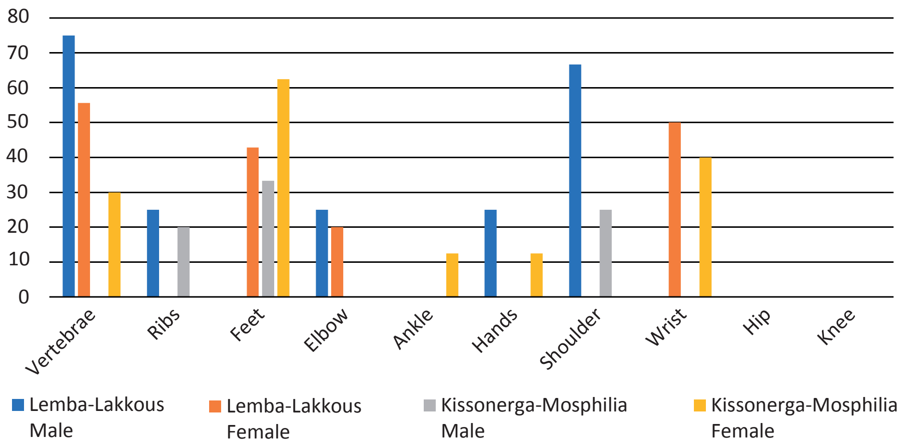

Fig. 5 Percentage of each sex with osteoarthritic changes by joint at Lemba-*Lakkous* and Kissonerga-*Mosphilia* (© M. Gamble)

In regards to the results of the osteoarthritic changes based on sex, there were some differences in the prevalence of expression based on the sex of the individual (fig. 5). Females from Lemba-*Lakkous* and Kissonerga-*Mosphilia* exhibit a higher prevalence of osteoarthritic changes to at least one bone in the foot and the wrist. The males from Lemba-*Lakkous* and Kissonerga-*Mosphilia* display the only osteoarthritic changes observed to the shoulder and generally a higher prevalence of degenerative changes to the ribs.

Trauma

Trauma was only observed on two individuals at Lemba-*Lakkous* (a healing fracture of a distal foot phalanx; and a patch of woven bone on the medial aspect of a left tibia, mid-diaphysis); possibly on one individual at Kissonerga-*Mosphilia* (ankylosed intermediate and distal foot phalanges which could also be a result of symphalangism); and only on one individual from Chlorakas-*Palloures* (well-healed Colles' fracture of a right radius). Overall, there is very little trauma observed across the three sites, only effecting adults. However, as D. J. Ortner points out, skeletal evidence of trauma in subadult skeletons may be completely obliterated in the process of growth, and in general, he states that the actual prevalence of trauma in the living population will be underestimated[44].

[44] Ortner 2003, 119.

Infectious, Metabolic, or Hemaepoetic Disease or Disorder

There was no evidence for diseases or disorders on the Chlorakas-*Palloures* material, again likely due to the high levels of fragmentation, and small skeletal sample. Cribra orbitalia (porosity of the superior aspects of the frontal orbits) is the most common pathology expressed at both Lemba-*Lakkous* and Kissonerga-*Mosphilia* (tables 10. 11). Amongst the sample from Lemba-*Lakkous*, there is a wider demographic profile of individuals effected, while at Kissonerga-*Mosphilia*, this pathology is observed exclusively on subadult individuals. Sex determination of subadults is not possible, and only adolescent/adult females display evidence of disease/disorder at Lemba-*Lakkous*.

Table 10 Distribution and nature of evidence of disease or disorder at Lemba-*Lakkous* (CO = cribra orbitalia, PH = porotic hyperostosis)

Demographic group	Number with evidence of disease	Percent with evidence of disease	Context references and pathology observed
Infant	2	13.3	Grave 17 Skeleton C – CO Grave 45 – PH
Child	1	5.6	Grave 13 – CO
Adolescent	1 (female)	20	Grave 32 – CO
Young adult	2 (both female)	28.6	Grave 25 – bowing of right tibia Grave 50 – CO
Adult	–	–	
General adult	–	–	
Total	**6**	**11.3**	

Table 11 Distribution and nature of evidence of disease or disorder at Kissonerga-*Mosphilia* (CO = cribra orbitalia, PH = porotic hyperostosis)

Demographic group	Number with evidence of disease	Percent with evidence of disease	Context references and pathology observed
Foetus	–	–	
Infant	3	15	Grave 551 – CO Grave 563 Skeleton B – PH Grave 549 – PH
Child	2	10.5	Grave 566 – CO Grave 567 – CO and bowing of right radius
Adolescent	1	20	Grave 532 – CO and bowing of right and left femora
Young adult	–	–	
Adult	–	–	
General adult	–	–	
Total	**6**	**8.5**	

Overall, the prevalence of pathology is quite low at the Chalcolithic settlement sites. Trauma tends to be very insignificant and infrequent and osteoarthritic changes have not led to debilitating lesions on the joint surfaces. With the small sample size from Chlorakas-*Palloures* it is difficult to come to any conclusions for that community, but it is perhaps enough to say that at least demographically, it is paralleling the two neighbouring sites.

Discussion

The expression of different pathologies on the skeletal material from the three settlement sites can provide insight into the lives and lifeways of the individuals represented within the mortuary sample and perhaps make suggestions regarding the social organisation of the settlements. It is important to consider the severity of the pathologies observed and the impact that this would have had on the individual. Further, the differences in pathological expression amongst different biological groups can indicate different activities and roles within the community and whether the previous studies regarding the social relationships and structure can be understood through the pathological analysis. Understanding the severity of disease expression and its impact on the individual is complicated by the fact that, in order for the pathology to appear extensively on the bone, the individual would have had to survive for a long period of time, which may reflect a less severe symptomology for the individual compared to those who experience a more acute version of the disease which caused their death before the bones were affected[45].

The large subadult portion of the skeletal samples inherently affects the nature and prevalence of the degenerative pathologies which are observed on these collections. This creates a smaller sub-sample of adults and older adolescents who were evaluated for osteoarthritic changes. The skeletal material is in poor preservation, reflecting high levels of fragmentation, and very eroded surfaces. This results in the preservation of fewer articular surfaces, which affects the ability to assess the prevalence of osteoarthritic changes. There were no complete skeletons recovered from any site, with most individuals partially represented by cranial and/or post-cranial remains, and thus systemic diseases and disorders are difficult to diagnose.

Dental Pathologies

Discussion of the dental pathologies is focused on the differences of expression between the sexes, as the inter-site differences cannot readily be explained using the archaeological evidence, as all three sites have relatively similar archaeological remains. The higher prevalence of caries in females is a common phenomenon across time periods and locations[46]; the causes for which are attributed to three factors in agricultural populations: (1) earlier tooth eruption times in females, exposing the teeth to a cariogenic environment for a longer period of time; (2) the proximity of females to food during preparation resulting in snacking; and (3) pregnancy and hormonal influences[47]. Given that E. J. Peltenburg has associated females with the domestic space and food preparation in the Middle Chalcolithic, it is possible that females were consuming a slightly different diet than males, who have been associated with hunting and herding[48]. Males show a higher prevalence of calculus than the females, particularly at Kissonerga-*Mosphilia* where 80 % of the males display at least one tooth with calculus. This result supports previous studies, which indicate that males tend to have a greater prevalence of calculus accumulation[49]. High levels of calculus are correlated with an alkaline oral environment and a dependence on agricultural products and increased consumption of animal products[50]. While, calculus is also caused by poor oral hygiene and non-masticatory uses of the teeth, the results could reflect a differential access to particular foodstuffs based on sex, as is possibly suggested by the expression of dental caries.

Linear enamel hypoplasia is a marker of general health status, particularly related to incidences of physiological stress in childhood as the tooth is forming. Therefore, the higher prevalence of

45 Wright – Yoder 2003; DeWitte – Stojanowski 2015.
46 Hillson 2001, 253; Lukacs – Largaespada 2006, 541.
47 Lukacs – Largaespada 2006, 541.
48 Peltenburg 2002, 59 f.
49 Hillson 1996, 259 and accords with modern studies as per Beiswanger et al. 1989.
50 Lieverse 1999.

expression at Kissonerga-*Mosphilia* may reflect periods of systemic metabolic distress such as nutritional deficiency caused by a lack of foodstuffs either due to availability or a socio-cultural restriction or perhaps a childhood illness, which effected this community more than the others. Though it must be noted that overall, there are relatively low numbers of LEH expression at the Chalcolithic Cypriot sites[51]. There was no LEH observed on deciduous dentition at any site, which could reflect relatively little physiological stress on pregnant women affecting the foetus. Therefore, the appearance of LEH must be considered in a socio-cultural context for the health of women and children.

The archaeological evidence, in regard to the possible social status of women and children, is primarily derived from studies by D. Bolger and E. J. Peltenburg[52] relating to aspects of social complexity and socio-political exchange. The ritual deposit from Kissonerga-*Mosphilia* is described within the context of a ›Cypriot ideology of birth‹ and taken to represent a focus on fertility and birth in the early Middle Chalcolithic population[53]. The figurines and the picrolite pendants which are described by E. J. Peltenburg as »… integral to the formation and maintenance of the social customs involving birth …« are thus associated closely with the females and children respectively[54]. He furthermore states that picrolite was a prestige item based on its inclusion in only a select number of graves[55]. Picrolite figurines and pendants have thus far primarily been associated with children's burials at the settlement sites[56]. The inclusion of ›prestige‹ items with children may reflect a particular reverence for children within the Middle Chalcolithic period, which may be tentatively supported by the limited expression of LEH in the permanent teeth across all three sites. However, this connection is speculative at best. In general, the slightly higher prevalence of LEH at Kissonerga-*Mosphilia* may suggest that this slightly larger population faced more challenges in childhood than those at the smaller settlement of Lemba-*Lakkous*, but overall, physiological stress in childhood, as represented by LEH is relatively minimal in the Chalcolithic, suggesting communities with adequate nutrition and little systemic disease.

The poor surface preservation and high fragmentation of the mandibles and maxillae makes it difficult to assess the percentage of teeth lost *in vivo* because often portions of the alveolar bone are missing or damaged. The discrete individuals from Lemba-*Lakkous* display the highest prevalence of ante-mortem tooth loss as 15.4 % with a maxilla or mandible from the site have lost at least one tooth *in vivo*. This could be associated with dental caries leading to tooth loss, particularly as a higher proportion of individuals at Lemba-*Lakkous* displayed dental caries. There are many reasons for tooth loss during life, including trauma, carious lesions, periodontal disease, apical cavities or abscesses and modification[57]. In most cases, it is impossible to determine the cause of the tooth loss and resultant alveolar remodelling (unless an apical cavity or other trauma is still evident).

The rate of dental attrition within a population has many different factors, for example the consistency and texture of food, manner of food preparation, cultural practices, force of occlusion, age, sex and/or the quality of the tooth[58]. Therefore, it is difficult to make conclusive statements about the causes of the patterns of attrition within and amongst populations. The general low levels of attrition at the Chalcolithic sites likely represents a more agricultural-based diet, and/or a homogenous higher tooth quality to resist wear.

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51 See i.e. Cucina 2002; Cucina – İşcan 1997; Fischer – Norén 1988; Goodman et al. 1980; Wright 1997 for higher rates.
52 Bolger 1994; Bolger 1996; Bolger 2002; Bolger 2003; Peltenburg 1991b; Peltenburg 2002.
53 Peltenburg 1991b, 98–100.
54 Peltenburg 1991a, 114.
55 Peltenburg 1991a, 114.
56 Bolger 2002, 72–74.
57 Lukacs 2007, 157 f.
58 i.e. Ortner 2003, 604.

Osteoarthritic Changes

The prevalence and severity of osteoarthritic changes is associated with activity and other localised cultural, behavioural and environmental factors[59]. Previous studies have indicated that an agriculturalist lifestyle is more physically demanding than the hunter-gatherer lifestyle in the Levant[60]. There is also evidence for a division of labour based on sex in the agricultural communities, with females gaining a more labour-intensive role in subsistence[61]. The differences in the joints affected by osteoarthritic changes across the two sites potentially indicate that patterns of activity were sex-based. Sexual differentiation of joints affected with osteoarthritic changes are interpreted in previous studies as due to differences in activities performed by the different sexes[62].

The severity of the osteoarthritic changes and the implications for the individuals suffering with these pathological changes varies both within and across the sites. In general, most lesions on the joints are mild to moderate and in many cases would not affect the individual's general health status or ability to function. R. D. Jurmain notes that osteophytes, which were the most commonly observed degenerative change on the Chalcolithic Cypriot skeletal material, are more likely to be related to biological aging than mechanical stress which impacts the joint surface[63]. E. Weiss and R. D. Jurmain present the different and multifactorial aetiologies of osteoarthritis using clinical studies, which indicate that it is an oversimplification of the pathology to directly correlate the observation of osteoarthritic changes with activities[64]. Based on the archaeological evidence, the Chalcolithic populations were engaged in hunting (possibly involving spear throwing or use of a sling) and gathering (of naturally occurring fruits, nuts and cereals), food processing (represented by quern stones, rubbers, mortars and pestles for example), private and public works (including digging, building, terracing) for the construction of round houses with stone foundations and mudbrick walls, burials and possibly community buildings, as well as tree felling for use in building and fires, production of large ground stone tools, agricultural labour (sowing, reaping), production of lime plasters, mudbricks, pottery, smaller ornaments such as figurines and beads and a multitude of other tasks which would have occurred routinely[65]. Each of these activities utilises specific muscle groups and places workload stress on specific bones and joints, which can eventually lead to changes in the bone structure (MSMs), or degeneration of the joint surface. It is not possible to associate a specific activity with a specific change observed on the bones at this point, but with the shoulders and ribs solely affected in males and the wrists and feet predominately affected in females, there is evidence of sex-based differences in activities across the populations.

Trauma

The assessment of injury (either accidental or violent) within a population can facilitate the discussion of environmental, cultural and social influences on behaviour[66]. Within the Cypriot Chalcolithic collections studied here, trauma seems to be accidental and typically takes the form of a healed fracture or a disruption in nerve and/or blood supply which has caused a lesion on

[59] Larsen 2002, 134.
[60] Eshed et al. 2004; Eshed et al. 2010.
[61] Eshed et al. 2004; Eshed et al. 2010.
[62] i.e. Eshed et al. 2010, 129; Larsen 1997, 176–178.
[63] Jurmain 1991, 249.
[64] Weiss – Jurmain 2007.
[65] For more information on all these aspects of Chalcolithic life, refer to Peltenburg et al. 1985; Peltenburg 1998; Peltenburg et al. 2019; Knapp 2013; and for a brief synopsis see Croft 1999 or Steel 2004, 83–118.
[66] Larsen 1997, 109.

the bone. Peri-mortem trauma is very difficult to identify within this skeletal material due to the high levels of fragmentation. Overall, there is very little trauma observed across the three sites.

Disease or Disorder

The relatively small number of individuals across the three sites, which display evidence of a metabolic, haemopoetic, infectious, or parasitic disease or deficiency, does not necessarily reflect low prevalence of disease, simply that perhaps individuals died before the symptoms effected the skeleton[67]. The main difference between the two sites which display cribra orbitalia, porotic hyperostosis, or bowing of the long bones, is that a greater range of ages are affected at Lemba-*Lakkous* than at Kissonerga-*Mosphilia*. It is difficult to make any interpretations regarding the Chalcolithic communities based on the small number of affected individuals, it does not seemingly support the hypothesis by J. L. Angel suggesting thalassemia, as a reaction to malaria, was endemic in the prehistoric period[68].

Limitations

There are several limitations to the study of health and disease observed through this study, including: variations in burial practices which entail the movement and removing of skeletal elements; issues with recovery and excavation methods which affects the skeletal elements available for examination (i.e. the carpals); curation and reconstruction attempts which can obscure the surface of the skeletal element; and taphonomic processes which have had a detrimental effect on surface condition and fragmentation levels of the skeletal elements. Despite these limiting factors, this study has demonstrated that information regarding the population's health status can be derived. In order to deal with issues of recovery due to burial practice or excavation methods, pathological lesions were recorded and analysed based on discrete skeletal elements, which provided a more precise prevalence of pathology as like elements were compared. To deal with issues of curation, preservation and fragmentation, qualitative descriptive levels were created and scaled to provide a better understanding of general skeletal survival. As well, pathological prevalence was recorded and described based on the specific part of the skeletal element and compared with like parts for a more precise reflection of pathology prevalence. Over-confidence and over-estimation of particular pathologies, which can be associated with poor preservation, was avoided within this study by maintaining general categories of pathology types and applying the standard differential diagnoses approach.

New excavations at Kissonerga-*Skalia* have revealed that Kissonerga-*Mosphilia* likely has an external cemetery down slope from the main settlement site. Thus far, five Chalcolithic graves at Kissonerga-*Skalia* have been excavated. Stable isotope analysis from one of the graves (HB 15) was completed by S. Douglas, which has revealed that the Chalcolithic people from Kissonerga-*Mosphilia* were eating a mixed diet of marine and terrestrial animals and plants[69]. More data is needed to discuss any trends further, but it is interesting to note the possibility of obtaining isotopic results from this prehistoric material and that it seemingly supports the conclusion that more recently excavated material is more likely to contain traces of collagen which can be analysed.

67 i.e. Wright – Yoder 2003; DeWitte – Stojanowski 2015.
68 Angel 1966; Angel 1978; though there is significant discussion and debate over the aetiology of cribra orbitalia and porotic hyperostosis, see Walker et al. 2009 for example.
69 Sarah Douglas, personal communication.

Conclusions

When combined with the archaeological evidence from this period, the analyses of the pathological markers reflect a population in the southwest of Cyprus which has a mixed subsistence economy and where there is a division of labour and diet between the sexes based on the joints affected with osteoarthritic changes and the types and prevalence of dental pathologies affecting each sex. Females and males across all three sites seemed to have shared similar lifestyles, marked by a general limited prevalence of osseous responses to physiological stress, injury or congenital defect on the skeletal remains from all three sites studied. The differences in pathological lesions observed based on sex does not in itself reflect an inequality between the sexes.

That more subadults than adults display evidence of disease across the sites perhaps corroborates the high level of infant mortality estimated by D. A. Lunt and M. Domurad[70] for these populations. The overall low prevalence of systemic disease markers across the populations, either indicates that these individuals were in poor health and did not survive the first assaults of disease, or there was simply not a lot of physiological stress, disease or physical damage to these individuals. Given that these are discrete skeletal populations and there are individuals from all age groups derived from all sites, further analysis into burial practice is needed to discern aspects of burial practice in association with age-at-death. The greatest proportion of adult individuals from the Chalcolithic period died in their early mid-twenties, which is not uncommon in prehistoric populations[71]. There is a population bias within the settlement burials, which seems to reflect differences in mortuary practices more than a social stratification – with mostly females and infants through adolescents buried within the settlements and the burial location of the majority of the males and foetuses still to be discovered[72].

The types, nature and levels of expression of pathological lesions on the skeletal remains examined for this study of the Chalcolithic peoples on Cyprus indicate similar lifeways with no indication of social stratification across the southwest of the island, and in general suggest that the populations were fairly healthy, with low prevalence and mild expression of pathological lesions.

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70 Lunt et al. 1998; Domurad 1986.

71 i.e. Boldsen 2007, 64; Preston 1997, 30.

72 The cemetery burials at Souskiou-*Laona* and Souskiou-*Vathyrkakas* are more diverse in their demography with individuals from foetus to mature adult (50 years plus), though the majority are adults with few subadults, and both males and females are represented more equally. Thus, there could also be a link between age-at-death and burial location (i.e. within the settlement or in an external cemetery) or a distinct regional difference. See Gamble 2011; Lorentz 2019.

Bibliography

Angel 1966 — J. L. Angel, Porotic Hyperostosis, Anemias, Malarias, and Marshes in the Prehistoric Eastern Mediterranean, Science 153, 1966, 760–763.

Angel 1978 — J. L. Angel, Porotic Hyperostosis in the Eastern Mediterranean, Medical College of Virginia Quarterly 14, 1978, 10–16.

Aufderheide – Rodriguez-Martin 1998 — A. C. Aufderheide – C. Rodriguez-Martin, The Cambridge Encyclopaedia of Human Palaeopathology (Cambridge 1998).

Baker – Bolhofner 2014 — B. J. Baker – K. L. Bolhofner, Biological and social implications of a medieval burial from Cyprus for understanding leprosy in the past, International Journal of Paleopathology 4, 2014, 17–24.

Bass 1995 — W. Bass, Human Osteology. A Laboratory and Field Manual ^{4}(Columbia 1995).

Beiswanger et al. 1989 — B. B. Beiswanger – V. A. Segreto – M. E. Mallatt – H. J. Pfeiffer, The Prevalence and Incidence of Dental Calculus in Adults, Journal of Clinical Dentistry 1/3, 1989, 55–58.

Boldsen 2007 — J. L. Boldsen, Early Childhood Stress and Adult Age Mortality – A Study of Dental Enamel Hypoplasia in the Medieval Danish Village of Tirup, American Journal of Physical Anthropology 132/1, 2007, 59–66.

Bolger 1994 — D. Bolger, Engendering Cypriot Archaeology. Female Roles and Statuses before the Bronze Age, OpAth 20/1, 1994, 9–17.

Bolger 1996 — D. Bolger, Figurines, Fertility and the Emergence of Complex Society in Prehistoric Cyprus, Current Anthropology 37/2, 1996, 365–373.

Bolger 2002 — D. Bolger, Gender and Mortuary Ritual in Chalcolithic Cyprus, in: D. Bolger – N. Serwint (eds.), Engendering Aphrodite. Women and Society in Ancient Cyprus, CAARI Monographs 3 = American Schools of Oriental Research Archaeological Reports 7 (Boston, MA 2002) 67–86.

Bolger 2003 — D. Bolger, Gender in Ancient Cyprus. Narratives of Social Change on a Mediterranean Island (Walnut Creek, CA 2003).

Brooks – Suchey 1990 — S. T. Brooks – J. M. Suchey, Skeletal Age Determination Based on the Os Pubis. A Comparison of the Acsadi-Nemeskeri and Suchey-Brooks Methods, Human Evolution 5, 1990, 227–238.

Buikstra – Ubelaker 1994 — J. E. Buikstra – D. H. Ubelaker (eds.), Standards for Data Collection from Human Skeletal Remains. Proceedings of a seminar at the Field Museum of Natural History, Research Series 44 (Fayetteville, AR 1994).

Croft 1999 — P. Croft, Lemba and Kissonerga (Nicosia 1999).

Cucina 2002 — A. Cucina, Brief Communication: Diachronic Investigation of Linear Enamel Hypoplasia in Prehistoric Skeletal Samples from Trentino, Italy, American Journal of Physical Anthropology 119/3, 2002, 283–287.

Cucina – İşcan 1997 — A. Cucina – M. Y. İşcan, Assessment of Enamel Hypoplasia in a High Status Burial Site, American Journal of Human Biology 9/2, 1997, 213–222.

DeWitte – Stojanowski 2015 — S. N. DeWitte – C. M. Stojanowski, The Osteological Paradox 20 Years Later. Past Perspectives, Future Directions, Journal of Archaeological Research 23, 2015, 397–450.

Domurad 1986 — M. Domurad, The Populations of Ancient Cyprus (PhD thesis University of Cincinnati 1986).

Düring et al. 2018 — B. S. Düring – V. Klinkenberg – C. Paraskeva – V. Kassianidou – E. Souter – P. Croft – A. Charalambous, Metal Artefacts in Chalcolithic Cyprus. New Data from Western Cyprus, Mediterranean Archaeology and Archaeometry 18/1, 2018, 11–25.

Düring et al. 2019 — B. S. Düring – M. V. Klinkenberg – C. Pareskeva – P. Croft – E. Souter – T. F. Sonnemann, Excavations at Chlorakas-*Palloures*: New Light on Chalcolithic Cyprus, RDAC New Series 1, 2019, 467–490.

Eshed et al. 2004 — V. Eshed – A. Gopher – T. B. Gage – I. Hershkovitz, Has the Transition to Agriculture Reshaped the Demographic Structure of Prehistoric Populations? New Evidence from the Levant, American Journal of Physical Anthropology 124/4, 2004, 315–329.

Eshed et al. 2010 — V. Eshed – A. Gopher – R. Pinhasi – I. Hershkovitz, Paleopathology and the Origin of Agriculture in the Levant, American Journal of Physical Anthropology 143/1, 2010, 121–133.

Fischer – Norén 1988 — P. M. Fischer – J. G. Norén, Enamel Defects in Teeth from a Prehistoric Cypriot Population, Ossa. International Journal of Skeletal Research 13, 1988, 87–96.

Fox-Leonard 1997 — S. C. Fox-Leonard, Comparing Health from Paleopathological Analysis of the Human Skeletal Remains Dating to the Hellenistic and Roman Periods, from Paphos, Cyprus and Corinth, Greece (PhD thesis University of Arizona, Ann Arbor, MI 1997).

Gamble 2011 — M. Gamble, Health and Disease in Chalcolithic Cyprus: A Problem-oriented Palaeopathological Study of the Human Remains (PhD thesis University of Newcastle 2011).

Goodman et al. 1980 A. H. Goodman – G. J. Armelagos – J. C. Rose, Enamel Hypoplasias as Indicators of Stress in Three Prehistoric Populations for Illinois, Human Biology 52/3, 1980, 515–528.

Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent Research in Cypriot Bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.

Hillson 1996 S. Hillson, Dental Anthropology (Cambridge 1996).

Hillson 2001 S. Hillson, Recording Dental Caries in Archaeological Human Remains, International Journal of Osteoarchaeology 11/4, 2001, 249–289.

Hillson 2005 S. Hillson, Teeth, Cambridge Manuals in Archaeology ²(Cambridge 2005).

Junkins – Carter 2017 E. N. Junkins – D. O. Carter, Relationships between Human Remains, Graves and the Depositional Environment, in: E. M. J. Schotsmans – N. Márquez-Grant – S. L. Forbes (eds.), Taphonomy of Human Remains. Forensic Analysis of the Dead and the Depositional Environment (Chichester 2017).

Jurmain 1991 R. D. Jurmain, Degenerative Changes in Peripheral Joints as Indicators of Mechanical Stress. Opportunities and Limitations, International Journal of Osteoarchaeology 1/3–4, 1991, 247–252.

Knapp 2013 A. B. Knapp, The Archaeology of Cyprus from Earliest Prehistory through the Bronze Age, Cambridge World Archaeology (Cambridge 2013).

Larsen 1997 C. S. Larsen, Bioarchaeology. Interpreting Behavior from the Human Skeleton, Cambridge Studies in Biological Anthropology 21 (Cambridge 1997).

Larsen 2002 C. S. Larsen, Bioarchaeology. The Lives and Lifestyles of Past People, Journal of Archaeological Research 10/2, 2002, 119–166.

Lieverse 1999 A. R. Lieverse, Diet and the Aetiology of Dental Calculus, International Journal of Osteoarchaeology 9/4, 1999, 219–232.

Lorentz 2016 K. O. Lorentz, Challenges for Funerary Taphonomy viewed through Prehistoric Cyprus, JASc Reports 10, 2016, 757–768.

Lorentz 2019 K. O. Lorentz, Human remains, in: Peltenburg et al. 2019, 135–164.

Lovejoy 1985 C. O. Lovejoy, Dental Wear in the Libben Population: Its Functional Pattern and Role in the Determination of Adult Skeletal Age at Death, American Journal of Physical Anthropology 68/1, 1985, 47–56.

Lovejoy et al. 1985 C. O. Lovejoy – R. S. Meindl – T. R. Pryzbeck – R. P. Mensforth, Chronological Metamorphosis of the Auricular Surface of the Ilium. A New Method for the Determination of Age at Death, American Journal of Physical Anthropology 68/1, 1985, 15–28.

Lukacs 2007 J. R. Lukacs, Dental Trauma and Antemortem Tooth Loss in Prehistoric Canary Islanders: Prevalence and Contributing Factors, International Journal of Osteoarchaeology 17, 2007, 157–173.

Lukacs – Largaespada 2006 J. R. Lukacs – L. L. Largaespada, Explaining Sex Differences in Dental Caries Prevalence. Saliva, Hormones, and »Life-History« Etiologies, American Journal of Human Biology 18/4, 2006, 540–555.

Lunt 1985 D. A. Lunt, Report on the Human Dentitions, in: Peltenburg et al. 1985, 54–58. 150–153.

Lunt et al. 1998 D. A. Lunt – E. Peltenburg – M. E. Watt, Mortuary Practices, in: Peltenburg et al. 1998, 65–92.

Lunt et al. 2006 D. A. Lunt – Z. Parras – M. E. Watt, The Mortuary Population, in: Peltenburg 2006, 45–66.

Miles 1963 A. E. W. Miles, Dentition in the Estimation of Age, Journal of Dental Research 42, 1963, 255–263.

Niklasson 1991 K. Niklasson, Early Prehistoric Burials in Cyprus, SIMA 96 (Jonsered 1991).

Ortner 2003 D. J. Ortner, Identification of Pathological Conditions in Human Skeletal Remains ²(San Diego, CA 2003).

Osterholtz 2015 A. J. Osterholtz, Bodies in Motion: A Bioarchaeological Analysis of Migration and Identity in Bronze Age Cyprus (2400–1100 BC) (PhD thesis University of Nevada 2015).

Parras 2004 Z. Parras, The Biological Affinities of the Eastern Mediterranean in the Chalcolithic and Bronze Age. A Regional Dental Non-metric Approach, BARIntSer 1305 (Oxford 2004).

Peltenburg 1991a E. J. Peltenburg, Local Exchange in Prehistoric Cyprus. An Initial Assessment of Picrolite, BASOR 282/283, 1991, 107–126.

Peltenburg 1991b E. J. Peltenburg, A Ceremonial Area at Kissonerga, Lemba Archaeological Project 2, 2, SIMA 70, 3 (Göteborg 1991).

Peltenburg 1991c E. J. Peltenburg, Kissonerga-Mosphilia. A Major Chalcolithic Site, BASOR 282/283, 1991, 17–35.

Peltenburg 1998 E. J. Peltenburg, The Character and Evolution of Settlements at Kissonerga, in: Peltenburg et al. 1998, 232–260.

Peltenburg 2002 E. J. Peltenburg, Gender and Social Structure in Prehistoric Cyprus. A Case Study from Kissonerga, in: D. Bolger – N. Serwint (eds.), Engendering Aphrodite. Women and Society in Ancient Cyprus, CAARI Monographs 3 = American Schools of Oriental Research Archaeological Reports 7 (Boston, MA 2002) 53–64.

Peltenburg 2006 E. J. Peltenburg (ed.), The Chalcolithic Cemetery of Souskiou-Vathyrkakas, Cyprus. Investigations of Four Missions from 1950–1997 (Nicosia 2006).

Peltenburg et al. 1985 E. J. Peltenburg – D. Baird – A. Betts – S. Colledge – P. Croft – C. Elliott – T. Lawrence – D. A. Lunt – K. Niklasson – J. Renault-Miskovsky – J. S. Ridout-Sharpe – E. Slater – J. D. Stewart – C. Xenophontos, Excavations at Lemba-Lakkous, 1976–1983, Lemba Archaeological Project 1, SIMA 70, 1 (Göteborg 1985).

Peltenburg et al. 1998 E. J. Peltenburg – D. Bolger – P. Croft – E. Goring – B. Irving – D. A. Lunt – S. W. Manning – M. A. Murray – C. McCartney – J. S. Ridout-Sharpe – G. Thomas – M. E. Watt – C. Elliott-Xenophontos, Excavations at Kissonerga-Mosphilia 1979–1992, Lemba Archaeological Project 2, 1, A. B, SIMA 70, 2 (Jonsered 1998).

Peltenburg et al. 2019 E. J. Peltenburg – D. Bolger – L. Crewe (eds.), The Figurine Makers of Prehistoric Cyprus. Settlement and Cemeteries at Souskiou (Oxford 2019).

Phrenice 1969 T. Phrenice, A Newly Developed Visual Method of Sexing in the Os Pubis, American Journal of Physical Anthropology 30, 1969, 297–301.

Powell 1985 M. L. Powell, The Analysis of Dental Wear and Caries for Dietary Reconstruction, in: R. I. Gilbert – J. H. Mielke (eds.), The Analysis of Prehistoric Diets (Orlando, FL 1985) 307–338.

Preston 1997 S. H. Preston, Human Mortality Throughout History and Prehistory, in: J. L. Simon (ed.), The State of Humanity (Oxford 1997) 30–36.

Roberts – Manchester 2005 C. Roberts – K. Manchester, The Archaeology of Disease ³(Stroud 2005).

Schaefer et al. 2009 M. Schaefer – S. Black – L. Scheuer, Juvenile Osteology. A Laboratory and Field Manual (Burlington, MA 2009).

Schwartz 1995 J. H. Schwartz, Skeleton Keys. An Introduction to Human Skeletal Morphology, Development, and Analysis (Oxford 1995).

Steel 2004 L. Steel, Cyprus Before History: From the Earliest Settlers to the End of the Bronze Age (London 2004).

Todd 1920 T. W. Todd, Age Changes in the Pubic Bone I. The White Male Pubis, American Journal of Physical Anthropology 3/3, 1920, 285–334.

Waldron 2009 T. Waldron, Palaeopathology, Cambridge Manuals in Archaeology (New York 2009).

Walker et al. 2009 P. L. Walker – R. R. Bathurst – R. Richman – T. Gjerdrum – V. A. Andrushko, The Causes of Porotic Hyperostosis and Cribra Orbitalia. A Reappraisal of the Iron-Deficiency-Anemia Hypothesis, American Journal of Physical Anthropology 139/2, 2009, 109–125.

Weiss – Jurmain 2007 E. Weiss – R. D. Jurmain, Osteoarthritis Revisited. A Contemporary Review of Aetiology, International Journal of Osteoarchaeology 17/5, 2007, 437–450.

White – Folkens 2005 T. D. White – P. A. Folkens, The Human Bone Manual (Amsterdam 2005).

Wright 1997 L. E. Wright, Intertooth Patterns of Hypoplasia Expression: Implications for Childhood Health in the Classic Maya Collapse, American Journal of Physical Anthropology 102/2, 1997, 233–247.

Wright – Yoder 2003 L. E. Wright – C. J. Yoder, Recent Progress in Bioarchaeology. Approaches to the Osteological Paradox, Journal of Archaeological Research 11/1, 2003, 43–70.

A Bioarchaeological Approach to the Rise of Social Stratification in Prehistoric Cyprus

An Analysis of Entheseal Changes in Chalcolithic Human Remains

Martina Monaco

Abstract

This paper details the results of the first stage of macroscopic analysis, which attempts to quantify changes in activity patterns of three Middle to Late Chalcolithic Cypriot groups (Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Erimi-*Pamboula*) through an in-depth examination of the distribution of entheseal changes in the skeleton. Three main questions were addressed: (a) whether severity of entheseal changes increased with age, (b) whether there was a significant difference in the distribution of lower, medium and higher severity scores based on sex and between different archaeological sites, and (c) which muscles or functional complexes were more frequently recruited in habitual activities. Twenty-one entheses of the upper and lower limbs of a total of 24 individuals were evaluated using the Mariotti method. A significant correlation was observed between age and robusticity marker. Females exhibited a greater development of the muscles associated with the shoulder, while males presented greater development of forearm and knee. Overall results also suggest that females were more involved in physically demanding activities respect to males. Consequently, the hypothesis of a sex-based division of labour is supported.

Introduction

Entheseal change (EC) is bone remodelling at muscle insertion sites resulting from hypertrophy stimulated by an increase in blood flow to periosteum. EC may manifest as increased robusticity, a rugosity or, in extreme expression, as a crest on the entheseal extension, in addition to osteolytic lesions, cortical defects, and enthesophytic formations, deposition of new bone or osteophytes at enthesis margins[1]. While there are established links to activity patterns, the aetiology of EC is multifactorial[2]. Indeed, bone tissue, due to its plastic nature, reacts variously to external (e.g. work loading) and internal (e.g. diseases) forces by altering its structure[3]. Recent research emphasises the concept of a complex interaction between physiology and biomechanical function of muscle insertions, identifying age, sex, body mass and genetic background as potentially confounding factors[4]. For this reason, many scholars have urged caution in the reconstruction of occupation and labour patterns through activity-related stress markers[5]. Despite these drawbacks, the number of bioarchaeological studies, which document activity patterns, addressing issues such as sex-based or social division of labour, continues to increase and new, productive avenues of research continue to be found[6].

1 Foster et al. 2014, 512; Drapeau 2008; Hawkey – Merbs 1995, 328.
2 Weiss 2007, 931 f.
3 Eshed et al. 2004, 310.
4 Foster et al. 2014, 520; Steen – Lane 1998; Chapman 1997.
5 Wilczak 1998.
6 Chapman 1997; Molnar 2006; Al Oumaoui et al. 2004; Eshed et al. 2004.

New research has particularly focused on the identification of high-performing assessment methods[7]. C. Y. Henderson's work, centred on the creation of the new Coimbra method for recording EC, aimed to respond to the combined need for standardisation of scoring methods as well as in terminology and bone surfaces selected for analysis[8]. V. Mariotti and colleagues' publications have successfully documented the presence of a significant difference in patterns of EC between farmers and merchants of Sardinian and Sperino collections by using a new protocol centred around a division between the »normal osseous response«, identified by the robusticity, and the »enthesopathies«, consisting of »anomalous« pathological manifestations potentially due to different causes, such as pathological conditions or excessive loading (resulting in osteolytic lesions and enthesophytic formations)[9].

Evaluation of entheseal changes in human remains from Chalcolithic to Late Bronze Age Cyprus has been only partially addressed by previous studies[10]. Presence of a higher degree of EC has been noted briefly in sections of theses dealing with the health status of the communities[11]. However, the moderate to poor preservation of skeletal material available in this period and region has been recognised as the primary reason of their under-utilisation in the reconstruction of activity patterns[12]. Z. Parras attributed water actions combined with the alkaline composition of the soils to the degradation of the bone, as well as the teeth surfaces[13]. Poor preservation and completeness of skeletal remains prevent an approach to EC that considers variation across individual skeletons. In response, this project shifts the focus of the examination from the individual to single muscles or functional complexes, so that the data, albeit incomplete, can contribute to the interpretation of certain phenomena, such as patterns of labour within and across the communities.

This paper presents an assessment and evaluation of entheseal change in Cypriot Chalcolithic human remains. This is intended to: (a) verify whether severity of EC increased with age; (b) identify the muscles or functional complexes which were more frequently recruited in habitual activities by sex among the three contemporaneous groups; (c) determine whether significant differences exist in the distribution of lower, medium and higher severity scores, based on sex and between the two communities of Lemba-*Lakkous* and Kissonerga-*Mosphilia* (the sample from Erimi-*Pamboula* was too small in include in the comparison). These two archaeological contexts yielded the best-preserved osteological assemblages on the island for the Chalcolithic period, in conjunction with the cemetery site of Souskiou-*Laona*[14]. The two contemporary and »spatially proximate sites« had two different strategies towards foreign influences: more receptive Kissonerga-*Mosphilia*, which imported exotic items (e.g. faience beads), more conservative Lemba-*Lakkous*[15].

Materials

The sample (n = 24 individuals) used for this study is drawn from a total of 142 individuals excavated from three Chalcolithic settlement contexts: Lemba-*Lakkous* (hereafter, Lemba), Kissonerga-*Mosphilia* (hereafter, *Mosphilia*) and Erimi-*Pamboula* (hereafter, Erimi)[16].

The Lemba and *Mosphilia* skeletal remains are currently curated in the Paphos Archaeological Museum, while the Erimi osteological remains are stored in the Limassol Archaeological Museum (Tomb 2) and in the Cyprus Museum in Nicosia (Tomb 1). While the three sites date to

7 Henderson et al. 2016; Mariotti et al. 2004; Mariotti et al. 2007.
8 Henderson et al. 2016; Henderson et al. 2017.
9 Mariotti et al. 2004, 146; Mariotti et al. 2007, 292.
10 Gamble 2011; Dikaios 1936; Guest 1936.
11 Osterholtz 2015.
12 Keswani 2004; Lorentz 2016.
13 Parras 2006, 54.
14 Peltenburg et al. 1985; Peltenburg et al. 1998; Peltenburg et al. 2019.
15 Bolger – Peltenburg 2014, 194.
16 Dikaios 1936; Peltenburg et al. 1985; Peltenburg et al. 1998.

roughly the same cultural period, there is variation in aspects, such as the extent of the habitation area. Lemba was the smallest settlement among the three, extending for 3 ha[17]. It yielded traces of occupation for only two phases: Middle and Late Chalcolithic (3500–2400 B.C.). In contrast, the short-lived Erimi (Middle Chalcolithic – 3400–3000 B.C.) and the longer-lived settlement of *Mosphilia* (Ceramic Neolithic to Philia/late 7th millennium – 2400 B.C.) occupied, respectively, areas of 13 ha and 12 ha[18].

Considering the aim of this work, to examine evidence for habitual activity patterns within and amongst these populations, data related to the subsistence activities performed by the inhabitants of these prehistoric communities provides crucial context. Faunal remains suggest a dependence on deer hunting in the Early Chalcolithic economy, which gradually declines in the Middle Chalcolithic (Period 2 Lemba). Concomitant with the decline of deer consumption, Middle to Late Chalcolithic sequences at *Mosphilia* and Lemba suggest an increase in pig and goat exploitation[19]. In addition, agricultural production plays a central role in the economy of these settlements[20]. The exploitation of marine, as well as mineral resources (picrolite) may be regarded as evidence of the trading routes operated by the members of these communities from the southwest coast to the Troodos massif[21]. Pottery production in domestic contexts was also a key activity in which Middle and Late Chalcolithic communities were involved. Other activities such as the production of stone objects (pestles and mortars), food processing and the crafting of body ornaments (e.g. beads) are also archaeologically attested[22].

The mortuary contexts at the three sites consisted predominately of single and, more rarely, multiple inhumations in simple pits, often closed by a capstone. The burials were located in close proximity to the houses within the settlements[23]. Adults, which represent the focus of this research, were interred with few grave goods as only a few ceramic objects, including flasks and bowls, were recovered from the graves[24].

Individuals were included in this preliminary study based on fulfilling two criteria: (a) the presence of at least one muscle insertion area per individual, and (b) the individual was skeletally mature. The omission of immature individuals was necessary to avoid any bias in the recording of entheseal developments due to immaturity of the skeletal structure[25]. Previous publications[26] document the presence of 58 individuals buried in Lemba. The majority are children aged between 3–12 years old at death. The remainder comprised 19 adult individuals. Only ten of these were suitable for the purpose of this study because they are represented by discrete articulated postcranial elements. The osteological materials excavated from *Mosphilia* comprised 80 individuals, but only 71 are represented by discrete articulated skeletons[27]. Among these 24 were assessed as adults and 13 have been evaluated as suitable for this analysis[28]. Only two adults were among the four individuals exhumed from Erimi-*Pamboula*[29]. Both were included in this study.

Biological sex and age-at-death of the individuals within this sample were reported in previous analyses[30]. Three age categories were identified to make these data comparable with each other: 1 = 20–30 years, 2 = 30–40 years, 3 = over 40 years. Allocation of the individuals into each age category was made on the basis of the median age.

17 Bolger – Peltenburg 2014, 194.
18 Manning 1993, 43; Bolger – Peltenburg 2014, 194.
19 Croft 1998, 213.
20 Murray 1998, 223.
21 Steel 2004, 86.
22 Knapp 2013, 248–250; Peltenburg et al. 1985; Peltenburg et al. 1998.
23 Knapp 2013, 207; Peltenburg et al. 1985; Peltenburg et al. 1998; Bolger 2013.
24 Peltenburg et al. 1985; Peltenburg et al. 1998; Dikaios 1936; Niklasson 1991.
25 Foster et al. 2014, 518.
26 Gamble 2011, 100.
27 Gamble 2011, 112.
28 Gamble 2011, 113.
29 Dikaios 1936, 58–61.
30 Gamble 2011; Dikaios 1936.

Methods

Twenty-one postcranial entheses from eight skeletal elements (clavicle, scapula, humerus, radius, ulna, femur, tibia and patella) were examined to evaluate entheseal change. In addition, muscles insertions were aggregated into five functional complexes (table 1) in order to reduce error in the results[31].

Table 1 List of the entheses divided according to functional complex and the skeletal element to which they belong (based on Mariotti et al. 2007, 292)

Functional complex	Element	Enthesis
Shoulder	Clavicle	*Costoclavicular ligament*
		Conoid ligament
		Trapezoid ligament
		Muscle deltoideus
		Muscle pectoralis major
	Humerus	*Muscle pectoralis major*
		Muscle deltoideus
		Muscle teres major
Elbow	Scapula	*Muscle triceps brachii*
	Humerus	*Muscle brachioradialis*
	Radius	*Muscle biceps brachii*
	Ulna	*Muscle triceps brachii*
		Muscle brachialis
Forearm	Radius	*Muscle pronator teres*
		Interosseous membrane
	Ulna	*Muscle supinator*
Hip	Femur	*Muscle gluteus maximus*
		Muscle iliopsoas
Knee	Femur	*Muscle vastus medialis*
	Tibia	*Quadriceps tendon*
	Patella	*Quadriceps tendon*

The recording of entheseal remodelling was conducted using V. Mariotti's graded visual reference system[32]. The selection of this method was led by three criteria: (1) the recognisability on dry bones of the relevant entheses; (2) the possibility to record both the fibrous and the fibrocartilaginous entheses, avoiding the loss of valuable information in cases of poor preservation[33]; (3) that this method has been tailored to examine muscle systems which were used frequently in prehistoric activities[34]. This protocol entails differentiation of normal osseous response associated with robusticity from enthesopathies, which include a range of pathological manifestations, namely osteolytic lesions (OL), porosity or eroded areas, and enthesophytic formations (EF) corresponding to the presence of the enthesophytes[35]. In the paper published in 2004, which presents

31 Mariotti et al. 2007.
32 Mariotti et al. 2004; Mariotti et al. 2007.
33 Indeed, other widely adopted methods (e.g. the Coimbra method) have been designed to exclusively record fibrocartilaginous entheses, which occur at the secondary ossification sites (epiphysis) of the bones and on the carpals, tarsal and vertebrae. These anatomical areas are unlikely to be found in Cypriot skeletal materials given the level of incompleteness of the skeletons.
34 Porčić – Stefanović 2009.
35 Mariotti et al. 2004, 148.

the results of analyses performed on 113 individuals from Sperino and Sardinian collections, V. Mariotti and colleagues point out that osteolytic and the enthesophytic formations follow different trends[36]. The OL, for instance, seem to have a higher frequency in young individuals than in mature adults[37]. For this reason, these lesions were recorded separately. Robusticity was scored in five stages: 1a, 1b, 1c (mild), 2 (moderate), and 3 (severe), but to facilitate statistical analysis of the data, the first three degrees (1a–1c) were aggregated[38]. OL and EF were evaluated based on a three-point scale (mild, moderate and severe) as V. Mariotti suggests[39].

A range of bivariate non-parametric statistics suitable for categorical and ordinal data were utilised to examine relationships in the data. All statistical analyses were performed with SPSS 25. The small sample size prevented detailed statistical examination. Where expected counts were too low to enable valid use of the Chi-Square test, the Fisher Exact test was performed to explore associations between two variables. The Kruskal-Wallis test was conducted where ordinal data was examined, for example, on the five functional complexes to identify statistically significant differences based on sex. In other cases, frequency data were examined based on percentages and prevalences. In reference to this latest analysis, as V. Mariotti recommended[40], the use of a two-point scale (1 and 2+3) was deemed preferable in order to avoid excessive fragmentation of the sample, which would make interpretation of the data more difficult.

Results

The demographic profile of the three osteological populations is presented in table 2. The complete study sample comprised nine individuals from Lemba, 13 individuals from *Mosphilia,* and two individuals from Erimi. The youngest age-at-death group (20–30 years) included five females (two from Lemba and three from *Mosphilia*) and only two males who derived from *Mosphilia*. The 30–40 years old age category comprised six females (two from *Mosphilia* and four from Lemba) and four males (one from Erimi and three from *Mosphilia*). Finally, the oldest age category (> 40) included three individuals, one male from Lemba and two males from *Mosphilia*.

Table 2 Age and sex composition of the sample

Site	Sex	**Young adult** 20–30 years	**Middle adult** 30–40 years	**Old adult** >40 years	**Age not determined**	**Total**
Lemba-*Lakkous*	Male	–	–	1	–	1
	Female	2	4	–	–	6
	Not determined	1	1	–	–	2
Kissonerga-*Mosphilia*	Male	2	3	2	–	7
	Female	3	2		1	6
	Not determined	–	–	–	–	–
Erimi-*Pamboulia*	Male	–	1	–	1	2
	Female	–	–	–	–	–
	Not determined	–	–	–	–	–
	Total	**8**	**11**	**3**	**2**	**24**

36 Mariotti et al. 2004, 154; Drapeau 2008, 104.
37 Mariotti et al. 2004, 156.
38 Mariotti et al. 2007.
39 Mariotti et al. 2004.
40 Mariotti et al. 2007, 297.

In addition, two individuals for whom sex could not be determined were examined from Lemba, one aged 20–30 years-at-death, and the second 30–40 years-at-death. Two individuals could not be assigned an age category beyond general adult; one female from *Mosphilia* and one male from Erimi. Thus, in total the sample included twelve females and ten males, as well as two individuals for whom sex could not be determined.

A preliminary investigation of the frequency of the three EC markers (robusticity, osteolytic lesions and enthesophytic formations) demonstrates that robusticity, detected on the 100.0 % (178/178) of the entheses observed, was followed by enthesophytic formations (34.8 %, 62/178) and osteolytic lesions (12.9 %, 23/178) (tables 3. 4).

Table 3 Frequency distributions in age categories of low and medium osteophytes and porosity (N: number of entheses affected; %: percentages of the observable entheses affected at that location)

EC Marker	Degree	Age						Total	
		20–30		30–40		> 40			
		N	%	N	%	N	%	N	%
Enthesophytic formations	Mild	18	94.7	32	84.2	3	60	53	85.5
	Moderate	1	5.3	6	15.8	2	40	9	14.5
	Severe	–	–	–	–	–	–	–	–
	Total	**19**	**100**	**38**	**100**	**5**	**100**	**62**	**100**
Osteolytic lesions	Mild	3	75	14	84.4	1	50	18	78.3
	Moderate	1	25	3	17.6	1	50	5	21.7
	Severe	–	–	–	–	–	–	–	–
	Total	**4**	**100**	**17**	**100**	**2**	**100**	**23**	**100**

Table 4 Frequency distributions in age categories of mild, moderate and severe robusticity (N: number of entheses observed per age category, %: percentage of entheses observed per age category)

EC Marker	Degree	Age						Total	
		20–30		30–40		> 40			
		N	%	N	%	N	%	N	%
Robusticity	Mild	28	65.1	91	78.4	8	42.1	127	71.3
	Moderate	15	34.9	23	19.8	9	47.4	47	26.4
	Severe	–	–	2	1.7	2	10.5	4	2.2
	Total	**43**	**100**	**116**	**100**	**19**	**100**	**178**	**100**

Age-at-Death

The statistical associations between robusticity, osteolytic lesions and enthesophytic formations and age-at-death were explored separately (pooled sexes) on the total number of entheses (n = 178) observed on the individuals of a determined age (n = 22). Overall, the prevalence and severity of the three skeletal markers follow a similar trend suggesting that entheseal remodelling decreased from the young adults to the middle adults and increased from the middle to the old adults. The Kruskal-Wallis H test performed on the total number of surfaces recorded shows that there is a statistically significant difference in robusticity score between age categories (p = 0.002) (table 5).

Table 5 Kruskal-Wallis test result for association of grades 1, 2 and 3 of robusticity with age (N: total number of entheses observed by age category)

Kruskal-Wallis Test					
Ranks				**Test statistics**[a,b]	
	Age	**N**	**Mean rank**		**Robusticity score**
Robusticity	20–30	43	94.35	Kruskal-Wallis	12.214
	30–40	116	83.19	df	2
	> 40	19	117.05	Asymp. Sig.	.002

Kruskal-Wallis Test
b. Grouping variable: age

Dunn's pairwise tests, carried out for the three pairs of groups, revealed that there was very strong evidence (p = 0.002, adjusted using the Bonferroni correction) of a difference between the group of individuals aged between 30–40 years-at-death and those over 40 years (table 6). In contrast, no significant differences were observed in osteolytic lesions and enthesophytic formations scores (moderate and severe manifestations) between the three age categories (table 7). Hence, development of robusticity was associated with age to a greater extent than the other pathological manifestations, confirming trends already observed by other authors[41].

Table 6 Dunn's pairwise tests for association of grades 1, 2 and 3 of robusticity with age in years

Sample 1 – Sample 2	**Test statistic**	**Std. Error**	**Std. Test statistic**	**Sig.**	**Adj. Sig.**
30–40 – 20–30	11.159	7.235	1.542	.123	.369
30–40 – > 40	–33.863	10.029	–3.377	.001	.002
20–30 – > 40	–22.704	11.163	–2.034	.042	.126

Table 7 Kruskal-Wallis test result for association of grades 1 and 2 of porosity and osteophytes and age in years (N: number of entheses affected by age category)

Kruskal-Wallis Test					
Ranks				**Test statistics**[a,b]	
	Age	**N**	**Mean rank**		**Osteophytes score**
Enthesophytic formations	20–30	19	28.63	Kruskal-Wallis	3.913
	30–40	38	31.89	df	2
	> 40	5	39.40	Asymp. Sig.	.141
	Total	**62**	–	–	–
					Porosity score
Osteolytic lesions	20–30	4	12.38	Kruskal-Wallis	1.082
	30–40	17	11.53	df	2
	> 40	2	15.25	Asymp. Sig.	.582
	Total	**23**	–	–	–

Kruskal-Wallis Test
b. Grouping variable: age

41 Henderson et al. 2013; Mariotti et al. 2004.

Biological Sex

Considering that sexual dimorphism is population specific, as a first step of the study, no pooled sample of males and females from each of the three groups could be considered. Only the *Mosphilia* sample included sufficient males (n = 7) and females (n = 6) to enable statistical analysis of entheseal development between the sexes. For this reason, differences in the distribution of the mild, moderate and severe robusticity development between the sexes were explored using the Kruskal-Wallis H test only for the population from *Mosphilia* (table 8). Thus, a total of 93 entheses, 37 from male and 56 from female individuals, were considered. It must be noted that the overall level of preservation of the muscle insertions by sex indicate a bias in survival. Males were represented by only 39.8 % (37/93) of the total surfaces present, while 60.2 % (56/93) of the entheses recorded derive from females. Results show no significant difference between the overall development of entheses between males and females in this population (p = 0.256) (table 8). However, it was apparent that some dimorphism was present when comparing the frequency of the higher degrees of entheseal development between the sexes by functional complex (fig. 1). Females presented a greater development of shoulder and forearm in comparison to elbow, hip and knee. More specifically, data indicate that muscle *M. deltoideus* is the most utilised, followed by the conoid ligament, the muscle *M. brachioradialis* and *supinator* at the same level (fig. 2). Turning to the males, the most developed functional complexes were the shoulder and elbow, with a greater development of the *M. brachioradialis* and the costoclavicular ligament (fig. 2). Overall, females appear to have utilised muscles of the forearm more intensively than males, manifesting a higher percentage of moderate to severe entheseal remodeling (table 9).

Table 8 Kruskal-Wallis test result for association of combined robusticity score with sex at Kissonerga-*Mosphilia* (N: number of entheses observed per sex)

Kruskal-Wallis Test					
Ranks				Test statistics[a,b]	
	Sex	**N**	**Mean rank**		**Combined robusticity scores**
Combined robusticity scores	Males	37	44.16	Kruskal-Wallis	1.288
	Females	56	48.88	df	1
	Total	93	117.05	Asymp. Sig.	.256

Table 9 Cross tabulation for the presence and absence of higher degrees of robusticity in males and females from Kissonerga-*Mosphilia* (Count: number of entheses observed with higher robusticity)

Grade			**Sex**		
			Male	Female	Total
Grade 2 + 3 robusticity scores	Absence	Count % of the total	31 33.3 %	41 44.1 %	72 77.4 %
	Presence	Count % of the total	6 6.5 %	15 16.1 %	21 22.6 %
	Total	Count Expected count	37 39.8 %	56 60.2 %	93 100.0 %

Inter-Site Comparation

Inter-site variation has been explored only for females, comparing the frequency of higher-grade robusticity scores exhibited by women from *Mosphilia* (n = 6) and Lemba (n = 6) (fig. 3). When considering each enthesis, different frequencies between the sites have emerged exclusively at the trapezoid ligament, *deltoideus* (clavicle) and *supinator* muscles. Lemba females showed a

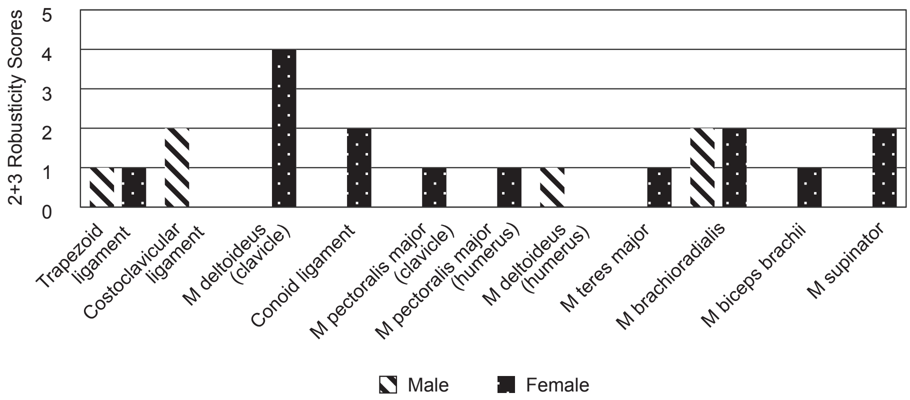

Fig. 1 Frequency of higher degrees (2+3) of entheseal change by functional complex between sexes at Kissonerga-*Mosphilia* (© M. Monaco)

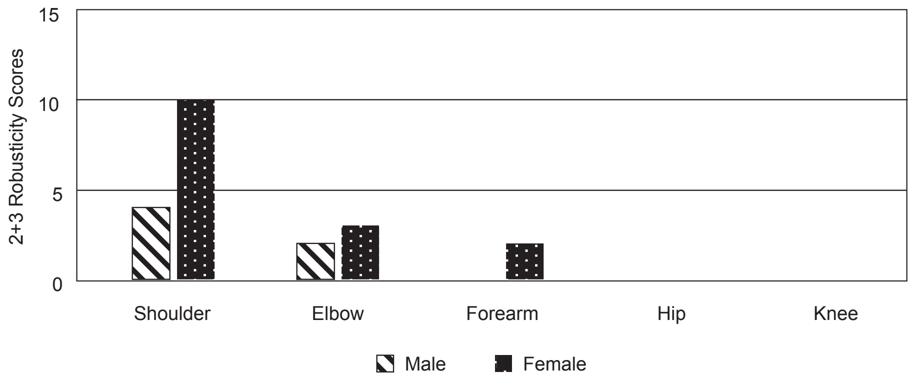

Fig. 2 Frequency of higher degrees (2+3) of robusticity by enthesis between sexes at Kissonerga-*Mosphilia* (© M. Monaco)

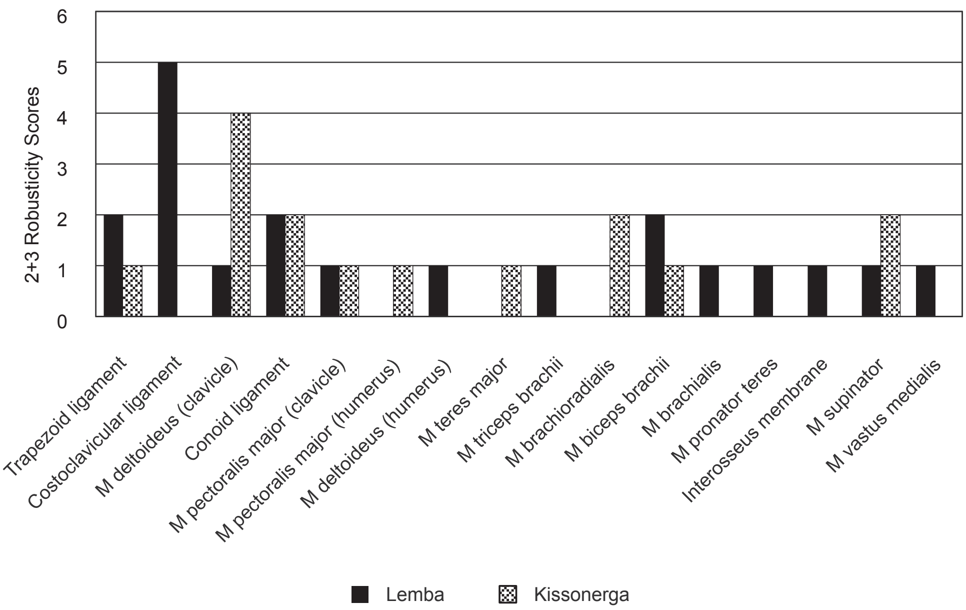

Fig. 3 Frequency of higher degrees (2+3) of entheseal change by enthesis (females) (© M. Monaco)

greater development of the trapezoid muscle and the costoclavicular ligament compared to *Mosphilia* females. In contrast, *deltoideus* (clavicle) and *supinator* muscles appeared to be utilised more by the *Mosphilia* women, compared to the Lemba group.

Comparison of male entheseal robusticity grades was not permitted due to the small number of males from Lemba (one individual) and Erimi (two individuals) and pooled-sex samples were not deemed appropriate given the identification of sex-based differences in entheseal changes discussed above.

Discussion

Given the limitations resulting from the fragmentary nature and small size of the population samples derived from the three Chalcolithic osteological assemblages analysed, the analysis of data has to adopt a pragmatic approach, integrating inferential statistics only where valid (e.g., robusticity ranks distribution between males and females from *Mosphilia*). The analysis of frequency and prevalence data was, therefore, also a valuable means to explore activity patterns of the three prehistoric communities. The frequency analysis carried out on the pooled sample (178 entheses from a total of 24 individuals) was, for instance, essential to discuss the distribution of the three markers by age and sex categories. Results produced by adopting this strategy have demonstrated that the robusticity of the functional complexes examined increase with age. This finding corroborates a number of studies that identify age as one of the major confounding factors in the evaluation of the entheseal changes to study activity patterns[42]. This pattern is biologically plausible, as the older adults have more time to accumulate change in bone morphology[43].

Regarding sexual dimorphism, while no overall sex-based differences in activity were detected, when entheses were examined by functional group it appeared that females had particularly pronounced development of the entheses in the shoulder and forearm. H. M. Frost[44] states that estrogen deficiency in post-menopausal females increases osteoclastic activity causing loss of bone. According to this assumption, we should expect to detect a greater robusticity in male entheses compared to females. Considering that within this Chalcolithic sample no post-menopausal females were found, this assumption could not be verified. Very few published studies have documented the opposite pattern, namely a greater developed of these functional complexes in the females compared to the males[45]. In those cases, however, as E. Weiss[46] stresses, a reduction of the sex differences may be observed by aggregating the variables considered: it has been widely proven that the use of functional aggregated entheses reduces error variance in the results. For this reason, in this study, entheses were examined firstly as part of the functional complex to which they belong. Despite this approach, it remains the case that males appear to have had a reduced workload in the shoulder compared to females.

Given the small number of entheses recorded, any discussion of sexual division of labour or differences in activity patterns between sites must be speculative. Hence, it is considered more appropriate to focus here on the potential contexts in which similar patterns have been found in past studies, rather than developing a detailed interpretation of activity patterns. Looking at the specific muscles, which seem to have been more extensively utilised by females, *deltoideus* (clavicle) is recruited during flexion forward and down of the arm[47]. Among the range of prehistoric activities explored by using entheseal changes, T. Molleson and V. Eshed mention the pounding grain in a mortar with a stone pestle as a compatible task to justify a repetitive and

42 Al Oumaoui et al. 2004; Weiss 2007; Foster et al. 2014; Steen – Lane 1998; Chapman 1997.
43 Weiss 2015.
44 Frost 1999, 1475.
45 E.g. Al Oumaoui et al. 2004; Chapman 1997.
46 Weiss 2004, 232.
47 Chapman 1997.

intensive use of this muscle[48]. This sequence of movements, thus, might have been predominately carried out by the females, as part of the food processing or to prepare ochre. A variety of tool kits (e.g. hammerstone/grinder or pestle with traces of ochre), excavated at Lemba for instance, would corroborate this latter hypothesis[49]. As for the food processing, this activity was archaeologically documented both at *Mosphilia* and at Lemba by the identification of rubbers associated with basins, or with the discovery of waste products (e.g. carbonised seeds)[50].

Regarding the development of the muscle *brachioradialis*, involved in the flexion of the forearm and equally represented in the sex categories, it may potentially depend by a wider range of physical tasks recurrent over the time. This may include grinding, use of a hoe and production of a variety of objects[51]. Clear evidence of the bone, picrolite, stone or flint working was provided by the recovery of waste fragments of picrolite, unfinished beads or handles, cores and debitage[52]. Indeed, this muscle was found to be widely utilised by both the sexes within the *Mosphilia* sample.

The *supinator* muscle is a short muscle whose fibers run from the ulna to the radius, which assists the *biceps brachii* (radius) in the lateral rotation of the forearm. According to V. Galera and M. D. Garralda, this movement could be indicative of frequent lifting and carrying of heavy loads for long distances[53]. In the same way, severe remodelling at the conoid ligament (clavicle) has been associated with the carrying burdens on the shoulder[54]. According to the results, thus, this kind of task might have been carried out more intensively or frequently by the females of *Mosphilia* compared to the females of Lemba.

Conclusion

Despite challenges due to the state of preservation of the Chalcolithic human remains recovered from the three sites of Lemba-*Lakkous*, Kissonerga-*Mosphilia* and Erimi-*Pamboula*, the results of the evaluation of entheseal change appears encouraging. The findings of this study support the hypothesis of a relationship between age and entheseal changes, with the robusticity increasing with age. A sex-based division of activities is also indicated by the observation of the distribution of degrees of entheseal robusticity by functional complex. Therefore, activity-induced skeletal markers are a powerful tool to explore social division of labour over time.

Bibliography

Al Oumaoui et al. 2004 — I. Al Oumaoui – S. Jimenéz-Brobeil – P. du Souich, Markers of Activity Patterns in Some Populations of the Iberian Peninsula, International Journal of Osteoarchaeology 14/5, 2004, 343–359.

Bolger 2013 — D. Bolger, A Matter of Choice: Cypriot Interactions with the Levantine Mainland during the Late 4th–3rd Millennium BC, Levant 45/1, 2013, 163–188.

Bolger – Peltenburg 2014 — D. Bolger – E. Peltenburg, Material and Social Transformations in 3rd Millennium BC Cyprus: Evidence of Ceramics, in: J. M. Webb (ed.), Structure, Measurement and Meaning. Studies on Prehistoric Cyprus in Honour of David Frankel, SIMA 143 (Uppsala 2014) 187–198.

48 Molleson 1994; Eshed et al. 2004.
49 Peltenburg et al. 1998, 320.
50 Peltenburg et al. 1985, 320–329; Peltenburg et al. 1998, 123.
51 Eshed et al. 2004.
52 Peltenburg et al. 1985, 322; Peltenburg et al. 1998.
53 Galera – Garralda 1993, 255.
54 Chapman 1997.

Chapman 1997 N. M. S. Chapman, Evidence for Spanish Influence on Activity Induced Musculoskeletal Stress Markers at Pecos Pueblo, International Journal of Osteoarchaeology 7/5, 1997, 497–506.
Croft 1998 P. Croft, Animal Remains: Synopsis, in: Peltenburg et al. 1998, 207–214.
Dikaios 1936 P. Dikaios, The Excavations at Erimi 1933–1935, RDAC 1936, 1–81.
Drapeau 2008 M. S. M. Drapeau, Enthesis Bilateral Asymmetry in Humans and African Apes, HOMO Journal of Comparative Human Biology 59/2, 2008, 93–109.
Eshed et al. 2004 V. Eshed – A. Gopher – E. Galili – I. Hershkovitz, Musculoskeletal Stress Markers in Natufian Hunter-Gatherers and Neolithic Farmers in the Levant: The Upper Limb, American Journal of Physical Anthropology 123/4, 2004, 303–315.
Foster et al. 2014 A. Foster – H. Buckley – N. Tayles, Using Enthesis Robusticity to Infer Activity in the Past: A Review, Journal of Archaeological Method and Theory 21/3, 2014, 511–533.
Frost 1999 H. M. Frost, On the Estrogen-Bone Relationship and Postmenopausal Bone Loss: A New Model, Journal of Bone and Mineral Research 14, 1999, 1473–1477.
Galera – Garralda 1993 V. Galera – M. D. Garralda, Enthesopathies in a Spanish Medieval Population: Anthropological, Epidemiological, and Ethnohistorical Aspects, International Journal of Anthropology 8, 1993, 247–258.
Gamble 2011 M. Gamble, Health and Disease in Chalcolithic Cyprus: A Problem-oriented Palaeopathological Study of the Human Remains (PhD thesis University of Newcastle 2011).
Guest 1936 E. M. Guest, The Human Remains, in: Dikaios 1936, 58–62.
Hawkey – Merbs 1995 D. E. Hawkey – C. F. Merbs, Activity-Induced Musculoskeletal Stress Markers (MSM) and Subsistence Strategy Changes Among Ancient Hudson Bay Eskimos, International Journal of Osteoarchaeology 5/4, 1995, 324–338.
Henderson et al. 2013 C. Y. Henderson – V. Mariotti – D. Pany-Kucera – S. Villotte – C. Wilczak, Recording Specific Entheseal Changes of Fibrocartilaginous Entheses: Initial Tests Using the Coimbra Method, International Journal of Osteoarchaeology 23/2, 2013, 152–162.
Henderson et al. 2016 C. Y. Henderson – V. Mariotti – D. Pany-Kucera – S. Villotte – C. Wilczak, The New ›Coimbra Method‹: A Biologically Appropriate Method for Recording Specific Features of Fibrocartilaginous Entheseal Changes, International Journal of Osteoarchaeology 26/5, 2016, 925–932.
Henderson et al. 2017 C. Y. Henderson – C. Wilczak – V. Mariotti, Commentary: An Update to the new Coimbra Method for Recording Entheseal Changes, International Journal of Osteoarchaeology 27, 2017, 522–523.
Keswani 2004 P. Keswani, Mortuary Ritual and Society in Bronze Age Cyprus, Monographs in Mediterranean Archaeology 9 (London 2004).
Knapp 2013 A. B. Knapp, The Archaeology of Cyprus from Earliest Prehistory through the Bronze Age, Cambridge World Archaeology (Cambridge 2013).
Lorentz 2016 K. O. Lorentz, Challenges for funerary taphonomy viewed through prehistoric Cyprus, JASc Reports 10, 2016, 757–768.
Manning 1993 S. W. Manning, Prestige, Distinction and Competition: The Anatomy of Socioeconomic Complexity in 4th–2nd Millennium B.C.E. Cyprus, BASOR 292, 1993, 35–58.
Mariotti et al. 2004 V. Mariotti – F. Facchini – M-G. Belcastro, Enthesopathies – Proposal of a Standardized Scoring Method and Applications, Collegium Antropologicum 28/1, 2004, 145–159.
Mariotti et al. 2007 V. Mariotti – F. Facchini – M-G. Belcastro, The Study of Entheses: Proposal of a Standardized Scoring Method for Twenty-Three Entheses of the Postcranial Skeleton, Collegium Antropologium 31/1, 2007, 291–313.
Molleson 1994 T. Molleson, The Eloquent Bones of Abu Hureyra, Scientific American 271/2, 1994, 70–75.
Molnar 2006 P. Molnar, Tracing Prehistoric Activities: Musculoskeletal Stress Marker Analysis of a Stone-Age Population on the Island of Gotland in the Baltic Sea, American Journal of Physical Anthropology 129/1, 2006, 12–23.
Murray 1998 M. A. Murray, Archaeobotanical Report, in: Peltenburg et al. 1998, 215–223.
Niklasson 1991 K. Niklasson, Early Prehistoric Burials in Cyprus, SIMA 96 (Jonsered 1991).
Osterholtz 2015 A. J. Osterholtz, Bodies in Motion: A Bioarchaeological Analysis of Migration and Identity in Bronze Age Cyprus (2400–1100 BC) (PhD thesis University of Nevada 2015).
Parras 2006 Z. Parras, Osteological evidence, in: E. Peltenburg (ed.), The Chalcolithic Cemetery of Souskiou-Vathyrkakas, Cyprus. Investigations of Four Missions from 1950 to 1997 (Nicosia 2006) 53–66.
Peltenburg et al. 1985 E. J. Peltenburg – D. Baird – A. Betts – S. Colledge – P. Croft – C. Elliott – T. Lawrence – D. A. Lunt – K. Niklasson – J. Renault-Miskovsky – J. S. Ridout-Sharpe – E. Slater – J. D. Stewart – C. Xenophontos, Excavations at Lemba-Lakkous, 1976–1983, Lemba Archaeological Project 1 = SIMA 70, 1 (Göteborg 1985).

Peltenburg et al. 1998 E. J. Peltenburg – D. Bolger – P. Croft – E. Goring – B. Irving – D. A. Lunt – S. W. Manning – M. A. Murray – C. McCartney – J. S. Ridout-Sharpe – G. Thomas – M. E. Watt – C. Elliott-Xenophontos, Excavations at Kissonerga-Mosphilia 1979–1992, Lemba Archaeological Project 2, 1, A. B = SIMA 70, 2 (Jonsered 1998).

Peltenburg et al. 2019 E. J. Peltenburg – D. Bolger – L. Crewe, Figurine makers of prehistoric Cyprus: settlement and cemeteries at Souskiou (Oxford 2019).

Porčić – Stefanović 2009 M. Porčić – S. Stefanović, Physical Activity and Social Status in Early Bronze Age Society: The Mokrin Necropolis, Journal of Anthropological Archaeology 28/3, 2009, 259–273.

Steen – Lane 1998 L. S. Steen – R. W. Lane, Evaluation of Habitual Activities among Two Alaskan Eskimo Populations Based on Muscoloskeletal Stress Markers, International Journal of Osteology 8, 1998, 341–353.

Steel 2004 L. Steel, Cyprus Before History: From the Earliest Settlers to the End of the Bronze Age (London 2004).

Weiss 2004 E. Weiss, Understanding Muscle Markers: Lower Limbs, American Journal of Physical Anthropology 125/3, 2004, 232–238.

Weiss 2007 E. Weiss, Muscle Markers Revisited: Activity Pattern Reconstruction with Controls in a Central California Amerind Population, American Journal of Physical Anthropology 133/3, 2007, 931–940.

Weiss 2015 E. Weiss, Examining Activity Patterns and Biological Confounding Factors: Differences Between Fibrocartilaginous and Fibrous Musculoskeletal Stress Markers, International Journal of Osteoarchaeology 25/3, 2015, 281–288.

Wilczak 1998 C. A. Wilczak, Considerations of Sexual Dimorphism, Age, and Asymmetry in Quantitative Measurements of Muscle Insertion Sites, International Journal of Osteoarchaeology 8/5, 1998, 311–325.

The Bioarchaeology of the Necropolis of Ktima-Upper City

A Preliminary Look into the Health and Lifeways of Hellenistic-Roman Cypriot Populations

Grigoria Ioannou

Abstract

This paper presents preliminary results of the osteological and palaeopathological analysis of human remains (n = 45) from the Hellenistic and Roman necropolis of Ktima-Upper City, situated in Paphos, Cyprus. It attempts to introduce some preliminary inferences on aspects of health and diseases of the people buried within the necropolis. Recent excavations brought to light a substantial number of rock-cut, multi-burial tombs, likely reflecting a necropolis, the place of burial of a local population, which was part of suburban Nea Paphos, capital of Cyprus during the Hellenistic and Roman periods. The study of this particular population is part of a larger doctoral research project focusing on the analysis and comparison of populations dating to the Hellenistic and Roman periods from Cyprus, exploring aspects of urbanisation, health, disease, diet and demography, as well as mortuary behaviour. The major pathologies within the sample from Ktima-Upper City, identified through this preliminary osteological analysis, are degenerative joint changes, linear enamel hypoplasia, ante-mortem tooth loss and periodontal disease. Metabolic disorders (cribra orbitalia and porotic hyperostosis), infectious diseases (periostitis and maxillary sinusitis) and traumas have been recorded in overall low levels, as well as dental pathologies (calculus, caries and dental abscesses). These preliminary results indicate that the individuals are exposed to factors contributing to the development of osteoarthritic changes, such as activity and labour. Low rates of calculus, caries and dental abscesses may reflect a balance in diet with low levels of carbohydrates but rich in proteins. Periodontal disease and ante-mortem tooth loss affected people relatively frequently, however further research is required. The results also indicate a correlation between pathologies and sex, suggesting differences between males and females. These differences are likely linked to diet, social practices and activity.

Introduction

Bioarchaeology is the analysis of human remains from archaeological contexts with the intention of answering questions related to life, health and lifestyles of ancient populations. An individual is impacted by their close interaction with their living environment, both natural and cultural. Therefore, the analysis of human remains enables our understanding of past populations life experiences[1]. Archaeological research has made a significant contribution to the investigation of ancient Cyprus as the island has attracted the attention of researchers and collectors since the early 19th century[2]. The study of the ancient populations of Cyprus from a bioarchaeological perspective, however, is still developing, as problem-oriented bioarchaeological studies began relatively recently. Several factors have contributed to the delay in the development and flourishing of Cypriot bioarchaeology, nevertheless during the last two decades there has been a significant increase in the number and variety of studies and researchers focusing on the investigation of ancient Cypriot skeletal assemblages[3].

1 Larsen 2002; Roberts 2016.
2 Pilides 2009.
3 Harper – Fox 2008; Ioannou – Lorentz (in preparation).

While the Cypriot Hellenistic and Roman periods are of great interest to archaeologists, there have been few studies conducted placing human remains at the centre of the enquiry[4]. Bioarchaeological inferences are vital to understanding the Hellenistic-Roman urban and rural environment in Cyprus. The lack of primary sources describing living conditions during these periods renders the archaeological context and human remains the only sources available to obtain data. The district of Paphos, particularly Nea Paphos, enjoys a rich historical and archaeological setting, especially during the Hellenistic (312–58 B.C.) and Roman (58 B.C. – A.D. 395) periods. The city, after its foundation in the late 4th century B.C., had rapidly transformed into one of the major cities in Cyprus; and in a short period of time, a powerful economic and political centre. In the 2nd century B.C., Nea Paphos became the capital of the island[5]. This rapid progression from rural to urban environment has led to questions regarding the effects of that urbanism upon the health of the people living within the city, particularly in contrast to those living in suburban (Ktima-Upper City) and rural sites of the region[6]. This paper presents preliminary results from the osteological and palaeopathological analysis of the Ktima-Upper City necropolis. The study of this necropolis is part of a larger problem-oriented bioarchaeological doctoral thesis. The primary aim of this research is to explore to what extent, and in which ways, the profound changes and urban character of Nea Paphos affected the health of the people living within the city, and how does it compare to the people living in the same district (Ktima-Upper City) and the wider region.

Materials and Methods

Materials

Site Description

The necropolis of Ktima-Upper City is situated in the southwestern part of Cyprus, approximately 3 km from the ancient capital of Cyprus, Nea Paphos, and its Eastern Necropolis (fig. 1). According to the archaeological remains, discovered during systematic excavations by the French Expedition in Cyprus in the 1950s in the area of Ktima-*Iskender,* as well as during rescue excavations by the Department of Antiquities of Cyprus, the area of the modern city-centre of Paphos, today known as Ktima, has been inhabited since the Geometric period (1050–750 B.C.) to Roman times (58 B.C. – A.D. 395)[7]. The archaeological context suggests that there was a continuous inhabitation of the area from this time until the Late Roman period (c. A.D. 330–395), probably with a hiatus during the Classical period (475–312 B.C.).

Previously, it was thought that the necropolis of Ktima was a later expansion of the Eastern Necropolis of Nea Paphos. The Eastern Necropolis is one of the two large necropoleis of Nea Paphos during the Hellenistic and Roman times. The second necropolis is the so-called Tombs of the Kings, the place of burial of the high status Ptolemaic and Roman officials and their families[8]. However, the discovery of a number of tombs at Ktima, particularly over the last few years, strengthens the hypothesis that this is the necropolis of a local population in Paphos-Ktima, contemporaneous with Hellenistic-Roman Nea Paphos, and not an expansion of the Eastern Necropolis[9]. According to the rich funerary contexts, with some of the tombs embellished with elaborate decorations (e.g. frescoes) and architecture, it seems that this is a rich and prestigious

4 Fox-Leonard 1997; Ioannou 2013; Ioannou (unpublished).
5 Maier – Karageorghis 1984; Młynarczyk 1990.
6 Redfern et al. 2015; Walter – DeWitte 2017.
7 Caubet – Yon 1993; Raptou 2004; Raptou 2007.
8 Parks 1999.
9 Demetrios Michaelides, personal communication; Margarita Kouali, personal communication.

Fig. 1 Satellite map showing the modern city of Paphos. The rectangles indicate: (a) the ancient city of Nea Paphos, (b) the Eastern Necropolis, (c) the Ktima-Upper City area (map developed by G. Ioannou)

suburban site, which shares a number of mortuary features similar to Nea Paphos[10]. Prior to the current research project, the human remains from Ktima-Upper City had not been studied. Despite the commingled nature of the majority of the human skeletal remains, the analysis of them can provide substantial information about the health, diseases and lifeways of the people of Ktima-Upper City during the Hellenistic and Roman period.

Sample Description

Skeletal remains recovered from seven Hellenistic-Roman rock-cut chamber tombs from Ktima-Upper City were analysed within a large-scale doctoral research project. These tombs contain individuals in both articulated and commingled condition. The collection is comprised of a minimum of 207 individuals (MNI). This paper presents results and inferences obtained from the analyses of 45 articulated individuals, while the results from the commingled assemblages are not included in this paper[11]. Bone preservation ranges from fair to good. The architectural style of the tombs is predominantly, rock-cut tombs with a *dromos* (either a shaft or a corridor, sloping or stepped) leading to a main chamber with several *loculli* (small hollows cut into the rock) and/or niches on the walls; characteristic features of the Hellenistic and Roman period[12]. Both single and multiple inhumations took place, with the latter being more common[13]. The tombs were continually re-used throughout time, which is evident by the commingled assemblages, which were intentionally moved to the sides of the *loculli*, to create space for the subsequent

10 Raptou 2004; Raptou 2007.
11 Ioannou (unpublished).
12 Parks 1999.
13 Margarita Kouali, personal communication.

single inhumations[14]. Articulated individuals were placed directly on the floor of the *locullus*, in a supine position and with their arms either extended next to the torso or folded across the area of the pelvis or the sternum.

Methods

The analysis of the human remains took place at the Archaeological Museum of Paphos, Cyprus, where they are curated since their excavation. The remains were analysed following standard macroscopic osteological methods outlined by J. L. Buikstra and D. H. Ubelaker[15], and on the »Updated Guidelines to the Standards for Recording Human Remains« by P. D. Mitchell and M. Brickley[16] for the assessment of their preservation and completeness, age-at-death, sex and stature. Estimation of sex was achieved by observing sexually diagnostic traits of the skull and pelvis of adult individuals only, as defined by J. L. Buikstra and D. H. Ubelaker[17]. While there are studies, which approach the issue of determination of sex in subadult remains, none have achieved widespread acceptance to-date, and thus only adults are routinely provided with a sex estimation[18]. Age estimations for adult individuals were determined based on the observation of the pubic symphysis, cranial suture closure, the auricular surface and tooth wear[19]. The estimation of age in subadult individuals was based on bone and tooth development, with the post-cranial features observed, including the size of the bone and the epiphyseal fusion of long bones after B. Baker et al.[20] and L. Scheuer and S. M. Black[21]. Subadult age assessment was based on dental development, using the »London Dental Atlas«[22]. Skeletal pathologies were interpreted in accordance with A. C. Aufderheide and C. Rodriguez-Martin[23], as well as T. Waldron[24] and D. J. Ortner[25]. Dental pathologies were recorded and interpreted in accordance with B. H. Smith, D. R. Brothwell and S. Hillson[26]. For bone and tooth identification, J. H. Schwartz, T. D. White et al. and L. Scheuer and S. M. Black were used[27]. Pathologies and conditions (bone and tooth) recorded and discussed in this paper are: porotic hyperostosis (PH), cribra orbitalia (CO), periostitis, maxillary sinusitis (MS), degenerative joint diseases (DJD), trauma, linear enamel hypoplasia (LEH), dental calculus (DC), dental wear (DW), periodontal disease (PD), caries, ante-mortem tooth loss (AMTL) and dental abscesses (DA). The collected data was statistically analysed using the statistical tool SPSS.

14 Margarita Kouali, personal communication.
15 Buikstra – Ubelaker 1994.
16 Mitchell – Brickley 2018.
17 Buikstra – Ubelaker 1994.
18 i.e. McIntyre et al. 2006; Schutkowski 1993; Rogers 2009.
19 Miles 1963; Brothwell 1981; Brooks – Suchey 1990; Buckberry – Chamberlain 2002; Lovejoy et al. 1985; Meindl – Lovejoy 1985.
20 Baker et al. 2005.
21 Scheuer – Black 2000.
22 AlQahtani et al. 2010.
23 Aufderheide – Rodriguez-Martin 1998.
24 Waldron 2009.
25 Ortner 2003.
26 Smith 1984; Brothwell 1981; Hillson 1996.
27 Schwartz 2007; White et al. 2012; Scheuer – Black 2000.

Results

Preservation

The human remains were generally in a fair to good state of surface preservation, with part of the sample exhibiting extreme fragmentation and bone surface alterations caused by advanced stages of erosion and weathering. In general, human remains after death are exposed to physical, chemical and biological factors, which will lead to a diagenetic procedure causing alternations. These alterations to the skeletal remains are determined by the nature of the environment[28]. Post-depositional disturbance and excavation treatment can also shape the preservation of the bones[29]. In terms of overall skeletal completeness, there is variation amongst the individuals from Ktima-Upper City, with the majority of the individuals exhibiting a low-rate of completeness. In total, 25 individuals (of the 45 examined) show a poor state of completeness (> 25 % present). Eight individuals exhibited a fair rate, with 50–75 % of the skeleton present, while the remaining 13 individuals are in a considerably good state of completeness, with > 75 % of the skeleton present.

Demographics

A total of 45 individuals, of varying age ranges, were examined for this paper. Of these 45 individuals, 38 (84 %) are adults (skeletally mature) while only seven (16 %) are subadults (skeletally immature). The ages-at-death of the 45 individuals ranges from ›infants‹ (0–2 years) to ›older adults‹ (50+). According to the age distribution (fig. 2), only two (5 %) individuals were estimated to be infants at death, two (5 %) as young children, (3–11 years), two (4 %) as adolescents (12–19 years), and one for whom age estimation could not be carried out. Within the group of adult individuals, 14 (31 %) were estimated as young adults, eleven (24 %) as middle adults and only three (7 %) as older adults. For ten (11 %) adult individuals, age was not able to be assessed due to poor preservation of bones. Of the 38 adult individuals, 21 (47 %) were determined to be male and only eight (18 %) are female (fig. 3). Sex determination could not be carried out for nine (20 %) adult individuals. Observing the sex distribution in association with age (table 1), eleven (28.95 %) young adult individuals have been assessed as male while seven (18.42 %) male individuals were estimated to be 35–49 years-at-death. No female young adults have been identified within the sample. Four (10.53 %) females have been estimated to be within the middle adult age group, and only one (2.63 %) is an older adult.

Skeletal and Dental Pathology Results

Palaeopathology is the study of diseases of past populations[30]. It contributes to providing information about health, nutritional levels and lifeways of an individual, as well as at the population level. Through palaeopathology, evidence of health, diet and activities can be derived, enabling a better understanding of the life experiences of ancient populations, and their environment[31]. Pathological changes on the skeleton were recorded and interpreted in terms of presence and absence, severity, and anatomical location. Pathologies discussed in this paper affected adults exclusively (barring one individual under 19 years-at-death who presented dental caries). No pathologies were observed on the remains of subadult individuals, thus they are not included in this summary but will be included in the comprehensive PhD thesis.

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28 Kendal et al. 2018.
29 Mitchell – Brickley 2018.
30 Larsen 2002.
31 Larsen 2002; Roberts – Manchester 2010; Roberts 2016.

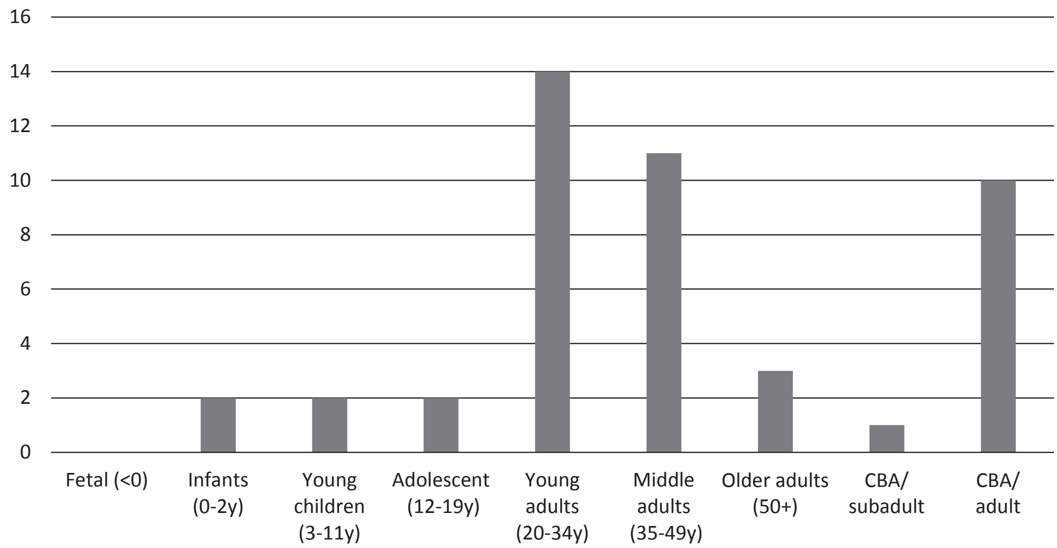

Fig. 2 Distribution of age-at-death at the site of Ktima-Upper City (CBA = Cannot Be Assessed) (© G. Ioannou)

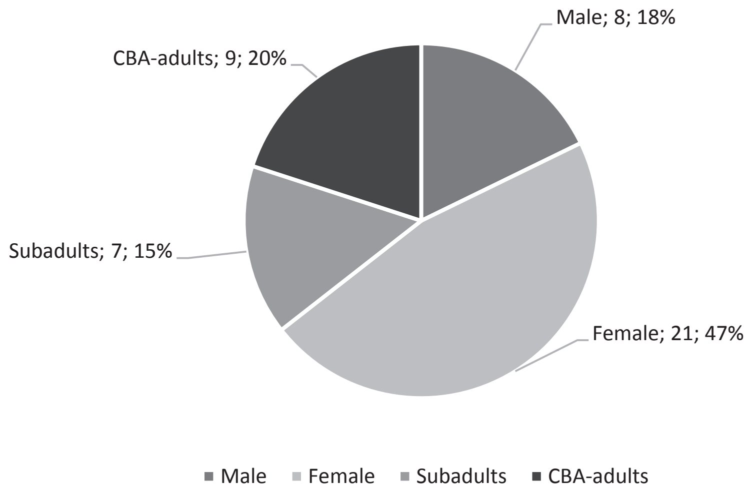

Fig. 3 Distribution of sex at Ktima-Upper City (CBA = Cannot Be Assessed) (© G. Ioannou)

Table 1 Age and sex cross tabulation

Age group	CBA	Male	Female	Subadults	Total
Infants (0–2)	–	–	–	2	2
Young children (3–11)	0	–	–	2	2
Adolescent (12–19)	0	–	–	2	2
Young adults (20–34)	3	11	–	–	14
Middle adults (35–49)	–	7	4	–	11
Older adults (50+)	–	1	2	–	3
CBA	6	2	2	1	11
Total	**9**	**21**	**8**	**7**	**45**

Dental Pathologies

All the dental pathologies observed in the Ktima-Upper City sample are listed in table 2. The dentition of each individual was recorded in respect to tooth presence or absence, dental wear, pathologies, and trauma. It is presented here on an individual basis, rather than on a tooth location basis. Therefore, the pathology is considered present for the individual if it is observed on one or more teeth. The dental pathologies recorded are: linear enamel hypoplasia (LEH), antemortem tooth loss (AMTL), caries, calculus, periodontal disease (PD) and dental abscess (DA). The surface condition of the teeth from Ktima-Upper City is generally good to excellent. For 19 individuals, it was not possible to observe any dental pathologies, mainly due to post-mortem tooth loss and absence or poor preservation of alveolar bone.

Table 2 Dental diseases distribution by individual

Dental Pathologies Distribution												
	LEH		DA		AMTL		Calculus		PD		Caries	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
No lesion	11	24.4	24	53.3	12	26.7	19	40	10	22.2	18	40
Lesion present	15	33.3	2	35.6	14	31.1	7	15.6	16	35.6	8	17.8
CBA	19	42.2	19	42.2	19	42.2	19	44.4	19	42.2	19	42.2
Total	**45**	100	**45**	100	**45**	100	**45**	100	**45**	100	**45**	100

LEH was recorded in 15 (57.69 %) adult individuals of the total 26 individuals who could be assessed for the condition. Eleven (42.31 %) showed no evidence of LEH. All LEH are noted in adult individuals, of which nine (60 %) were aged between 20–34 years-at-death, four (26.67 %) between 35–49 years-at-death and two (13.33 %) were of unknown age-at-death. There is a noticeable difference in the distribution of LEH in Ktima-Upper City between the sexes. Of the 15 individuals with LEH, twelve (80 %) were adult males and only one (6.67 %) was identified as adult female, while two (13.33 %) adult individuals did not have a sex determined. There is a statistically significant difference between the sexes and the occurrence of LEH ($p = 0.003$).

From the 26 individuals for whom DA could be examined, by presence or absence, only two (7.69 %) cases were observed. Twenty-four (92.31 %) individuals displayed no signs of DA. Both individuals affected by DA are young adult males.

From the 26 individuals who could be assessed for AMTL and alveolar resorption, 14 (53.85 %) had lost teeth *in vivo*, while 12 (46.15 %) individuals exhibited no evidence of AMTL. From the 14 individuals with AMTL, five (35.71 %) were young adults, five (35.71 %) middle adults and two (14.29 %) over the age of 50 years. For two (14.29 %) adult individuals with AMTL age was not possible to be estimated. Again, there was a noticeable difference in the distribution of AMTL based on sex, as eleven (78.6 %) of the individuals displaying AMTL are adult males and only three (21.4 %) are adult females. There is a statistically significant difference between the sexes and the occurrence of AMTL ($p = 0.015$). In general, mandibular molars and premolars show higher rates of tooth loss, which could be the result of pulp exposure due to heavier wear/attrition and root resorption. AMTL of incisors, which is often caused by using the teeth as tools[32], was also recorded but less often. Of the 14 individuals with AMTL, eight (57.14 %) have also been affected with PD.

Calculus, on at least one tooth, was observed in seven (26.92 %) individuals from the 26 assessable individuals, while 19 (73.08 %) showed no signs of mineralised plaque. All individuals exhibiting calculus are male; four (57.14 %) young adults and three (42.86 %) middle adults.

32 Baker et al. 2012.

Fig. 4
Right mandible fragment, anterior to the right with occlusal surface up, lateral view, skeleton 3, P.M. 3937, central chamber. Advanced periodontitis of all three molars and pulp exposure caused by severe caries in second and third molars. Dental abscess at the apex of the second premolar and AMTL in progess of healing at time-at-death, with periapical activity, bone resorption and remodelling (© G. Ioannou)

There is a statistically significant difference between the sexes and the occurrence of calculus ($p = 0.008$).

PD (fig. 4) prevalence is high as it was recorded in 16 (61.54 %) of the 26 assessable individuals. Ten (38.46 %) individuals showed no signs of the pathology. According to age-at-death distribution of PD occurrence, of the 16 individuals afflicted with PD, seven (43.75 %) were young adults, five (31.25 %) were middle adults and three (18.75 %) were adults of unknown age-at-death. There is a statistically significant difference ($p = 0.000$) in the distribution of PD based on sex within the sample. Of the 16 individuals affected with PD, 11 (68.75 %) were males and only three (18.75 %) were females while for the remaining two (12.5 %), sex could not be determined.

From the 26 individuals who could be assessed, carious lesions affected eight (30.77 %) adult individuals, while 18 (69.23 %) individuals showed no signs of the lesion. Of the eight (17.8 %) individuals with caries, only one is under the age of 19 years-at-death. In terms of age, four (57.14 %) of the seven adults with caries were assessed as young adults (20–34 years), two (28.57 %) as middle adults (35–49 years) and for one (14.29 %) adult individual, age could not be estimated. Of the seven adult individuals with caries, five (71.43 %) were assessed as males and the sex of the remaining two (28.57 %) adult individuals could not be assessed.

Bone Pathologies

All bone pathologies observed in the 45 individuals of the Ktima-Upper City sample population are listed in table 3. Generally, there was at least one pathology observed in the majority of the adult individuals. Degenerative joint diseases (DJD) expressed either on joints of the limbs and/or on the vertebral column, show the highest prevalence.

Five (22.73 %) individuals of the total 22 individuals that were assessable for CO and PH, exhibit a pathologic indicator most commonly associated with metabolic disorders[33]. These indicators are: cribra orbitalia, porotic hyperostosis and cranial vault thickening. At the individual level, of the five affected individuals from Ktima-Upper City, one (20 %) adult exhibits healed CO while all the rest of the individuals (80 %) exhibit PH. From the individuals with PH, two (50 %) are assessed as middle adult aged males, one (25 %) as a middle adult aged female and one (25 %) as a female older than 50 years old.

33 Roberts – Manchester 2010.

Table 3 Osseous pathologies distribution

Pathological conditions	Observed (n)	Percentage (%)	No pathology (n)	CBA (n)
Skeletal pathological markers – Metabolic disorders				
Porotic hyperostosis	4	8.9 %	19	22
Cribra orbitalia	1	2.2 %	21	23
Infectious diseases				
Periostitis	8	17.8 %	15	22
Maxillary sinusitis	1	2.2 %	17	27
DJD and activity related				
Osteoarthritic changes	22	48.89 %	2	21
Vertebral osteoarthritic changes	19	42.2 %	2	24
Schmorl's nodes	5	11.1 %	19	21
Ankyloses spondylitis	2	4.4 %	20	23
Traumas	8	17.8 %	18	19

Fig. 5 Left tibia, posterior-lateral view, skeleton 1, central chamber, P.M. 3937. Periostitis on distal lateral diaphysis (© G. Ioannou)

Infectious diseases were recorded in the form of non-specific infections (periostitis) (fig. 5) and maxillary sinusitis. Periostitis was detected in eight (34.78 %) individuals of the 23 individuals who could be assessed for the lesion. All individuals affected with periostitis are adults; from which four (50 %) are young adults, three (37.5 %) middle-age adults and one (12.5 %) of unknown age-at-death. Of these eight individuals, five (62.5 %) are males and three (37.5 %) are females. The bones affected with periostitis are mostly long bones; one (12.5 %) fibula, five (62.5 %) tibiae, one (12.5 %) humerus and one (12.5 %) on the ribs. From the 18 individuals who could be assessed for maxillary sinusitis, only one (5.56 %) case, affecting a middle adult male, has been identified.

DJD is the most prevalent palaeopathological condition recorded on the skeletal material from Ktima-Upper City. DJD was observed both in the vertebral column and the post-cranial joints in the form of osteophytes, erosion and pitting, eburnation (fig. 6) and ankylosis. Of the 24 individuals who could be assessed for DJD, 22 (91.67 %) displayed a form of osteoarthritic change. From these, 16 (72.73 %) were assessed as males and six (27.27 %) as females, which is a statistically significant difference ($p = 0.001$). Vertebral osteoarthritic changes were observed on 19 (90.48 %) of the 21 assessable individuals – 14 (73.68 %) males and four females (26.32 %). According to the analysis, 18 (81.82 %) individuals suffered with osteoarthritic changes to the joints, also suffered from vertebral osteoarthritic changes. One (4.17 %) individual was diagnosed with ankylosing spondylitis and five (20.83 %) with Schmorl's nodes who also suffered from additional osteoarthritic changes to the vertebral column. When looking at the age distribution (fig. 7) of DJD affecting the joints, a high prevalence is observed in the group of young adults (41.67 %), while it also affects eight (33.33 %) middle adults, two (8.33 %) older adults and three (12.5 %) adults for whom age-at-death could not be estimated. Vertebral OA changes affect, in total, nine (42.86 %) young adults, seven (33.33 %) middle adults, two (9.52 %) older adults, and one (4.76 %) of unknown age-at-death.

Fig. 6 Right and left distal femurs, skeleton 3, central chamber, P.M. 3937. Eburnation on the lateral condyles of the distal epiphyses of the right and left femora (© G. Ioannou)

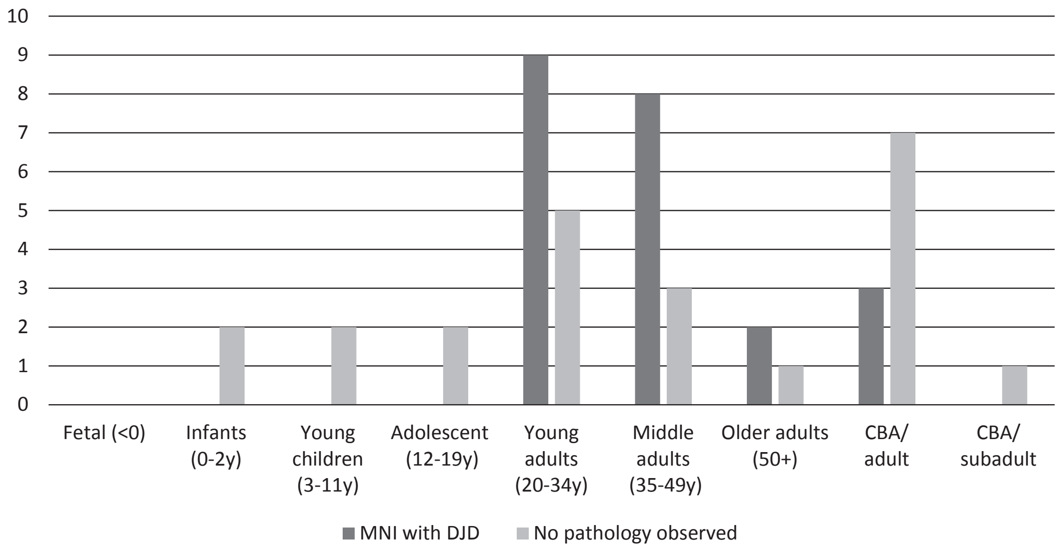

Fig. 7 Age distriution of DJD in the Ktima-Upper City sample group (© G. Ioannou)

Finally, trauma has been recorded in eight (30.77 %) individuals of the total 26 individuals assessable for the lesion. All traumas recorded are healed. Trauma was more prevalent in male individuals (75 %), in contrast to females (25 %). In regard to age, four (50 %) were assessed as young adults and four (50 %) as middle adults. The bones in which trauma was identified are primarily long bones: one humerus, one ulna, one pelvis, one fibula, two metacarpals, one metatarsal and one rib.

Discussion

The palaeopathological analysis indicates that the most common health problem afflicting the Hellenistic-Roman population at Ktima-Upper City is degenerative joint disease in the synovial joints (91.67 %) and the vertebral column (81.82 %). Metabolic disorders, infectious diseases and traumas have been recorded overall low to moderate levels, suggesting that the sample is comprised by individuals who are not highly exposed to health hazards and risks that could be associated with poorer health status. In addition, the presence of older adults at Ktima-Upper City implies increased survivorship and provides further evidence for the relatively advantageous nature of the living environment in Hellenistic-Roman suburban territories of Nea Paphos.

Demographics

The general demographic profile of the individuals of the sample from Ktima-Upper City reflects a predominately skeletally-mature population. Subadults comprise a small percentage (16 %) within the sample. This might be an indication that the population survived the crucial period of infancy/childhood. While the hypothesis of a different burial practice for subadults cannot be ruled out, archaeological research indicates that there is no evident distinction between adults and subadults in terms of their place of burial or treatment during the Hellenistic-Roman period[34]. This implication will be further investigated within the comprehensive study of the collection from Ktima. In regard to sex, the results of the osteological analysis of the sample indicates a predominately male population. Nevertheless, factors such as bone preservation, recovery and commingling must be considered as limitations within this sample group and will be more widely discussed in the subsequent doctoral thesis. Below is a summary of the interpretations based on each pathology observed and should be considered as preliminary to the wider population.

Dental Pathologies

Linear Enamel Hypoplasia

Linear enamel hypoplasia is a ›non-specific stress‹ or ›growth disruption‹ indicator and is associated with episodic stress in an individual's early life, during childhood. Enamel defects provide a permanent record of developmental stress during childhood[35]. This distress could be associated with nutritional deficiency, trauma, episodes of severe illness such as fever, as well as with socio-economic and cultural factors[36]. LEH was recorded in more than the half individuals of those who could be assessed for the condition within the sample from Ktima, indicating periods of systemic metabolic distress during their early life. As the majority of individuals with LEH are adults, this indicates that they experienced at least one episode of physiological stress in childhood, yet they survived the crucial years of childhood. A correlation between age-at-death and LEH prevalence cannot be addressed at this stage, however the comprehensive analysis of the complete collection from Ktima is expected to shed light on this research question. Males showed higher prevalence of LEH than females (80 % vs. 6.67 %). This is a preliminary indication that males in Ktima-Upper City experience more physiological stress than females during childhood. The factors contributing to this pattern are not clear yet, but these differences may reflect a physiological susceptibility of these individuals or the differences between the two sexes could also represent differences in diet or access to food during childhood, or differences

34 Parks 1999.
35 Minozzi et al. 2020.
36 Lukacs 1989; King et al. 2002; Mays 2002; Hillson 2005; Hillson 2014; Pinhasi – Mays 2008; Betsinger – DeWitte 2017.

in weaning practices between males and females[37]. Minozzi and colleagues have detected a relationship between the expression of LEH and social status in Imperial Rome, suggesting that the socially advantaged group had enjoyed better health in contrast to lower classes[38].

Dental Abscesses

Dental abscesses are the result of a localised resorption of bone due to infection of the tooth pulp. The infections are most commonly caused by caries and advanced dental wear, which has progressed, to the point of pulp cavity exposure[39]. There is low prevalence of DA within the sample from Ktima and no correlation with dental caries or advanced dental wear was yet detected.

Ante-Mortem Tooth Loss

Ante-mortem tooth loss is dental pathology often observed in archaeological populations. It is the result of several factors including dental caries, pulp-exposure, tooth wear and periodontal disease. In bioarchaeological studies, AMTL, in conjunction with other dental diseases, is analysed for the assessment of general oral health[40]. AMTL was observed at a high prevalence (53.85 %) at Ktima-Upper City, and in more males than females, across all adult age groups. Studies have suggested that AMTL is likely the pathogenic consequence of carious lesions resulting in dental pulp exposure[41]. In the sample from Ktima, only four (28.57 %) of the 14 individuals with AMTL display caries, suggesting there is no correlation between the two pathologies, however further analysis is required in order to prove this assumption. Interestingly, it seems that there is a correlation between PD and AMTL, as more than the half of the individuals with AMTL also display PD. In addition, there seems to be a difference in AMTL occurrence between males and females, with males showing a higher percentage of AMTL. This difference could be related to nutritional and behavioural patterns between the two sexes at Ktima.

Calculus

Dental calculus is mineralised plaque, of which the main constituent is calcium phosphate. It is developed within an alkaline oral environment, thus it mostly occurs on the lingual surface of the anterior teeth since this is the most alkaline area of the mouth[42]. The aetiology of calculus is uncertain and complex, but its prevalence can be associated with food texture, diet, as well as with poor oral hygiene and care[43]. While past studies have linked calculus with meat consumption and proteins[44] as protein increases the alkalinity of the oral environment, recent studies[45] have associate calculus with higher carbohydrate consumption. Thus, the examination of calculus prevalence and factors contributing to its formation must be considered in conjunction with the occurrence of other dental pathologies such as caries and periodontal disease. Some studies have shown that high rates of calculus and low rates of caries in a population are indications that their diet is high in proteins and low in carbohydrates, while a population with high calculus rates and high caries rates indicate a diet rich in carbohydrates and low in proteins[46]. Ktima-Upper City showed low prevalence of dental plaque deposits while dental caries showed a slightly higher prevalence. This pattern suggests the individuals consumed a diet, which would have been low in carbohydrates and higher in protein.

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37 Wheeler 2012.
38 Minozzi et al. 2020.
39 Peck 2013; Griffin 2017.
40 Cucina – Tiesler 2003; Waldron 2009; Kinaston et al. 2016.
41 Masotti et al. 2013.
42 Waldron 2009; Griffin 2017.
43 Hillson 2005; Greene et al. 2005; Marado et al. 2018; Hillson 1996; Roberts – Manchester 2010.
44 Littleton – Frohlich 1989; Lieverse 1999.
45 Marado et al. 2018; Radini et al. 2017; Giuffra et al. 2020.
46 Giuffra et al. 2020.

Periodontal Disease

Periodontitis is characterised by resorption of the alveolar bone, creating distance between the bone and the cement-enamel junction of the tooth. Several conditions can cause PD, but the inflammatory diseases of gingivitis and periodontitis are the most common. Both are caused by pathogenic bacteria in the dental plaque[47]. This accumulation is associated with the lack of oral hygiene and dental treatment. The sample from Ktima showed a considerably high incidence of PD, particularly in male individuals in contrast to female. This difference could be related to nutritional and behavioural patterns between the two sexes. The results also indicate a correlation of increased age with the occurrence of PD however, this requires further analysis. Overall, the relatively high rates of PD within the sample might reflect a general poor oral hygiene and little dental treatment for the suffering individuals. It seems that carious lesions do not affect the genesis of periodontal disease, as caries were present in lower ratios.

Caries

Carious lesions are defined as the localised progressive destruction of the hard tissue of the tooth, caused by enamel demineralisation. Caries progress from a small spot which can expand into the dentine and finally expose the tissues of the pulp to infection[48]. The development of lesions is associated with acidic products from the bacterial fermentation of cariogenic foods and carbohydrates in the diet, especially including domesticated plants, along with progressing age[49]. Carbohydrates are the major factor in caries development and are found in agriculture products (e.g. grains), fruits and honey[50]. A moderate prevalence of caries is associated with a balanced diet, including a mixed foraging-farming lifestyle. Low prevalence is more closed to a diet based on a forager or fish-rich subsistence. The low ratio of caries in the sample from Ktima may reflects that the individuals had a low carbohydrate diet and may have included higher levels of proteins and fat, as well as fluorides found in fish. Protein and fat contribute inhibit caries[51]. In addition, fluoride and strontium contribute to a good oral health and they are elements found in high quantities in marine foods[52]. This could be an indication that fish was a staple food for these individuals.

Bone Pathologies

Metabolic Disorders

Cribra orbitalia and porotic hyperostosis are two bone lesions, linked with metabolic disorders, typically occurring during childhood. Macroscopically, porotic hyperostosis is characterised by pitting and porosity expressed on the external surface of the frontal and parietal bones, and in severe stages, it takes a ›hair-on-end‹ appearance, as well as causing thickening of the diploë of the skull. Cribra orbitalia is characterised by porosity on the outer surface of the orbital roofs[53]. They are often expressed as a result of severe period of stress during childhood and their aetiology is often related to metabolic disorders and malnutrition (e.g. iron-deficiency, vitamin B12 deficiency), infections (e.g. malaria) and hematopoietic diseases (e.g. genetic and haemolytic anaemias)[54]. In adult individuals, the two lesions are typically observed in healed or healing stages and their presence implies that during childhood the individual went through severe physical stress yet, they have survived[55]. The prevalence of CO and PH combined is relatively low

47 Waldron 2009; Tomczyk et al. 2017.
48 Hillson 2005.
49 Hillson 2005; Larsen 1997; Larsen 2002; Klaus – Tam 2010.
50 Marado et al. 2018.
51 Novak – Šlaus 2010; Šlaus et al. 2011.
52 Šlaus et al. 2011; Michael et al. 2017.
53 Stuart-Macadam 1985; Aufderheide – Rodriguez-Martin 1998; Blom et al. 2005; Walker et al. 2009.
54 Angel 1966; Walker et al. 2009; Blom et al. 2005.
55 Blom et al. 2005.

(22.73 %) at Ktima. All individuals displaying the lesions are adults indicating that they survived the assault causing the lesions. In contrast to earlier periods, such as the Neolithic and Chalcolithic in Cyprus when infant mortality was higher[56], during the Hellenistic and Roman period in Paphos, it seems that individuals who display possible evidence of a metabolic disorder survived long enough for the disease to manifest itself in the bones. While more evidence and research are required to determine diachronic changes of expression of metabolic disorders within Ktima, this is a preliminary indication that survivorship during the crucial early years of the life was good. In addition, the predominately skeletally-mature population at Ktima, with no sign of CO and PH, might be an indication that factors contributing to the development of porotic hyperostosis and cribra orbitalia were low. In order to proceed with this hypothesis, further research and a larger sample are required. Evidence derived from the investigation of environmental conditions, dietary habits of the population, lifestyle and hygiene, as well as taphonomic factors should be taken into consideration[57].

Infectious Diseases

Infectious diseases recorded are of non-specific origins, periostitis and maxillary sinusitis. Periostitis is defined as the formation of abnormal bone on the periosteum caused by inflammation of the bone surface and is commonly associated with infections occurring after injuries and trauma[58]. Periostitis was recorded in moderate ratios at Ktima. The slightly elevated levels of periostitis might preliminarily indicate that individuals were exposed to infection, as well as injuries, both resulting in inflammation and new bone formation on the periosteum.

Chronic sinusitis is characterised by the presence of new bone on the floor of the sinus[59]. Several factors can affect the respiratory health of an individual or a population, among them infections, advanced dental infections (e.g. caries or pulp cavity exposure caused by advanced tooth wear), allergens, living organism (i.e. bacteria, viruses), as well as immunodeficiency diseases and environmental conditions (i.e. pollution) within a site[60]. Maxillary sinusitis was recorded in a low prevalence at Ktima (only in one individual). This might be a preliminary indication that people at Ktima were not greatly exposed to factors contributing on the onset of maxillary sinusitis.

Degenerative Joint Disease

The principle causes of DJD are: Age (age-progressive), mechanical stress caused from extra-articular causes (i.e. obesity, occupational stress, congenital deformities), trauma, infection, metabolic and autoimmune conditions[61]. Osteoarthritic changes are characterised as chronic and they cause degeneration of the articular cartilage. Subsequently, they cause subchondral bone reaction, with marginal new bone proliferation (osteophytes), pitting on the joint surface and eburnation in more advance stages[62]. Physical stress can lead to the development of osteoarthritic changes in joints earlier in the life of an individual if these occurs under specific circumstances related to severe biomechanical stress, systemic disorders, cultural and behavioural practices, or environmental factors.

Individuals from the sample from Ktima-Upper City display a significantly high prevalence of osteoarthritic changes. Analysis of the discrete and articulated individuals showed that osteoarthritic changes were recorded both in the vertebral column and other joints in the form of osteophytes, erosion and pitting, eburnation and ankyloses. While mild osteophytes on joints

56 Lunt 1985; Gamble 2011; Zariņa et al. 2016.
57 Wood et al. 1992; Waldron 2009; Larsen 2010.
58 Ortner – Putschar 1981; Waldron 2009; Novak – Šlaus 2010.
59 Waldron 2009.
60 Boocock et al. 1995; Liebe-Harkort 2012; Roberts 2016; DiGangi – Sirianni 2017; Mitchell – Brickley 2018.
61 Jurmain – Kilgore 1995; Aufderheide – Rodriguez-Martin 1998; Waldron 2009.
62 Larsen 2002; Minozzi et al. 2012; DeWitte – Stojanowski 2015.

is likely linked to biological aging, this preliminary study shows that, in Ktima-Upper City, people have been exposed to severe biomechanical stress resulting in osteoarthritic changes on their joints from their twenties and early thirties. It could be suggested that this pattern is associated with activity and heavy workload of these individuals in the Hellenistic and Roman times. Nevertheless, future research on the complete collection from Ktima will provide a clearer image of the occurrence of joint diseases in Ktima-Upper City. In regard to sex, osteoarthritic changes in Ktima-Upper City seem to be more prevalent in male individuals than females. According to C. S. Larsen, osteoarthritic changes are typically observed at higher rates in males than females, indicating that workload and mobility is different between men and women in ancient populations[63]. It is likely that at Ktima-Upper City the prevalence of osseous change in the spine and the limbs have been the result of biomechanical effects of gendered activities. Gender roles and the particular gendered activities in which individuals may be engaged on a regular basis within a community have an impact on the skeleton. Unique activities or lifestyles of men and women may have contributed to distinct skeletal consequences between the two sexes. Thus, osseous changes in the joints could likely be associated with different aetiology between the two sexes[64].

Traumas

Traumas are defined as the result of traumatic events during the course of life. Their study provides knowledge on work-related activities and risk, as well as exposure to health hazards, repeated stress, and finally, it documents the degree of interpersonal violence within a population[65]. Traumas have been recorded at a low prevalence (30.77 %). Evidence of trauma at Ktima is related to accidental events and are mostly healed. Affected areas are the ribs, the long bones, the vertebral column and metacarpals. The low prevalence of trauma, as well as their type, preliminarily indicate that, in general, the population was not exposed to significant health hazards and risks. There is no evidence of interpersonal violence and the type of traumas indicate accidental injuries (e.g. fractures), as well as chronic exposure to heavy compressive loads (e.g. compression fractures of the vertebrae).

Conclusions

This paper presented some preliminary results of the osteological and palaeopathological analysis of a sample from the necropolis of Ktima-Upper City dating to the Hellenistic and Roman periods. The results of the analysis of demography, health and behaviour can be summarised as follows: The majority of the sample are adults, while there are relatively few subadults. The presence of older adults at Ktima-Upper City provides further evidence for the relatively healthy nature of the living environment in the Hellenistic-Roman suburban territories of Nea Paphos, which contributed to increased survivorship. The major pathologies within the sample from Ktima-Upper City, identified through this osteological analysis are degenerative changes, typically associated with elevated levels of mobility and physical stress. Metabolic disorders, infectious diseases and traumas have been recorded in overall low to moderate levels, suggesting that the sample is comprised of individuals who were not significantly exposed to health hazards and risks resulting in a poorer overall health status. In regards to dental pathologies, calculus, dental abscesses and caries are shown in low prevalence, which may reflect a balance in diet with low levels of carbohydrate intake. Periodontal disease and ante-mortem tooth loss affected people at a greater rate. The results indicate a correlation between pathologies and sex, suggesting differ-

63 Larsen 2002.
64 Sofaer Derevenski 2009.
65 Roberts – Manchester 2010; Minozzi et al. 2012; Judd – Redfern 2012.

ences between males and females. These differences are likely linked with diet, social practices as well as activity. This preliminary report provides insight and a jumping-off point for further research into the health and lifeways of the Hellenistic-Roman populations in the Paphos District, and the interpretations provided are further explored in the comprehensive analysis of the remains from Ktima-Upper City which are presented in the author's doctoral thesis.

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Bibliography

AlQahtani et al. 2010 — S. J. AlQahtani – M. P. Hector – H. M. Liversidge, Brief Communication: The London Atlas of Human Tooth Development and Eruption, American Journal of Physical Anthropology 142/3, 2010, 481–490.

Angel 1966 — J. L. Angel, Porotic Hyperostosis, Anemias, Malarias, and Marshes in the Prehistoric Eastern Mediterranean, Science 153, 1966, 760–763.

Aufderheide – Rodriguez-Martin 1998 — A. C. Aufderheide – C. Rodriguez-Martin, The Cambridge Encyclopaedia of Human Palaeopathology (Cambridge 1998).

Baker et al. 2005 — B. J. Baker – T. L. Dupras – M. W. Tocheri, The Osteology of Infants and Children (College Station, TX 2005).

Baker et al. 2012 — B. J. Baker – C. E. Terhune – A. Papalexandrou, Sew long? The Osteobiography of a Woman from Medieval Polis, Cyprus, in: A. L. W. Stodder – A. M. Palkovich (eds.), The Bioarchaeology of Individuals (Gainesville, FL 2012) 151–161.

Betsinger – DeWitte 2017 — T. K. Betsinger – S. DeWitte, Trends in mortality and biological stress in a medieval Polish urban population, International Journal of Paleopathology 19, 2017, 24–36.

Blom et al. 2005 — D. E. Blom – J. E. Buikstra – L. Keng – P. D. Tomczak – E. Shoreman-Ouimet – D. Stevens-Tuttle, Anemia and childhood mortality: Latitudinal patterning along the coast of pre-Columbian Peru, American Journal of Physical Anthropology 127/2, 2005, 152–169.

Boocock et al. 1995 — P. Boocock – C. A. Roberts – K. Manchester, Maxillary Sinusitis in Medieval Chichester, England, American Journal of Physical Anthropology 98, 1995, 483–495.

Brooks – Suchey 1990 — S. T. Brooks – J. M. Suchey, Skeletal Age Determination Based on the Os Pubis. A comparison of the Acsadi-Nemeskeri and Suchey-Brooks methods, Human Evolution 5, 1990, 227–238.

Brothwell 1981 — D. R. Brothwell, Digging up bones. The excavation, treatment and study of human skeletal remains [3](Ithaca, NY 1981).

Buckberry – Chamberlain 2002 — J. L. Buckberry – A. T. Chamberlain, Age estimation from the auricular surface of the ilium: A revised method, American Journal of Physical Anthropology 119/3, 2002, 231–239.

Buikstra – Ubelaker 1994 — J. E. Buikstra – D. H. Ubelaker (eds.), Standards for Data Collection from Human Skeletal Remains. Proceedings of a seminar at the Field Museum of Natural History, Research Series 44 (Fayetteville, AR 1994).

Caubet – Yon 1993 — A. Caubet – M. Yon, Paphos, la nécropole de Ktima. Fouilles 1952–1955 de Jean Bérad et Jean Deshayes/Paphos, the necropolis of Ktima. The 1952–1955 excavations of Jean Bérad and Jean Deshayes, in: M. Yon (ed.), Kinyras. L'Archéologie française à Chypre. Table-ronde tenue à Lyon, 5–6 novembre 1991, Travaux de la Maison de l'Orient Méditerranéen 22 (Lyon 1993) 159–166.

Cucina – Tiesler 2003 A. Cucina – V. Tiesler, Dental Caries and Antemortem Tooth Loss in the Northern Peten Area, Mexico: A Biocultural Perspective on Social Status Differences Among the Classic Maya, American Journal of Physical Anthropology 122, 2003, 1–10.

DiGangi – Sirianni 2017 E. A. DiGangi – J. E. Sirianni, Maxillary Sinus Infection in a 19th-Century Almshouse Skeletal Sample, International Journal of Osteoarchaeology 27/2, 2017, 155–166.

DeWitte – Stojanowski 2015 S. N. DeWitte – C. M. Stojanowski, The Osteological Paradox 20 Years Later: Past Perspectives, Future Directions, Journal of Archaeological Research 23, 2015, 397–450.

Fox-Leonard 1997 S. C. Fox-Leonard, Comparing Health from Paleopathological Analysis of the Human Skeletal Remains Dating to the Hellenistic and Roman Periods, from Paphos, Cyprus and Corinth, Greece (PhD thesis University of Arizona, Ann Arbor, MI 1997).

Gamble 2011 M. Gamble, Health and Disease in Chalcolithic Cyprus: A Problem-oriented Palaeopathological Study of the Human Remains (PhD thesis University of Newcastle 2011).

Giuffra et al. 2020 V. Giuffra – M. Milanese – S. Minozzi, Dental health in adults and subadults from the 16th-century plague cemetery of Alghero (Sardinia, Italy), Archives of Oral Biology 120, 2020, 104928.

Greene et al. 2005 T. R. Greene – C. L. Kuba – J. D. Irish, Quantifying calculus: A suggested new approach for recording an important indicator of diet and dental health, HOMO Journal of Comparative Human Biology 56/2, 2005, 119–132.

Griffin 2017 R. C. Griffin, Urbanization, Economic Change, and Dental Health in Roman and Medieval Britain, European Journal of Archaeology 20/2, 2017, 346–367.

Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent Research in Cypriot Bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.

Hillson 1996 S. Hillson, Dental Anthropology (Cambridge 1996).

Hillson 2005 S. Hillson, Teeth, Cambridge Manuals in Archaeology (Cambridge 2005).

Hillson 2014 S. Hillson, Tooth Development in Human Evolution and Bioarchaeology (Cambridge 2014).

Ioannou 2013 G. Ioannou, Health Status in Hellenistic and Roman Times: Health Assessment of the Eastern Necropolis of Nea Paphos and a Preliminary Comparative Research Among Cypriot Populations (MA thesis University of Sheffield 2013).

Ioannou (unpublished) G. Ioannou, Health and disease of Hellenistic and Roman Populations in Paphos District: a bioarchaeological and comparative study (unpublished PhD thesis, The Cyprus Institute, Nicosia).

Ioannou – Lorentz (in preparation) G. Ioannou – K. O. Lorentz, Osteological and Bioarchaeological Research in Cyprus: a review (in preparation).

Judd – Redfern 2012 M. A. Judd – R. Redfern, Trauma, in: A. L. Grauer (ed.), A Companion to Paleopathology (Oxford 2012) 359–379.

Jurmain – Kilgore 1995 R. D. Jurmain – L. Kilgore, Skeletal evidence of osteoarthritis: A palaeopathological perspective, Annals of the Rheumatic Diseases 54/6, 1995, 443–450.

Kendal et al. 2018 C. Kendall – A. M. Eriksen – I. Kontopoulos – M. J. Collins – G. Turner-Walker, Diagenesis of archaeological bone and tooth, Palaeogeography Palaeoclimatology Palaeoecology 491, 2018, 21–37.

Kinaston et al. 2016 R. L. Kinaston – G. L. Roberts – H. R. Buckley – M. Oxenham, A bioarchaeological analysis of oral and physiological health on the south coast of New Guinea, American Journal of Physical Anthropology 160/3, 2016, 414–426.

King et al. 2002 T. King – S. Hillson – L. T. Humphrey, Developmental stress in the past: a detailed study of enamel hypoplasia in a post-Medieval adolescent of known age and sex, Archives of Oral Biology 47, 2002, 29–39.

Klaus – Tam 2010 H. D. Klaus – M. E. Tam, Oral Health and the Post-contact Adaptive Transition: A Contextual Reconstruction of Diet in Morrope, Peru, American Journal of Physical Anthropology 141, 2010, 594–609.

Larsen 1997 C. S. Larsen, Bioarchaeology. Interpreting Behavior from the Human Skeleton, Cambridge Studies in Biological Anthropology 21 (Cambridge 1997).

Larsen 2002 C. S. Larsen, Bioarchaeology. The Lives and Lifestyles of Past People, Journal of Archaeological Research 10/2, 2002, 119–166.

Larsen 2010 C. S. Larsen (ed.), A Companion to Biological Anthropology (Chichester 2010).

Liebe-Harkort 2012 C. Liebe-Harkort, Cribra orbitalia, sinusitis and linear enamel hypoplasia in Swedish Roman Iron Age adults and subadults, International Journal of Osteoarchaeology 22/4, 2012, 387–397.

Lieverse 1999 A. R. Lieverse, Diet, and the Aetiology of Dental Calculus, International Journal of Osteoarchaeology 9/4, 1999, 218–232.

Littleton – Frohlich 1989 J. Littleton – B. Frohlich, An analysis of dental pathology and diet on historic Bahrain, Paléorient 15/2, 1989, 59–75.

Lovejoy et al. 1985 C. O. Lovejoy – R. S. Meindl – T. R. Pryzbeck – R. P. Mensforth, Chronological Metamorphosis of the Auricular Surface of the Ilium. A New Method for the Determination of Age at Death, American Journal of Physical Anthropology 68/1, 1985, 15–28.

Lukacs 1989 J. R. Lukacs, Dental Pathology: Method for Reconstructing Dietary Patterns, in: M. Y. İşcan – K. A. R. Kennedy (eds.), Reconstruction of Life from the Skeleton (New York 1989) 261–286.

Lunt 1985 D. A. Lunt, Report on the Human Dentitions, in: E. J. Peltenburg – D. Baird – A. Betts – S. Colledge – P. Croft – C. Elliott – T. Lawrence – D. A. Lunt – K. Niklasson – J. Renault-Miskovsky – J. S. Ridout-Sharpe – E. Slater – J. D. Stewart – C. Xenophontos, Excavations at Lemba-Lakkous, 1976–1983, Lemba Archaeological Project 1 = SIMA 70, 1 (Göteborg 1985) 150–153.

Maier – Karageorghis 1984 F. G. Maier – V. Karageorghis, Paphos. History and Archaeology (Nicosia 1984).

Marado et al. 2018 L. M. Marado – F. Andrade – B. Pereira – L. Fontes, Dental Pathology and Occlusal Wear in Valença, Portugal (Modern and Contemporary Ages): Preliminary Interpretations, Antropologia Portuguesa 35, 2018, 7–31.

Masotti et al. 2013 S. Masotti – O. M. Marzi – E. Gualdi-Russo, Dento-alveolar features and diet in an Etruscan population (6^{th}–3^{rd} c. B.C.) from northeast Italy, Archives of Oral Biology 58/4, 2013, 416–426.

Mays 2002 S. Mays, The Archaeology of Human Bones (Cambridge 2002).

McIntyre et al. 2006 M. H. McIntyre – B. A. Cohn. – P. T. Ellison, Sex Dimorphism in Digital Formulae of Children, American Journal of Physical Anthropology 129, 2006, 143–150.

Meindl – Lovejoy 1985 R. S. Meindl – C. O. Lovejoy, Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral-anterior sutures, American Journal of Physical Anthropology 68/1, 1985, 57–66.

Michael et al. 2017 D. E. Michael – C. Eliopoulos – S. K. Manolis, Exploring sex differences in diets and activity patterns through dental and skeletal studies in populations from ancient Corinth, Greece. HOMO. Journal of Comparative Human Biology 68/5, 2017, 378–392.

Miles 1963 A. E. W. Miles, Dentition in the Estimation of Age, Journal of Dental Research 42, 1963, 255–263.

Mitchell – Brickley 2018 P. D. Mitchell – M. Brickley (eds.), Updated Guidelines to the Standards for Recording Human Remains, Chartered Institute for Archaeologists, British Association for Biological Anthropology and Osteoarchaeology (2018) <https://www.babao.org.uk/assets/Uploads-to-Web/14-Updated-Guidelines-to-the-Standards-for-Recording-Human-Remains-digital.pdf> (01.06.2019).

Minozzi et al. 2012 S. Minozzi – P. Catalano – C. Caldarini – G. Fornaciari, Paleopathology of Human Remains from Roman Imperial Age, Pathobiology 79, 2012, 268–283.

Minozzi et al. 2020 S. Minozzi – C. Caldarini – W. Pantano – S. di Giannantonio – P. Catalano – V. Giuffra, Enamel hypoplasia and health conditions through social status in the Roman Imperial Age (First to third centuries, Rome, Italy), International Journal of Osteoarchaeology 30/1, 2020, 53–64.

Młynarczyk 1990 J. Młynarczyk, Nea Paphos in the Hellenistic Period, Nea Paphos 3 (Warsaw 1990).

Novak – Šlaus 2010 M. Novak – M. Šlaus, Health and disease in a Roman walled city: an example of Colonia Iulia Iader, Journal of Anthropological Science 88, 2010, 189–206.

Ortner 2003 D. J. Ortner, Identification of Pathological Conditions in Human Skeletal Remains (San Diego, CA 2003).

Ortner – Putschar 1981 D. J. Ortner – W. G. J. Putschar, Identification of Pathological Conditions in Human Skeletal Remains (Washington, DC 1981).

Parks 1999 D. A. Parks, Burial customs of Roman Cyprus: origin and development (PhD thesis University of Missouri, Columbia, MO 1999).

Peck 2013 J. J. Peck, Status, health, and lifestyle in Middle Iron Age Britain: A bioarchaeological study of elites and non-elites from East Yorkshire, Northern England, International Journal of Paleopathology 3/2, 2013, 83–94.

Pilides 2009 D. Pilides, Evidence for the Hellenistic period in Nicosia: The settlement at the Hill of Agios Georgios and the cemetery at Agii Omologites, Cahiers du Centre d'Etudes Chypriotes 39, 2009, 49–67.

Pinhasi – Mays 2008 R. Pinhasi – S. Mays, Advances in Human Paleopathology (Chichester 2008).

Radini et al. 2017 A. Radini – E. Nikita – S. Buckley – L. Copeland – K. Hardy, Beyond food: The multiple pathways for inclusion of materials into ancient dental calculus, American Journal of Physical Anthropology 162, 2017, 71–83.

Raptou 2004 E. Raptou, A Painted Roman Tomb at Paphos (P.M. 3510), MedA 17, 2004, 311–321.

Raptou 2007 E. Raptou, Painted Tombs of Roman Paphos, Archaeologia Cypria 5, 2007, 117–128.

Redfern et al. 2015 R. C. Redfern – S. N. DeWitte – J. Pearce – C. Hamlin – K. E. Dinwiddy, Urban-rural differences in Roman Dorset, England: a bioarchaeological perspective on Roman settlements, American Journal of Physical Anthropology 157, 2015, 107–120.

Roberts 2016 C. A. Roberts, Palaeopathology and its relevance to understanding health and disease today. The impact of the environment on health, past and present, Anthropological Review 79/1, 2016, 1–16.

Roberts – Manchester 2010 C. Roberts – K. Manchester, The Archaeology of Disease [3](Stroud 2010).

Rogers 2009 T. L. Rogers, Sex Determination of Adolescent Skeletons Using the Distal Humerus, American Journal of Physical Anthropology 140/1, 2009, 143–148.

Sofaer Derevenski 2009 J. R. Sofaer Derevenski, Sex differences in activity-related osseous change in the spine and the gendered division of labor at Ensay and Wharram Percy, UK, American Journal of Physical Anthropology 111/3, 2009, 333–354.

Scheuer – Black 2000 L. Scheuer – S. M. Black, Developmental juvenile osteology (San Diego, CA 2000).

Schutkowski 1993 H. Schutkowski, Sex Determination of Infant and Juvenile Skeletons: Morphognostic Features, American Journal of Physical Anthropology 90, 1993, 199–205.

Schwartz 2007 J. H. Schwartz, Skeleton Keys. An Introduction to Human Skeletal Morphology, Development, and Analysis (New York 2007).

Šlaus et al. 2011 M. Šlaus – Ž. Bedić – P. Rajić Sikanjić – M. Vodanović – A. Domić Kunić, Dental Health at the Transition from the Late Antique to the Early Medieval Period in Croatia's Eastern Adriatic Coast, International Journal of Osteoarchaeology 21/5, 2011, 577–590.

Smith 1984 B. H. Smith, Patterns of molar wear in hunter-gatherers and agriculturalists, American Journal of Physical Anthropology 63/1, 1984, 39–56.

Stuart-Macadam 1985 P. Stuart-Macadam, Porotic Hyperostosis: Represententative of a Childhood Condition, American Journal of Physical Anthropology 66/4, 1985, 391–398.

Tomczyk et al. 2017 J. Tomczyk – A. Turska-Szybka – M. Zalewska – D. Olcxak-Kowalczyk, Reliability of the Assessment of Periodontal Disease in Historical Populations, International Journal of Osteoarchaeology 27/2, 2017, 206–216.

Waldron 2009 T. Waldron, Palaeopathology, Cambridge Manuals in Archaeology (New York 2009).

Walker et al. 2009 P. L. Walker – R. R. Bathurst – R. Richman – T. Gjerdrum – V. A. Andrushko, The Causes of Porotic Hyperostosis and Cribra Orbitalia. A Reappraisal of the Iron-Deficiency-Anemia Hypothesis, American Journal of Physical Anthropology 139/2, 2009, 109–125.

Walter – DeWitte 2017 B. S. Walter – S. N. DeWitte, Urban and rural mortality and survival in Medieval England, Annals of Human Biology 44/4, 2017, 338–348.

Wheeler 2012 S. M. Wheeler, Nutrition and Disease Stress of Juveniles from the Dakhleh Oasis, Egypt, International Journal of Osteoarchaeology 22/2, 2012, 219–234.

White et al. 2012 T. D. White – M. T. Black – P. A. Folkens, Human Osteology (Amsterdam 2012).

Wood et al. 1992 J. W. Wood – G. R. Milner – H. C. Harpending – K. M. Weiss, The Osteological Paradox: Problems of Inferring Prehistoric Health from Skeletal Samples, Current Anthropology 33, 1992, 343–370.

Zariņa et al. 2016 G. Zariņa, – S. B. Sholts – A. Tichinin – V. Rudovica – A. Vīksna – A. Engīzere – V. Muižnieks – E. J. Bartelink – S. K. Wärmländer, Cribra orbitalia as a potential indicator of childhood stress: Evidence from paleopathology, stable C, N, and O isotopes, and trace element concentrations in children from a 17th–18th century cemetery in Jēkabpils, Latvia, Journal of Trace Elements in Medicine and Biology 38, 2016, 131–137.

The Bioarchaeology of Cyprus

A Perspective from Polis

Brenda J. Baker

Abstract

Bioarchaeological research is increasing in Cyprus as new topics and approaches are explored by a growing number of investigators. Challenges include variable preservation, environmental issues, commingling of skeletal remains in archaeological deposits or in storage, and work with legacy collections. My work at Polis, on the northwest coast of Cyprus, illustrates ways of grappling with some of these challenges to glean information concerning life and death of the town's inhabitants from the Late Antique to Venetian period. Burials of more than 300 individuals in and around two basilicas constructed in the early 6th century have been uncovered during excavations by Princeton University's Cyprus Expedition from 1983 to 2007. Mortuary evidence indicates various ways of accommodating the dead, while analysis of skeletal remains provides insight into the lives and activities of community members, including evidence for the sexual division of labor. Patterns of grooves and notches on anterior teeth suggest their use in textile production and predominate in females. Healed fractures are more common in males, indicating labor that put them at greater risk of accidental trauma, although women disproportionately suffered violent trauma. Evidence of leprosy and tuberculosis is present but infectious disease prevalence appears to have been low.

Bioarchaeology in Cyprus

Prior to the more problem-oriented work conducted by J. L. Angel (1915–1986), descriptive reports on human remains were included in appendices of site reports. Angel's analyses of human skeletal remains, for example frequently formed a section within archaeological reports or monographs[1] with emphasis on cranial morphology and population affinities. His more synthetic work involved the diagnostic lesions of thalassemia and the relationship of this genetic anemia to malaria and marshlands in the ancient Eastern Mediterranean[2]. Until the 1990s and even beyond, however, little attention was paid to human remains in archaeological excavations and involvement of human osteologists or bioarchaeologists during fieldwork was uncommon. This situation has led to collections that have been unstudied or understudied. Such legacy collections present several challenges to bioarchaeologists who wish to analyze them, including issues of preservation and environmental conditions, commingling of remains, accessing documentation, and variable quality of contextual information available. Even when involved in fieldwork, bioarchaeologists must grapple with variable preservation and frequently encounter commingled deposits. Using my work with Princeton University's Cyprus Expedition at Polis-tis-Chrysochous, on the northwest coast of Cyprus, I illustrate ways in which such challenges are being met to glean information about the lives of town's medieval inhabitants.

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1 E.g. Angel 1953; Angel 1961; Angel 1972.

2 E.g. Angel 1964; Angel 1966; see Harper 2008 for a thorough review of his contributions to Cypriot anthropology.

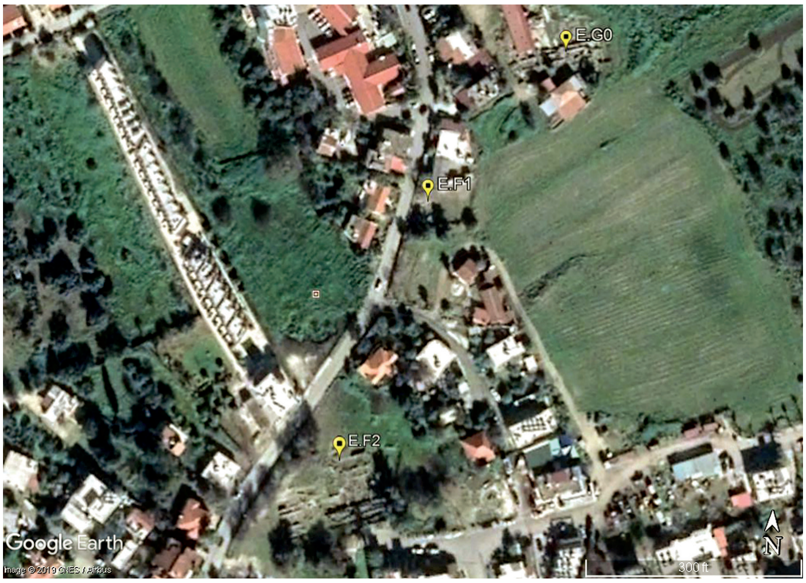

Fig. 1 Princeton Cyprus Expedition's areas of excavation in Polis that contain human remains. Burials are associated with basilicas in the E.F2 and E.G0 project areas and in the E.F1 domestic context (© Google Earth)

Polis Chrysochous: A Case Study

Between 1983 and 2007, Princeton University's Cyprus Expedition, directed by W. A. P. Childs, conducted fieldwork in several areas in the modern town of Polis, known in Late Antiquity (ca. A.D. 330–750) as Arsinoë[3]. The E.F2 and E.G0 project areas in Polis-Petrerades both include basilicas dating from the 6th century A.D. (fig. 1). These churches are only about 200 m apart from each other. A Late Antique domestic context (E.F1), which incorporated a single burial, lies between them. Together, these areas have produced skeletal remains of more than 300 individuals, although the minimum number represented is yet to be determined.

The church in the E.F2 project area was a three-aisled basilica built in the mid to late 6th century and the area around it continued to be used for burials into the 11th century[4]. This basilica was near the town's center at that time. Burials were found in its interior, south portico, and narthex, and more than 170 graves were excavated outside the church walls.

The E.G0 project area to the north of the E.F2 basilica sits on a bluff overlooking Chrysochou Bay. The church in this excavation area, also, was a three-aisled basilica constructed in the 6th century, but it was slightly larger than the E.F2 basilica[5]. After a hiatus, it was reused from the 13th through 16th centuries. This church, only half excavated, contains burials in its interior and commingled deposits in rectangular repositories dating to the 7th century along its north and east walls[6]. The highly fragmented commingled deposits from these repositories (fig. 2) vary in the volume of human skeletal remains they contain and await analysis in future study seasons.

3 Childs 2008; Childs et al. 2012.
4 Caraher et al. 2019; Papalexandrou 2012; Papalexandrou – Caraher 2012.
5 Papalexandrou – Caraher 2012.
6 Baker – Papalexandrou 2012; Najbjerg et al. 2002, 147–150; Papalexandrou 2012, 39 f.; Papalexandrou – Caraher 2012.

Challenges for Bioarchaeological Analyses of Human Remains at Polis

My involvement with the project began in 2005 and included the last seasons of excavation in the E.F2 and E.G0 project areas, followed by four month-long study seasons (in 2007, 2010–2012), and a brief reorganization visit in 2019[7]. Prior to my work, a graduate student from Arizona State University spent two summers in the early 1990s documenting remains from identified tombs/graves that had been excavated from 1984–1990 for her M.A. thesis[8]. Most of the burials from the Princeton fieldwork were excavated by people who had no background in human osteology and, until 2005, no specific burial recording form was used. Instead, each excavator kept a »trench notebook« for the excavation unit they oversaw, in which information was recorded daily. Some notebooks provide detailed descriptions and drawings of designated tombs or burials, while others contain a sentence or two indicating only that another skeleton was found, often without any accompanying drawings (fig. 3). In the latter cases, the individual may not have been assigned a burial or tomb number and is not stored with the designated burials. Instead, these skeletons are stored in wooden »bone and ivory« (BI) trays along with faunal remains from each unit by year of excavation in Princeton University's apotheke (storage facility) in Polis (fig. 4). Photographs of burials *in situ*, when they exist, are of variable quality. Some are too overexposed or too underexposed to discern the skeleton, while excellent black and white photographs and occasional color photos are available for other burials.

Basic inventories of the human remains had not been completed for the bulk of the identified tombs/burials when I began my association with the project. Fortunately, the opportunity to excavate burials in the E.F2 area in 2005 and in the E.G0 basilica in 2006 provided a great deal of insight into the procedures used and how excavated material was registered. From this experience, it was also apparent that burial forms differed within and between the excavation areas. In the southern area (E.F2), burials outside of the church ranged from ashlar-lined cist tombs to simple pits covered with slabs or with bodies placed in coffins. A review of trench notebooks indicates that most burials are single inhumations that were likely marked since they were undisturbed, although a few contained both an articulated and disarticulated skeleton indicating reuse of a grave[9]. Some burials contained grave goods ranging from silver earrings to simple needles.

Fig. 2 One of several trays containing boxes of fragmented and commingled human remains from the bottom of a repository (Basin #9) in E.G0:k10-West of the northern basilica (© B. J. Baker)

7 Planned study seasons in 2020 and 2021 have been cancelled due to the COVID-19 pandemic.
8 Buck 1993.
9 Baker – Papalexandrou 2012, 85 f.

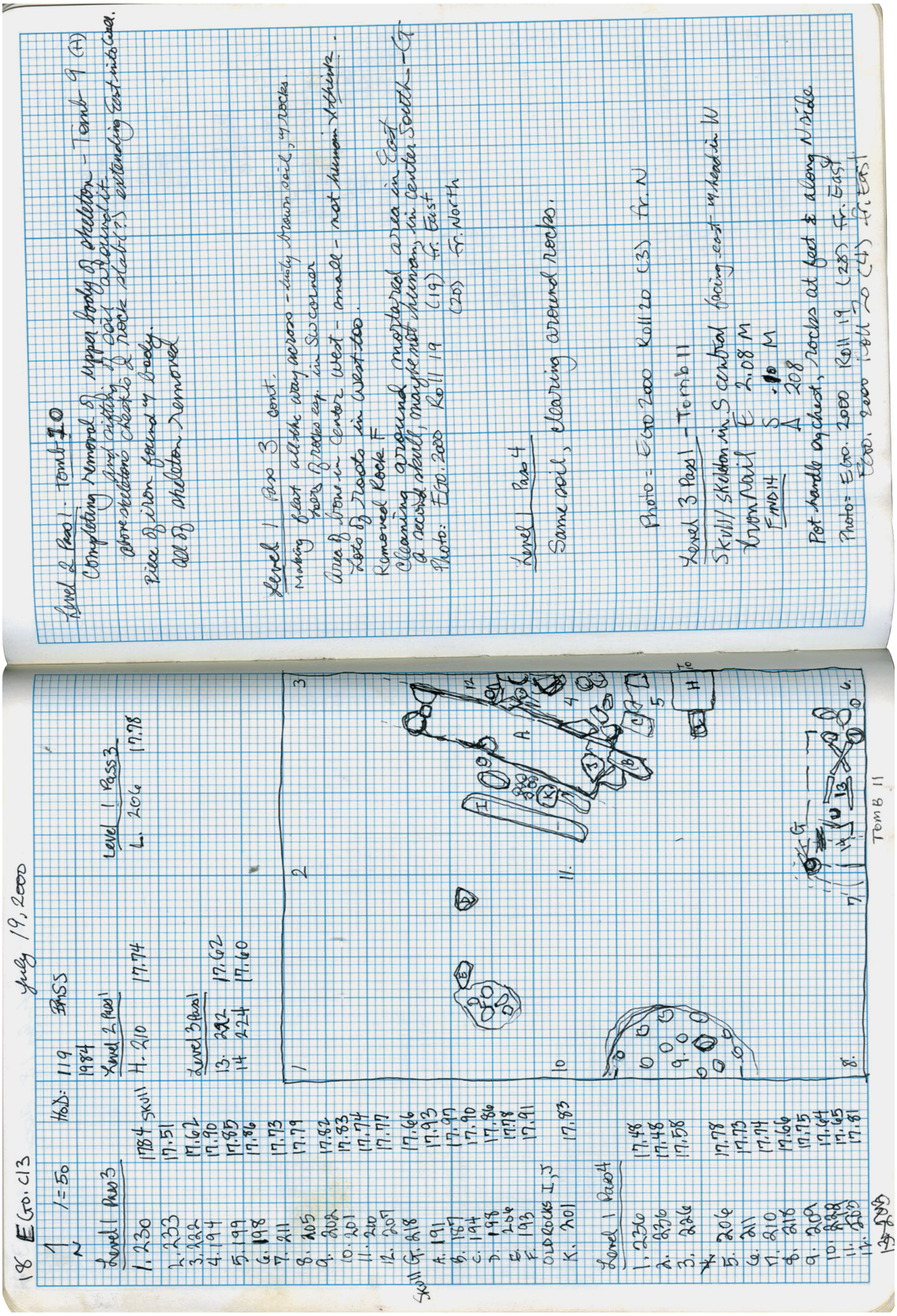

Fig. 3 Princeton Cyprus Expedition trench notebook pages from E.G0:c13 dated July 19, 2000, with a drawing of the unit showing a skeleton in Tomb 11 and the brief information provided about it and other excavated burials (© Princeton Cyprus Expedition)

Fig. 4
Bone storage area in the Princeton Cyprus Expedition's apotheke in June 2019. Bone and ivory (BI) trays containing mixed human and faunal remains are on racks at left and opposite side, while human skeletal remains from designated tombs/burials are at the right and along the back wall (© B. J. Baker)

Burials previously excavated inside the basilica included elaborate tombs with individuals who were likely members of the clergy[10]. Interments excavated in 2006 in the narthex of the northern basilica (E.G0) included individuals in coffins and others laid in pits with stones placed on either side of the head to keep it in position. Such stone head supports are lacking in burials from the E.F2 area, suggesting that this practice post-dates that cemetery and likely began in the 1200s[11]. Grave goods in the later burials (14^{th}–16^{th} centuries) within the northern E.G0 basilica typically included at least one vitreous glaze (sgraffito) bowl. Two previously excavated burials located near the main apse date to the 7^{th} century, however, and contained individuals accompanied by bronze javelins or pikes and an iron spear-point[12]. The variable burial styles and treatments suggest change over time but also provide insight into status and identity of those interred within and around these basilicas.

Due to the way excavation proceeded and the absence of specific forms to document burials prior to 2005, it was clear that each trench notebook must be reviewed for contextual information. This review is also critical to determine the level (stratigraphic unit) and pass (arbitrary division assigned by the excavator) that were being excavated when a burial was first identified. Once a tomb/skeleton was recognized, a new level and pass was assigned. This procedure led to inclusion of bones that were first encountered in the initial level and pass rather than being incorporated with the skeletal remains from the newly designated provenience. Thus, some skeletal elements, typically parts of the hands, pelvis, and skull, are often bagged separately and located in the BI trays for that trench. Consequently, all bone from the initial level and pass must be located, human remains sorted from faunal bone, and pieces cross-matched to determine if any belong to the individual subsequently given a burial designation. An example is provided by the analysis in 2011 of a young adult female with pathology of the foot bones that suggested she might have had leprosy[13]. Critical areas of the skeleton for differential diagnosis were missing, however, including hand bones and parts of the skull. Review of the trench notebook (fig. 3) led to a search of this unit's BI trays for bags of miscellaneous bone within the level and pass being excavated when the skeleton was initially encountered. One bag of bone contained human hand and cranial elements, including fragments of the occipital and maxilla that were cross-matched to pieces from this skeleton, ensuring they belonged to the same individual and permitting full assessment of the pathology present.

10 Baker – Papalexandrou 2012, 84.
11 Baker – Papalexandrou 2012, 93.
12 Papalexandrou 2012, 40.
13 Baker – Bolhofner 2013.

Fig. 5 Stabilized and consolidated femora from the burial in the E.F1 domestic context excavated in July 1988 were not stored with the rest of the skeleton and were found in June 2019 (© B. J. Baker)

Additional challenges include environmental factors that affect the preservation of the remains during both excavation and in storage. Alternate wet and dry periods in this area of Cyprus have led to poor preservation of cancellous bone, particularly ends of long bones, vertebral bodies, and pelvic bones, and the loss of collagen that limits bone flexibility. Bioturbation, particularly root activity, also caused considerable cracking and crumbling of bones upon removal from the matrix. Occasionally, bones were consolidated in the field by project conservators to keep them together and were stored for decades with no further attention. Thus, treated bones must be extracted from materials encasing or consolidating them in order to see their surfaces (fig. 5). Additionally, disturbance by later human activity, including intrusive grave cuts into older interments, has led to commingling of multiple individuals with loss of elements for some contexts. The humid conditions in Polis along with insect (especially silverfish) and rodent activity in the apotheke have also led to problems such as disintegration of plastic bags or holes chewed into them, illegibility of paper labels not encased in plastic, and mold growth. In 2012, after a water leak affected an area of BI storage, the bottoms of some wooden trays had collapsed onto the material stored below, storage boxes had gotten wet and warped, and mold growth was rampant in both boxes and resealable plastic bags (fig. 6). Bones in all affected trays were cleaned, dried, and rehoused during that study season, taking time away from analysis. Plastic sheeting was draped over the affected area of shelving at the end of the study season to prevent future water damage.

Fig. 6 Water-damaged bone storage trays and mold growth from a leak in the winter of 2011/2012 (© B. J. Baker)

In some cases, excavators erred on the side of caution by saving much of the soil matrix containing human remains, particularly in the case of infant burials or extensive commingling of multiple individuals. In these cases, the remains are excavated in the laboratory from the soil matrix contained in storage boxes or multiple plastic bags. All matrix is sieved to ensure the recovery of forming bones and tooth crowns, which are then repackaged (fig. 7).

Fig. 7 At left, remains of an infant, 5–6 months of age, from E.F2:p10 being sorted from a storage box and after analysis and packaging in June 2010 (© B. J. Baker)

Cleaning fragile bones to permit observation is another challenge. Rather than brushing and using dental picks or bamboo skewers to remove adhering matrix, a cleaning method using an air compressor and air brush allows removal of soil without damaging bone surfaces, anatomical features, or pathological lesions. This method, to which I was introduced by the project's head conservator Christoph von Bieberstein in 2010, permits variable air pressure and amounts of water to be used and has yielded far better results than traditional methods of cleaning (fig. 8).

Despite these challenges, the storage of skeletal remains in the apotheke in Polis is far better and considerably more organized than I have seen in some other places in Cyprus and other countries where I have worked. The storage organization is being improved as analyses proceed, but the original state of organization has aided progress. Careful curation of human remains is essential to ensuring they are not damaged in long-term storage and retain their provenience information for future study.

Fig. 8 Katelyn Bolhofner cleaning bones with the air compressor/air brush system (© B. J. Baker)

Skeletal Analyses

Because bioarchaeological research at Polis has only recently begun, principal research questions are aimed largely toward understanding both life and death among the Late Antique and medieval inhabitants of the town through the investigation of funerary behavior and the analysis of the human remains. As the human remains are inventoried, attention has been directed to evidence of pathology, activity-related alterations to the dentition and skeleton, and patterns of pathology related to age and sex. While the life course of individuals interred in each area is becoming evident as the inventory process proceeds, comparisons between the skeletal assemblages from the two basilicas are not yet feasible.

As of 2019, 77 individuals had been analyzed for demographic information and pathology, with four additional dentitions examined for wear patterns. The total analyzed sample of individual skeletons includes 30 preadults (39.0 %) and 47 adults (61.0 %). The latter group is comprised of those at least 17 years of age or older. Of the adults, 28 (59.6 %) are males and 17 (36.2 %) are females, with two (4.2 %) of indeterminate sex. Sex and age-at-death assessments were based on standard methods[14]. All adult dentitions were examined macroscopically for grooves, notches, and wear patterns indicative of nonalimentary use of the teeth. Magnification (2× to 10×) was subsequently used to discern further detail.

Nonalimentary Dental Use Wear

Frequent findings in the analyzed portion of the human remains collection at Polis include dentitions with notches and grooves on anterior teeth consistent with their use as tools. This sample includes 50 observable dentitions derived from the 47 adult individuals and four additional dentitions examined. Eighteen of the 50 (36.0 %) observable adult dentitions analyzed exhibit alterations of the anterior teeth. Use of teeth as tools is far more common in females (11 of 18, or 61.1 %) than in males (7 of 18, or 38.9 %). Nearly two-thirds of adult females show dental alterations (table 1), compared with less than one-fourth of males.

Table 1 Nonalimentary dental use wear

Sex	Number affected/observed	% affected
Male	7/31	22.6
Female	11/17	64.7
Indeterminate	0/2	–
Total	**18/50**	**36.0**

Three patterns of nonalimentary dental use wear have been discerned (fig. 9), suggesting that these 18 individuals used their teeth in somewhat different ways, though all patterns are associated with other skeletal alterations and grave goods consistent with sewing, spinning, or weaving. Pattern 1 consists of horizontal grooves on the distal aspects of maxillary lateral incisors and lingual surface attrition of the maxillary anterior teeth (LSAMAT), along with shallow labial-lingual grooves and anterior projection of the mandibular incisors. These dental alterations are accompanied by skeletal evidence of repetitive manual stress and long periods of sitting and kneeling and burial with a bone needle/awl[15]. An identical pattern was found by N. K. Harper in 5 of 35 (14.3 %) Venetian period (A.D. 1489–1571) women from Athienou-Malloura[16]. Pattern 2 consists of V-shaped notches on the maxillary central incisors with LSAMAT and cupping of

14 Buikstra – Ubelaker 1994.
15 Baker – Papalexandrou 2012, 104; Baker et al. 2012.
16 Harper – Fox 2008, 19.

Fig. 9 Notches and grooves presenting three patterns of nonalimentary dental use wear. Pattern 1 (left) includes grooves on the distal aspects of maxillary lateral incisors. Pattern 2 (center) presents notches on incisal aspects of incisors and substantial LSAMAT. Pattern 3 (right) shows a combination of grooves and notches. All teeth are shown at the same scale. (© B. J. Baker)

the anterior mandibular teeth. A 45–50-year-old female with the most severe notching in Pattern 2 was also buried with a bone needle/awl. Her skeleton also shows repetitive stress in the hands, left forearm, and neck, with rugose ischial tuberosities (known as weaver's bottom). The combination of V-shaped notches and small grooves on the incisal aspects of maxillary incisors in Pattern 3 is found in both males and females. A female, approximately 25–30 years old at death, who exhibits this pattern was the only burial from a domestic context in the sample. A bone needle/awl may also be associated with this individual.

Striations, grooves, and notches in anterior teeth have long been associated with their use as tools, particularly in the production of fibers, textiles, and basketry in the Mediterranean region[17]. In Cyprus, archaeological evidence for both household and workshop production of textiles dates to the Late Bronze Age, beginning by the 13th century B.C.[18]. Direct skeletal evidence for involvement in such work, however, is lacking from these earlier periods. Nonalimentary dental use wear, like that of Pattern 1, is attributed by N. K. Harper to mouth spinning[19]. Examples from 10th-century Anatolia associated with mouth spinning by Y. S. Erdal, however, show transverse, mesio-distal grooves[20] rather than the labio-lingually oriented grooves or notches found in all three patterns in the Polis sample. Incisors exhibiting grooves, notches, and chipping in the Venetian period remains from Athienou-Malloura are discussed at greater length by N. K. Harper[21], which he associates with increased cotton textile production during this period.

Grooves or notches are observable in individuals as young as 18–24 years of age at death but are more frequently found in middle and older adults (i.e., those age 35 or more), as expected with longer intervals of tooth use in this manner. Because such dental use wear is apparent even in some young adult dentitions, involvement in textile production undoubtedly began by adolescence in these individuals. Skeletal remains from medieval Polis with these dental alterations, as at Athienou-Malloura[22], suggest that textile production was performed principally by women. It is clear at Polis, however, that it was not exclusively in the female domain. Men may have participated in some aspects, including string and rope production, as per 19th- and early 20th-century ethnographic accounts from Cyprus[23].

17 E.g. Bonfiglioli et al. 2004; Minozzi et al. 2003.
18 Smith 2002.
19 Harper – Fox 2008, 19.
20 Erdal 2008.
21 Harper 2011.
22 Harper 2011.
23 Smith 2002, 287.

Healed Trauma

Healed trauma is present in 15 of 42 (35.7 %) adult, mostly complete, skeletons analyzed for pathology. Five other adults are excluded here due to their poor preservation that limits observation. Trauma has not been found, thus far, in any preadults. Healed fractures are more frequent in males than in females. Of the 15 affected, nine (60.0 %) are male, five (33.3 %) are female, and one (6.6 %) is of indeterminate sex. However, the overall proportion of males with healed trauma is much lower, with only 39.1 % affected (table 2). Five of the 17 (29.4 %) adult females analyzed show healed trauma. Therefore, trauma among males is not substantially greater than trauma among females across the overall population.

Table 2 Healed trauma

Sex	Number affected/observed	% affected
Male	9/23	39.1
Female	5/17	29.4
Indeterminate	1/2	50.0
Total	**15/42**	**35.7**

In males, trauma typically involves fractures of the clavicle, ribs, vertebral compression fractures, fingers, and toes. Clavicle injuries suggest falls, particularly in conjunction with rib and vertebral compression fractures. The pattern of fractures is consistent with accidental trauma associated with farming[24]. In contrast, two of the five affected females show trauma related to violence. One female has healed cranial depression fractures on the parietal bones, while another has a well-healed parry fracture of the right ulna and fractures of the right ninth and left tenth ribs. Parry fractures occur on the distal half of the ulna when warding off a blow to the face and and are distinguished from accidental breaks by the absence of radial involvement, a transverse rather than oblique fracture line, and minor displacement[25]. Blunt-force cranial trauma, including nonlethal injury, is typically related to violence[26]. No males thus far show evidence of intentional violence. Females with accidental injury had trauma to toes, a healed fracture of the left twelfth rib, and vertebral compression. Males likely performed labor that put them at higher risk of accidental trauma than females. Although females also show accidental trauma, they disproportionately suffered violent trauma. No evidence of peri-mortem trauma has been observed.

Other Pathology

Thus far, little evidence has been found for infectious disease among the medieval inhabitants of Polis. One young adult female suffered from leprosy[27] and one potential case of tuberculosis is present in a male, who was approximately 17–18 years old when he died. Another individual shows maxillary sinusitis. Otherwise, evidence of infection consists of 12 individuals with diffuse periosteal new bone reaction. Carious teeth are present in several individuals but are not pervasive, and two individuals exhibit abscesses. Thus, infectious disease prevalence appears to have been low. Evidence for anemias, including acquired or hereditary forms, is present. Five individuals I have examined show cribra orbitalia or porotic hyperostosis, although it is not common. S. A. Buck[28], however, discussed a few instances of thickened diploe that may be associated

24 Judd – Roberts 1999.
25 Judd 2008.
26 E.g. Alvrus 1999; Jiménez-Brobeil et al. 2009; Walker 1997.
27 Baker – Bolhofner 2013.
28 Buck 1993.

with thalassemia. One young child (1.5–2.5 years of age) with cribra orbitalia, porotic hyperostosis, hypervascularity of vertebral centra, and periosteal reaction on long bones may have had this condition. As analyses continue in Polis, therefore, any patterning of lesions indicative of thalassemia[29] will be evaluated in detail. So far, however, the relatively low frequencies of infection and metabolic disorders in the analyzed portion of the Polis collection suggest a community in relatively good health.

Conclusions

This case study from Polis Chrysochous demonstrates how much can be gleaned from skeletal collections, even if contextual information is sometimes lacking, preservation is not ideal, or remains are commingled. Bioarchaeology can provide social and biological information concerning age-related or gendered patterns of health, diet, activity, mobility, and migration on a population level. A sexual division of labor seems apparent in medieval Polis based on the differences found in nonalimentary tooth wear and healed trauma. Individuals are also illuminated through osteobiography, providing insights into their lived experiences. Understanding how the worsening effects of a disease like leprosy affected a young woman gradually over years of her life[30] or knowing that a medieval seamstress also snapped thread along her top lateral incisors permit people today to relate to them[31]. Ongoing analysis of the skeletal remains from Polis will continue to add insight to the fabric of daily life in medieval Cyprus.

In a broader perspective, bioarchaeological research now underway in Cyprus is showing how analytical advances, such as use of GIS, new imaging techniques, archaeological chemistry, and aDNA analyses of teeth or dental calculus can provide additional information about life on Cyprus in antiquity. Our work, however, requires greater interaction with classically trained archaeologists and other specialists to demonstrate the significance of bioarchaeological research and to enhance contextualization of the remains with which we work. Increasing community/public outreach is also essential to connect the island's present inhabitants with those who preceded them, demonstrating common aspects of life in the past with life in the present and perhaps offering new appreciation for bioarchaeological and forensic research. My own interactions in Cyprus with women who make lace or weave has proven fruitful in helping to understand the dental alterations found in the medieval Polis remains and has led to interesting discussions, such as dentists warning that continued use of teeth to cut thread will eventually break off the tooth. The examples I have related to them, tie these women to those who lived long ago. This humanizing of the past is critical to demonstrating the insights provided by bioarchaeology.

Many more bioarchaeologists are integrated into projects in Cyprus today, but interconnections among them are nascent. Continued workshops, seminars, and symposia will aid in finding solutions to the challenges we commonly face. Such interactions will also encourage new connections and collaborations that will move bioarchaeology forward in Cyprus.

Acknowledgments

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[29] See Lagia et al. 2007.
[30] Baker – Bolhofner 2013.
[31] Baker et al. 2012.

action among bioarchaeologists from an array of countries who work at different locations in Cyprus and resulted in this volume. I am grateful to the Department of Antiquities of Cyprus for permitting access to the skeletal remains, and to Willy Childs and Joanna Smith (co-directors of the Princeton Cyprus Expedition) and Amy Papalexandrou (Late Antique and Medieval research) for facilitating my participation in this project. My work has been aided by then-graduate students from Arizona State University, including Claire Terhune (2005, 2006), Michael Moramarco (2010, 2011), and Katelyn Bolhofner (2011, 2012). This work has been supported by the Princeton Cyprus Expedition, the School of Human Evolution and Social Change at Arizona State University, and by a private donor who has supported my bioarchaeological research for several years.

Bibliography

Alvrus 1999 — A. Alvrus, Fracture patterns among the Nubians of Semna South, Sudanese Nubia, International Journal of Osteoarchaeology 9, 1999, 417–429.

Angel 1953 — J. L. Angel, The Human Remains from Khirokitia, in: P. Dikaios, Khirokitia. Final Report on the Excavation of a Neolithic Settlement in Cyprus on Behalf of the Department of Antiquities, 1936–1946, Monographs of the Department of Antiquities of the Government of Cyprus 1 (London 1953) 416–430.

Angel 1961 — J. L. Angel, Neolithic crania from Sotira, in: P. Dikaios, Sotira, Museum Monographs (Philadelphia 1961) 223–229.

Angel 1964 — J. L. Angel, Osteoporosis: Thalassemia?, American Journal of Physical Anthropology 22/3, 1964, 363–373.

Angel 1966 — J. L. Angel, Porotic hyperostosis, anemias, malarias, and marshes in the prehistoric Eastern Mediterranean, Science 153, 1966, 760–763.

Angel 1972 — J. L. Angel, Late Bronze Age Cypriotes from Bamboula: The skeletal remains, in: J. L. Benson, Bamboula at Kourion. The Necropolis and the Finds, Museum Monographs (Philadelphia, PA 1972) 148–165.

Baker – Bolhofner 2013 — B. J. Baker – K. L. Bolhofner, Biological and social implications of a medieval burial from Cyprus for understanding leprosy in the past, International Journal of Paleopathology 4, 2014, 17–24.

Baker – Papalexandrou 2012 — B. J. Baker – A. Papalexandrou, A Bioarchaeological Perspective on the Burials and Basilicas of Medieval Polis, Cyprus, in: M. A. Perry (ed.), Bioarchaeology and Behavior. The People of the Ancient Near East (Gainesville, FL 2012) 80–114.

Baker et al. 2012 — B. J. Baker – C. E. Terhune – A. Papalexandrou, Sew long? The osteobiography of a woman from medieval Polis, Cyprus, in: A. L. W. Stodder – A. M. Palkovich (eds.), The Bioarchaeology of Individuals (Gainesville, FL 2012) 151–161.

Bonfiglioli et al. 2004 — B. Bonfiglioli – V. Mariotti – F. Facchini – M. G. Belcastro – S. Condemi, Masticatory and non-masticatory dental modifications in the Epipalaeolithic necropolis of Taforalt (Morocco), International Journal of Osteoarchaeology 14, 2004, 448–456.

Buck 1993 — S. A. Buck, Life on the Edge of the Empire: Demography and Health in Byzantine Cyprus (MA thesis Arizona State University, Tempe 1993).

Buikstra – Ubelaker 1994 — J. E. Buikstra – D. H. Ubelaker (eds.), Standards for Data Collection from Human Skeletal Remains. Proceedings of a seminar at the Field Museum of Natural History, Research Series 44 (Fayetteville, AR 1994).

Caraher et al. 2019 — W. Caraher – R. S. Moore – A. Papalexandrou, The south basilica at Polis on Cyprus, Hesperia 88, 2019, 319–364.

Childs 2008 — W. A. P. Childs, Polis Chrysochous: Princeton University's excavations of ancient Marion and Arsinoe, Near Eastern Archaeology 71/1–2, 2008, 64–75.

Childs et al. 2012 — W. A. P. Childs – J. S. Smith – J. M. Padgett (eds.), City of Gold: The Archaeology of Polis Chrysochous, Cyprus (New Haven 2012).

Erdal 2008 — Y. S. Erdal, Occlusal grooves in anterior dentition among Kovuklukaya inhabitants (Sinop, Northern Anatolia, 10th Century AD), International Journal of Osteoarchaeology 18, 2008, 152–166.

Harper 2008 — N. K. Harper, Short skulls, long skulls, and thalassemia: J. Lawrence Angel and the development of Cypriot anthropology, Near Eastern Archaeology 71/2, 2008, 111–119.

Harper 2011 N. K. Harper, Trade or trousseau. Skeletal evidence for spinning and weaving in Athienou-Malloura, in: M. K. Toumazou – P. N. Kardoulias – D. B. Counts (eds.), Crossroads and Boundaries. The Archaeology of Past and Present in the Malloura Valley, Cyprus, AASOR 65 (Boston, MA 2011) 259–268.

Harper – Fox 2008 N. K. Harper – S. C. Fox, Recent research in Cypriot bioarchaeology, Bioarchaeology of the Near East 2, 2008, 1–38.

Jiménez-Brobeil et al. 2009 S. A. Jiménez-Brobeil – P. du Souich – I. Al Oumaoui, Possible relationship of cranial traumatic injuries with violence in the South-East Iberian Peninsula from the Neolithic to the Bronze Age, American Journal of Physical Anthropology 140/3, 2009, 465–475.

Judd 2008 M. A. Judd, The Parry Problem, JASc 35/6, 2008, 1658–1666.

Judd – Roberts 1999 M. A. Judd – C. A. Roberts, Fracture trauma in a Medieval British farming village, American Journal of Physical Anthropology 109/2, 1999, 229–243.

Lagia et al. 2007 A. Lagia – C. Eliopoulos – S. Manolis, Thalassemia: Macroscopic and radiological study of a case, International Journal of Osteoarchaeology 17, 2007, 269–285.

Minozzi et al. 2003 S. Minozzi – G. Manzi – F. Ricci – S. di Lernia – S. M. Borgognini Tarli, Nonalimentary tooth use in prehistory. An example from early Holocene in central Sahara (Uan Muhuggiag, Tadrart Acacus, Libya), American Journal of Physical Anthropology 120, 2003, 225–232.

Najbjerg et al. 2002 T. Najbjerg – C. Nicklies – A. Papalexandrou, Princeton University Excavations at Polis/Arsinoë. Preliminary report on the Roman and Medieval levels, RDAC 2002, 139–154.

Papalexandrou 2012 A. Papalexandrou, Polis/Arsinoë in Late Antiquity. A Cypriot town and its sacred sites, in: M. J. Johnson – R. Ousterhout – A. Papalexandrou (eds.), Approaches to Byzantine Architecture and its Decoration. Studies in Honor of Slobodan Ćurčić (Ashgate 2012) 27–46.

Papalexandrou – Caraher 2012 A. Papalexandrou – W. Caraher, Arsinoe in Late Antiquity and the Middle Ages, in: Childs et al. 2012, 266–282.

Smith 2002 J. S. Smith, Changes in the workplace: women and textile production on Late Bronze Age Cyprus, in: D. Bolger – N. Serwint (eds.), Engendering Aphrodite. Women and Society in Ancient Cyprus, CAARI Monographs 3 = American Schools of Oriental Research Archaeological Reports 7 (Boston, MA 2002) 281–312.

Walker 1997 P. L. Walker, Wife beating, boxing, and broken noses: skeletal evidence for the cultural patterning of violence, in: D. L. Martin – D. W. Frayer (eds.), Troubled Times: Violence and Warfare in the Past (Amsterdam 1997) 145–179.

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