

Small Bones and Short Lives:
Evidence of Environmental Stress from Juvenile Skeletal Remains in Roman Barcino

By

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Abstract

Children have received far less attention than adults in bioarchaeology as it has been believed that little relevant information can be obtained through their study. This is problematic due to the fact that not only are they inherently foundational to any society, but they also provide excellent indication of the overall health of a population. This research looks at two samples of juvenile individuals derived from two Roman necropoleis in Barcino (ancient Barcelona) for evidence of environmental stress. Analysis of each individual consists of examining and comparing the estimated age values derived from maximum femoral and tibial lengths to the ages derived from dental eruption to look for any discrepancies between the values which may indicate possible stress indicators in a particular individual. The incorporated material evidence, burial context of each individual, and presence of palaeopathologies are also analyzed to provide additional information to their socioeconomic status. The results of this study showed that the majority of the individuals within the two samples were calculated to have their long bone ages below their dental ages, suggesting varying degrees of having suffered environmental stress. This research contributes not only to the particularly understudied area of bioarchaeology of children, but also provide new information regarding their health in the context of Roman Hispania.

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Introduction

In bioarchaeological research, children have historically received far less attention than adults. This is primarily due to the misconception that little relevant information can be obtained through studying them (Lewis, 2007). This has in turn created a considerable gap in our overall understanding of children in archaeological contexts. This is troublesome not only due to the obvious fact that children are a fundamental component of society, but they also provide excellent indication of the general health of a population since if a society is able to take care of their most vulnerable members, then something can be said about their overall stability. Moreover, the overall paucity of childhood studies means that the problem of underrepresentation compounds when focus is made on specific cultures or temporal periods. This, in turn, considerably limits any potential anthropological analysis as it fails to recognize the fact that children, as participating members, are integral both socially and economically to the operation of past societies. The study of children in bioarchaeological contexts and its subsequent integration with the existing knowledge of adults therefore contributes towards a more holistic view of social organization, diet, and health in societies in the past.

Drawing on standardized bioarchaeological methodology, this research examines two samples of juvenile individuals derived from two Roman necropoleis in Barcino (ancient Barcelona) to look for environmental stress. Analysis of each individual consists of examining and comparing the estimated age values derived from maximum femoral and tibial lengths using the Cardoso, Abrantes, & Humphrey (2014) ANCOVA formulae to the ages derived from dental eruption with the London Tooth Atlas (2010). Any discrepancies that are shown between age values in this comparison may indicate a possible adaptive response to stress in a particular individual by revealing compromised growth. Additionally, the incorporated material evidence,

and burial contexts, and any macroscopically visible palaeopathologies such as cribra orbitalia and linear enamel hypoplasias are all analyzed as well in order to provide supplementary information to the socioeconomic statuses and overall health of the respective individuals. This research argues: On the basis of comparing long bone and dental age estimations, the Vila de Madrid and Santa Caterina necropoleis contain juvenile individuals who show signs that indicate they suffered from nutritional stress during their lives. This is accomplished through first conducting a brief overview of some of the bioarchaeological considerations of estimating age in juvenile remains, building on the theoretical works of Mary Lewis (2007), and explaining some of the established methods of age estimation. The next section concerns diet and nutrition in Roman society through the examination of both contemporary studies and ancient sources to give an indication of what diet and nutrition was like during this period. Following this is a small introduction to Roman history in Spain in order to provide some background to how Romans came to occupy the area. Next, an overview of funerary customs is provided to demonstrate how the deceased were treated in Roman society, and how socioeconomic status played a fundamental role in this process. A comprehensive analysis of the two necropoleis being studied in this research is covered next, examining aspects such as chronology, location, recovered materials, and burial evidence to provide context to the individuals being investigated. Finally, the paper concludes with an evaluation of the juvenile individuals of the sample in which dental and skeletal age are compared. Results are then consolidated with supplementary evidence and then subsequently discussed.

In light of the limited number of individuals and samples, this study cannot comment on the *overall* health of Roman children from Barcino at these particular time periods. However, it does comment on the health of these children in particular. In doing so, this research contributes not only to the particularly understudied area of bioarchaeology of children, but also provides new

data regarding health of the individuals from these samples in the context of Roman Hispania. The significance of this research comes also particularly from the fact that there have been limited studies on Roman children in Spain, and that a study of this nature has not yet been undertaken on these particular samples of juveniles.

Bioarchaeological Considerations

The reconstruction of an individual's biological profile (i.e. a summary of essential biological information regarding an individual) would be incomplete without the determination of their age. Age-at-death estimations are crucial for bioarchaeological research, as they provide investigators with essential knowledge regarding the individuals themselves, and the society to which they belonged. Subadult age estimation is particularly important in bioarchaeology due to its usefulness in making inferences regarding growth and development, mortality rates, morbidity, weaning ages, congenital and environmental conditions and infanticide (Lewis, 2007). Age estimation in subadults is generally considered more precise in comparison to adults, as growth in non-adults relies on the development and fusion of skeletal elements which will occur in regular intervals throughout childhood. After reaching skeletal maturation, the number and speed at which developmental changes occur is reduced. Age estimation subsequently becomes harder to determine as it will then instead begin to rely on the extent of degeneration and deterioration in the skeleton, which can be influenced by a myriad of different factors, rendering it far less accurate.

The estimation of age in children and infants, as Lewis (2007) articulates, "is based on a physiological assessment of dental or skeletal maturation, and relies on the accurate conversion of biological into chronological age" (p.38). Factors such as random individual variation, environmental effects, disease, and genetics can influence the accuracy and precision of these

assessments and are important to stay aware of when conducting bioarchaeological research concerning age estimation (Scheuer, Black, & Christie, 2010).

The Three Ages: Biological, Chronological, and Social

An important distinction must be made to the three classifiable ages: chronological, biological, and social. A particular issue within archaeology is the proper definition of a “child” due to the cultural significance behind this term. Biological anthropology, for example, will often use Western notions of childhood and development when interpreting the remains of people from other cultures and societies, placing them into defined *social* ages. However, categories such as “infancy”, “childhood”, “adolescence”, or “adulthood” may not truly reflect the stages of life belonging to the culture from which some individuals are derived. For example, primary sources (Varro *De Ling.* 6. 52; Quintillian i. i. 18) tell us that the age of seven, which perhaps not so coincidentally corresponds approximately to the age when the permanent dentition begin to replace the deciduous, was generally regarded by the Romans to be the period in which an individual left *infantia*, signaling their admission into the adult world (Rawson, 2009). Similar parallels can be seen also in the epigraphical record which depict commemorations of the admission of children in the political orders of the municipalities. In Pompeii, for example, eight-year-old children would be admitted in the *ordo decurionum* (Rawson, 2009). Until this culturally significant point in time, subadults would be denied the funeral ritual of being cremated due to the fact that they were not yet considered properly part of society (Carroll, 2006), thereby influencing the subsequent archaeological record. Therefore, conducting a comprehensive inquiry on the population, including socio-cultural aspects, is essential to determine the corresponding socially defined age grades. In this way, if there are any potential discrepancies or misrepresentations in the archaeological evidence, they have a higher chance to be recognized, interpreted, and explained.

Encompassing both skeletal and dental ages, *biological age* is the physiological reality of an individual. Physiology is assessed by investigators to indicate to what degree an individual has progressed developmentally. In skeletal age, this is exhibited by the appearance and fusion of ossification centres throughout the body, along with the overall size and morphology of the bones. Dental age, rather, is indicated by the time in which tooth emergence occurs, or through the assessment of the stages of mineralization. Biological age is not entirely independent from social age, as it concerns the physical capabilities a child has to participate and interact with the world. The interactions that children make in turn shape the way that they are perceived in a society and the way that society places them into particular age categories. For example, in Roman society, the biologically pivotal period of puberty was considered a turning point in which an individual became criminally prosecutable; until this point a child would instead be regarded as incapable of criminal intent (*dolus malus*: Digesta Iustiniani. 48. 10. 22 pr.2). Therefore, biologically determined physiology was a deciding factor in the societal perception and treatment of children, as it was societally perceived that lack of strength or intelligence, as a result of immaturity, rendered a child incapable of conceiving and committing a crime (Rawson, 2009).

Finally, *chronological age* is the placement of an individual on a numeric scale, indicating approximately how many years or months the individual in question was when they died. This is typically the objective of skeletal and dental aging techniques. To obtain an accurate chronological age for an estimation of age-at-death, there must be a precise conversion of biological age based on the assessment of dental or osteological developmental stages. Chronological ages are typically obtained by comparing these stages to established developmental standards, or by inputting the measurements of a skeletal element into derived age estimation formulae. It is important to note that in the calculation of a chronological age, an age *range* is derived based on the confidence on

the formula, rather than a single year. The ranges calculated for subadult individuals are normally quite small due to the regular intervals of juvenile skeletal development, and for this reason they are more precise. As an individual reaches complete skeletal maturation, age ranges become larger, depending less on development and more on degeneration which follows no regular interval.

Skeletal Aging Methods

To understand the process of skeletal aging, a brief overview of bone growth must first be made. In the process of skeletal growth and development, the long bones of the body progress through a maturational process known as endochondral ossification (fig.1). They will begin as a hyaline cartilage model, to which a primary ossification centre will begin to form in the diaphysis (shaft) of the model, while secondary ossification centres will develop on the epiphyses at each extremity. When the bone stops growing in the late teenage years, the growth cartilage ossifies and the epiphysis is eventually fused to the diaphysis in a process aptly known as epiphyseal fusion. There are three identifiable stages associated with fusion: the diaphysis and epiphysis are entirely separate, the diaphysis and epiphyses are joined with their junction demarcated by a line, and lastly the diaphysis and epiphysis are completely fused with no sign of a line (fig. 2; Cardoso, 2008). In normal circumstances, the process of development and fusion will occur at regular intervals throughout childhood. These unions will occur at different times for different bones (fig. 3), and thus they can be used by investigators for deriving a precise age estimate for subadult remains.

An alternative method for deriving age estimates is through the analysis of long bone lengths. This method will usually employ an osteometric board (fig. 4) which precisely measures the maximum length of a bone from each end. It should be mentioned that caution should be taken if this method of age estimation is to be employed, as growth rates have not only been shown to vary considerably between populations, but also among members of the same population

(Ubelaker, 1999). Another issue arises in the fact that many of the established standards on long bone length have been derived from contemporary living populations. Bone is known to decrease in size up to 10% when it becomes dry, and therefore, accuracy may be compromised when contemporary standards are applied to archaeologically derived materials (Huxley, 1998). Long bone length, however, is very useful in the estimation of age of fetuses and infants. Numerous studies have been conducted which have shown it is possible to accurately predict age with a standard error of only a couple weeks using diaphyseal lengths (Olivier & Pineau, 1960; Fazekas & Kosa, 1978; Scheuer, Black, & Christie, 2010).

A considerable complication for the estimation of age using long bone lengths comes from growth retardation, in which the growth of a child may slow if they are under a substantial amount of stress. Factors such as nutrition (Metcoff, 1978), socio-economic status (Bogin, 1991), physiological stress (Eveleth & Tanner, 1990), and parasites (Worthen et al., 1998) among many others can affect the rate at which a child grows. Growth will slow its speed until adequate levels of nourishment are resumed, with the duration of the delay in growth corresponding to the severity of the stress episode and the age when it took place (Tanner, 1981). If subject to malnourishment, infants, however, will continue to grow at the same rate as their healthier counterparts for the first six months, relying on vitamin and nutrient stores from gestation (Chen, 1983); this is, however, contingent on the mother's overall nutrition. If the individual resumes normal levels of nourishment following a slow in growth rates, their original growth trajectory can be resumed in a phenomenon aptly known as "catch-up growth", which still today is not entirely understood (Scheuer, Black, & Christie, 2010). The ability for this phenomenon to occur, however, diminishes with age and if growth is slowed for too long around puberty, the individual will not be able to resume their original growth trajectory (Rallison, 1986). Evidently, this has implications on age

estimation since if the measurements of an individual who underwent growth retardation are applied to standardized age estimation formulae, they will be calculated to be chronologically younger than they actually were in reality. To account for this potential misrepresentation, bioarchaeologists may take radiographs of osteological material to examine for the presence of Harris lines (fig. 5). These distinct, radiopaque lines materialize when an individual undergoes a period of stress and then resumes normal growth, creating lines in the bone akin to those on a tree to which the frequency of stress episodes can be counted (Lewis, 2018). Though preventative measures can be taken to account for possible disproportionate or misrepresentative results from long bone age estimations, due to their constancy, age estimates derived from the dentition are instead generally favoured.

Dental Ageing Methods

Dental development, as a method for determining the age of a subadult individual, is generally considered to be a more reliable option for establishing a chronological age than using skeletal growth (Cardoso, 2007; Scheuer, Black & Christie, 2010). The development of teeth, as opposed to the skeleton, is affected less by environmental influences, which makes it the preferred method for age estimation used by bioarchaeologists (Cardoso, 2007). Furthermore, the sheer durability of teeth allows them to survive well in the archaeological record making them one of the most commonly found skeletal elements for study (Scheuer, Black & Christie, 2010). Mineralization of the teeth will typically follow a common sequence to which it can be divided into convenient stages of development. Revised charts, such as that produced by Alqahtani, Hector, and Liversidge (2010), have facilitated the determination of these developmental stages on archaeologically and forensically derived materials by outlining the sequence into a comprehensive visual lay out. Dental mineralization will begin in the deciduous dentition at around

15 weeks of gestation, starting with the central maxillary incisors, and will continue to develop until their complete eruption at approximately three years of age. The permanent dentition, instead, begin their development at around birth and, with the exception of the third molar, will finish around 14 years of age (Scheuer, Black & Christie, 2010). The third molar, being subject to the most individual variation, will generally complete its development at around 17 years of age. However, due to individual and congenital variation, they will sometimes become impacted and not erupt, or be entirely absent in development which may affect the process of age estimation (Scheuer, Black, & Liversidge, 2004).

Producing a dental age estimate typically considers two aspects of dental development: the eruption of the teeth, and the stage of mineralization of the crowns and roots (Scheuer, Black & Christie, 2010). It is important to note the distinction between eruption and emergence, which have in the past been wrongly interchanged. While emergence refers to only the tooth's breaching of the alveolar bone, eruption instead concerns the tooth's process of moving from alveolar bone to the occlusal surface. To the investigator, mineralization yields an advantage over emergence in that it can be studied over the entire course of a tooth's development, while emergence is confined to a single point in time which cannot be accurately known or determined by the investigator. Dental mineralization has been shown to be less affected by external influence than eruption, which suggests that it is more genetically determined. Eruption, on the other hand, can be affected by factors such as nutrition and environmental stress, early loss of deciduous teeth, or inadequate space in the jaws (Scheuer, Black & Christie, 2010). The degree of dental attrition can also be examined for the determination of an age estimate, though is rarely attempted in both adult and subadult remains. This is due to the fact that dental attrition can be influenced by a number of different factors which determine the speed and intensity of its occurrence, meaning that it does

not transpire at a constant rate and is specific to each sample. For this reason, it is generally considered an unreliable means of age estimation (Scheuer, Black & Christie, 2010). In the absence of any other available osteological material, however, dental attrition may be the only means of establishing an estimate. This was the case, for example, in the analysis of the osteological material excavated from Pompeii. Earlier excavations of the city placed little to no value on the osteological material derived from the city, which meant that they were stored away without any particular method of organization. Once the value of skeletal material became realized decades later, it became impossible to rearticulate individual skeletons due to the intermingling. Adult mandibles which had been separated from their crania then relied on the analysis of dental attrition for rough age estimation as there was no other possible alternative (Lazer, 2011). Aside from age estimation, dental wear in the deciduous dentition can be especially useful in juvenile analysis, since its presence implies the introduction of solid foods into a child's diet. This, in turn, can provide bioarchaeologists with valuable data regarding the weaning ages of a particular sample (Lewis, 2007).

While dental mineralization is, indeed, often recognized in bioarchaeological research to be more resilient to external pressures, it is important to realize that teeth are not absolutely constant, and differences do occur in their development. Cardoso (2007) illustrated in a study with the Lisbon collection in Portugal that socioeconomic status has a significant effect on the eruption of teeth. By studying juvenile individuals of known sex and age derived from both high and low socioeconomic statuses, he found that dental development showed significant delays on the lower end of the gradient. This work asserts the fact that although dental development is buffered against environmental factors to a higher degree than skeletal development, it is not entirely invulnerable. This caveat should therefore be kept in mind during any research that involves dental age.

The Combination of Methods and Other Age Estimation Considerations

Whether an age-at-death estimation is being calculated on a subadult or an adult, one should consider the different methods that can be employed for analysis, and the accuracy and precision of each. For the most accurate results in age-at-death estimation, multiple estimates should be combined whenever possible. In this way, errors are more likely to be revealed which can then be investigated further. For example, despite the fact that the age estimates calculated from long bone lengths can be at times inaccurate, by combining their estimates with those derived from an individual's dental development, there exists the possibility in revealing evidence of malnutrition or other environmental stress. Another important aspect to consider is the major role the overall preservation of the bones and teeth has in determining which method can be utilized. For example, the lack of complete skeletons found in the excavations of Pompeii severely limited the use certain ageing techniques. The fragmentary or incomplete nature of the osteological remains made it almost impossible to use standard multiple trait assessments on the skeletons (Lazer, 2011). Furthermore, one should not only consider the amount of time that will be required to undergo a particular method beforehand, but also the required equipment, along with the requisite precision, that will be needed to answer the question or questions being posed.

Diet and Nutrition in Roman Hispania

The analysis of humans remains is a topic of continuously increasing significance within classical bioarchaeology. This is due primarily to the fact that researchers have begun using the data derived from osteological remains in conjunction with evidence from archaeology, epigraphy, and historical texts for the creation of a comprehensive picture of the past (Killgrove, 2019). The

relationship between long bone length and nutrition has been analyzed in numerous classical studies (Bisell, 1988; Gowland & Garnsey, 2010; Lazer, 1995; Scheidel, 2010), but in order to develop a firm grasp on nutrition in Roman contexts, the integration of literary, epigraphical, and archaeological evidence is essential.

Modern Dietary Studies

From the study of diet, it is possible to thereby also derive information regarding a population's social and economic structure, overall health status, and the standards of living from that particular period (Mintz & Du Bois, 2002). Although changes in the dietary patterns of a population may be caused by historical events, such as invasions, draughts, or famine, they are instead more likely to be due to changes in their social, cultural, economic, or environmental conditions in which they lived (López-Costas & Müldner, 2016). The *communis opinio* (commonly held belief) on Roman society by most economic historians typically takes the assumption that it was a highly inegalitarian agrarian civilization, with the majority of the population being thought to work as rural peasants at a very low subsistence with poor diets consisting mainly of cereals (Lo Cascio & Malanima, 2009). This has, in turn, fed the belief that many of the individuals occupying Roman society were habitually nutritionally deficient. However, recent studies have advocated for the idea that the wages of the average Roman were likely sufficient, and citizens were often typically able to improve their financial position (Kron, 2018). Adequate wage stability would thereby imply that the nutritional availability was similarly accessible to the average individual. Institutional systems by the empire such as the introduction of bread at subsidized, low costs would have also helped a great deal in improving overall nutrition (Bakker, 2001). Despite these efforts, however, differences in dietary accessibility were surely present, as evidence shows from the biological remains of the individuals derived from this time

period. For this reason, anthropometric analysis is essential in the inquiry of dietary variation in a given population.

Research by Kron (2005) has demonstrated, for example, the importance that the study of anthropometry plays in assessing health in ancient populations in order to determine what the standards of living were at certain periods. His analysis consisted of compiling 49 different studies of late Iron Age and Roman era populations for the determination of the mean height from the adult male individuals in those samples. The results of his study showed that, although Roman era Italians shows some signs of under-nutrition, they were measured to have a mean height of 168 cm. Remarkably, this mean height would not be reached again until modern Italian populations in 1956 and gives an idea of the heights that can be achieved by well-fed individuals in an organized society (Kron, 2005). Kron's work highlights the fact that mean height is not only an excellent index of net nutrition in a population, but the close comparability between Roman and modern height facilitates any study in which stature is used to infer age.

Recent research by Killgrove and Tykot (2013) has suggested that there may have been significant differences between urban and suburban diets which would have in turn had an effect on the overall stature achieved between the two demographics. Dietary analysis from Roman skeletal samples dating to the 1st to 3rd centuries CE indicated that the two groups of people were utilizing different resources for their food. While the urban individuals were consuming more aquatic resources, the suburban individuals were making greater use of millet which was hypothesized to be a result of socioeconomic standing (Killgrove & Tykot, 2013). Similar dietary variation based on urban and suburban residence was found also by Cheung, Schroeder, & Hedges (2012) in a Roman Britain sample dating from the 1st to 5th centuries CE showing much of the same slight under nutrition in the suburban sample. These results may be attributed to fact that

poorer individuals in the suburbs were eating the foodstuffs available to them from the immediate area, while the wealthier in the urban centres could instead enjoy imported goods. Inquisitions on dietary variation such as those from the studies listed above demonstrate the variation that existed in Roman society, emphasizing the fact that there was in fact no single Roman diet. The fact that diet considerably varied geographically becomes more so evident when considering the sheer breadth of the Roman empire. This dietary variation, in conjunction with factors such as disease or physiological stress, no doubt influenced the nutritional levels of the populace, and therefore the extent to which their bones grew.

Dietary Analysis at the Necropolis of the Plaça Vila de Madrid

On the basis of macroscopic dental analysis, a small dietary inquiry conducted on the remains excavated from the necropolis of the Plaça Vila de Madrid offers a glimpse at the nutrition of the individuals from this cemetery. The adult remains, however, are the main focus, with little attention being made to the subadults. Based on the prevalence of caries and the degrees of dental wear among the adult sample, the individuals are suggested to have had diets high in carbohydrates and vegetables (Comín & Morera, 2007). Depositions of calculus on the teeth and recession of the alveolar bone were also inferred to indicate the presence of animal proteins (Comín & Morera, 2007). The study, despite suggesting that the diets were varied, does not provide any sort of indication to how prevalent a certain food may have been over another to provide some insight to nutritional levels. This is, however, a limitation a simple macroscopic dental analysis.

The inclusion of historical literary sources such as Cato, Varro, and Galen – poetry, prose, satires, epics – and documentary sources – epigraphical, papyrological – is an important aspect of conducting any study on diet, since they act as direct links to the time periods which are being

researched. A great deal of dietary information from the classical antiquity comes from these ancient texts, providing researchers with knowledge of the types of foods that were available, and the ways in which they were prepared. However, the simple listing of foodstuffs is not sufficient as it does not allow us to know to what extent particular foods were consumed, or how available they were to population as a whole. In this way, the coupling of independent sources such as anthropometric analysis, archaeological evidence, and historical literature yields an advantage in classical bioarchaeology, as it allows us to research the Roman diet, as opposed to simply just Roman foods. However, a caveat worth consideration in the combination of sources is to, as Beerden (2019) iterates, "...not fall victim to the so-called 'positivist fallacy' where we connect textual sources to archaeological ones, producing 'fallible connections'". To avoid this misinterpretation, she suggests that instead of the typical classicist approach of beginning their investigation endeavours with textual evidence, researchers change the order of their analysis beginning first with archaeological and then subsequently working toward literary sources (Beerden, 2019).

Roman History on the Iberian Peninsula

Pre-Roman History, a Brief Synopsis

Prior to Roman involvement, the Iberian peninsula had been occupied by a number of different societies and cultures, spanning back thousands of years. The long historical processes of the area have seen cultures such as the Phoenicians, Celts, Greeks, and Carthaginians among others contending with the natives for control over the region (Keay, 1988). Rome's involvement with the area began in 218 BC, in an effort to deter Carthaginian forces from moving toward Italy by disembarking at the Greek colony Emporion (Keay, 1988). This event subsequently signalled

the beginning of the Second Punic War which led to the Carthaginians eventually being expelled from the peninsula in 206 BCE (Keay, 1988). Between the 3rd and 2nd centuries BCE, Iberia thus began to undergo a drastic transformation through the introduction of road networks, towns, forts by the Romans. Moreover, the gradual implementation of a centralized government allowed for military peace and eventual assimilation of the native Iberian peoples into Roman society, who to that point had no tradition of central authority and would often engage in warfare among each other (Sutherland, 1971).

Barcino and its Foundation

The foundation of Barcelona traces back Augustus' declaration to the end of the Cantabrian Wars in 19 BCE. Having gained control over the northeastern side of the Iberian peninsula, the area acted as a base for further Roman conquests of the region. It was around this period that Barcino, Rome's second colony next to Tarraco, was settled by the Romans under the formal name Colonia Faventia Julia Augusta Paterna Barcino. The *coloniae* were the most important of the established Roman towns, as they acted as outposts in conquered areas. These settlements would be comprised of Roman citizens – commonly ex-military legionaries – who would have been granted individual plots of land for personal use (Keay, 1988). It was these settlements scattered across the empire that were largely responsible for the Romanization of foreign territories by spread of the Latin language, Roman laws, and cultural customs. The colonies saw the benefit of paying fewer taxes than the smaller municipalities, however they would be directly controlled by the state and therefore have less democratic freedom on how the city was run (Mackie, 1983).

Barcino was built in the typical *castrum* town style (fig. 6), with a central *forum* and two perpendicular main streets: the *cardus maximus* and the *decumanus maximus* which intersected at the Táber hill which would have been the site of the Iberian *Barkeno* settlement from where the

colony derived its name. Despite the fact that it was of considerably less importance than other settlements such as Tarraco and Caeseraugusta, the geographical situation of Barcino saw that it was a prominent centre for maritime resources, and later it would become a major centre for wine production by the 2nd century CE (Keay, 1988). Furthermore, its situation allowed a connection to the Via Augusta which further increased its development as an economic and commercial centre.

The characteristic city walls often depicted on representations of Barcino would not be built until the late 3rd century CE after raids to the city by Germanic tribes (Bowes & Kulikowski, 2005). In response to this, Claudius II ordered for the fortification of walls surrounding the colony, after which they stood up to eight metres high and included seventy-eight towers dotting the walls reaching heights of up to eighteen metres (Bowes & Kulikowski, 2005). The additions of these new reinforcements to the colony made Barcino the strongest city in the province, surmounting *Tarraco* in the South, which significantly increased its importance in the area.

Roman Funerary and Burial Customs

Analyzing skeletal remains is just one component of the complex study of funerary customs, which are also informed at an archaeological and cultural level. Before proceeding in analyzing each of the necropolises of the skeletal sample, it is necessary to briefly address some of the burial and funerary practices of Roman society in order to create a framework of reference for the treatment of the interred individuals and the specific practices within the necropoleis of Roman Hispania which will be analyzed.

Cemetery Placement

The corpses of the deceased, just as it is done today, were disposed of by the Romans in accordance to laws and regulations that were established by the state. An overarching belief at this

time was that separation should be made between the space for the living and that of the dead. As a result of this principle, burial and cremation were not permitted inside the confines of cities and towns, and cremation furnaces were particularly prohibited from being within 500 Roman feet of the city walls (Toynbee, 1982; Paulus, *Op.* i, 21, 2). Cemeteries were required to be outside the city walls of Roman settlements, beyond the sacred boundary known as the *pomerium* (Hope, 2007). Permission to be buried inside the *pomerium*, albeit exceptionally rare (see for example Cormack, 2004; Beltran de Heredia Bercero, 2008; Cicero, *De Leg.* ii 23, 58) was occasionally granted to particularly prominent and distinguished individuals (Toynbee, 1982). Wealthier individuals and families, however, would typically secure burials as close as they could to the city both as a symbol to their affluence and to increase the chance of their monuments being noticed (Toynbee, 1982). The law for extramural burial may have originally been developed from religious connotations, however Cicero writes that this decree derived from the mid-5th century BCE laws of the Twelve Tables was most likely instated as a means to protect the city from the risk of fire from cremations and the pollution resulting from the deceased (Cicero, *De Leg.* ii 23, 58). Epigraphic evidence proves that these regulations were in operation not only in the Italian peninsula, but also in the provinces. A town charter from the 1st century AD in Sevilla, Spain demonstrates that burials and cremations were not permitted within the city, and anyone who violated this law would be heavily fined accordingly (*ILS* 6087; Crawford, 1996).

Burial and Cremation

The treatment of loved ones after they had died was of great importance to Romans, and therefore a significant aspect of Roman identity was in the particular ways in which they disposed of their dead. Despite the fact that both Pliny the Elder and Cicero refer to inhumation as the most ancient form of burial rite, some of the earliest burials in Rome, which date to approximately 1000

BCE, are actually cremations (Carroll, 2006; Cicero, *De Leg.* ii 22, 55-57; Pliny. *Nat. Hist.* vii, 54, 187). The Laws of the Twelve Tables provides evidence that both cremation and inhumation were practiced contemporaneously in the 5th century BCE by Romans (Cicero, *De Leg.* ii 22, 56). Lucretius, writing in the 1st century BCE, states that during the Late Republic, the bodies of the deceased were known to be buried, cremated, or embalmed (Lucretius, *De Nat.* 3, 870-93). Although embalmment was the not nearly as extensively practiced as cremation and burial, some of the most well preserved remains ever excavated from Roman contexts are a result of this ritual (Toynbee, 1982). By the 1st century AD, however, cremation becomes the most commonly practiced rite across the empire (Toynbee, 1982). Tacitus, during this time, in fact refers to cremation as the “Roman custom” (*Romanus mos*) (Tacitus, *Ann.* xvi, 6). Indigenous populations of the conquered territories along with some older Roman families, however, are recorded to have continued interring their deceased. A notable example of this is the Gens Cornelia which buried their dead until Lucius Cornelius Sulla, who, after exhuming and desecrating the grave of Gaius Marius, became paranoid for his own grave desecration and requested to be the first cremation of his family line (Cicero, *De Leg.* ii 22, 55-57). The reasons for cremation’s rise in popularity are still largely unknown, however both Pliny and Cicero have written that Sulla’s precedent, given his influence, along with worries of grave desecration by the masses may have played a prominent role in its rise (Cicero, *De Leg.* ii 22, 55-57; Pliny, *Nat. Hist.* vii, 54, 187).

Burial began to overcome cremation in popularity in the early 2nd century CE in Italy to which it spread to the provinces (Hope, 2007). Until this time, it was used only sparsely throughout Italy, however it was the predominant funerary mode in the east, most notably in Greece. Petronius, in fact, describes inhumation as “in the Greek manner” (*Graeco more*) (Petronius, *Satyr.* 111, 2). By the 3rd century CE, it was almost universally practiced throughout the empire (Morris, 1992).

The reasons for this change are not fully understood, however it has been in the past attributed to a change in fashion, rather than any sort of change in moral or religious beliefs (Morris, 1992). For instance, the high esteem Roman elites and emperors possessed for Greek culture in the 2nd century CE is likely to have had some effect for its appropriation into Roman culture.

Tombs and Monuments

Any individual with the appropriate amount of money could mark their grave with a tombstone or monument. These funerary structures, corresponding to Roman customs, would often line the routes that lead to and from towns so that passing travelers had the opportunity to honour the dead (Toynbee, 1982). Many of the structures consisted of inscriptions aimed at the travelers, often recounting the lives and accomplishments of the deceased, and frequently expressed greetings and good wishes for those who stopped to read their *epitafium*. In this way, a traveler, when passing the burials, could stop and read the funerary inscriptions on the structures so that deceased would not be forgotten.

Funerary monuments varied significantly in size, shapes, and scale depending on the wealth of the purchaser. Humble graves of the poorer demographic of society could consist of simple wood or pottery markers, indicating that they sought to maintain a level of dignity in death. The graves of the wealthy, however, had endless possibilities, taking on the extravagant shapes of houses, benches, and temples among many others. *Stelae*, slabs of stone that were placed upright into the ground, represent one of the most common funerary markers suggesting that they were the middle ground of funerary markers. An important aspect to consider is that tombs differed throughout the empire, varying in style, decoration, and material. Roman Britain and the north-west provinces, for example, are characterized by their use of stone barrows (Toynbee 1982), while the barrel-shaped *cupae* are unique to Spain and some North African settlements (Tupman, 2005).

The process in which an individual with little financial resources acquired the land necessary for their burial is still not entirely clear. Individuals with rural property may have chosen to be buried there, however urban dwellers without a means to purchase a plot of land would instead most likely be dependent of the generosity of others to see that they had proper post mortem accommodations (Hope, 2007). However, when a plot of land was secured, it was a valuable asset and often they would be made into family tombs (Hope, 2007; Toynbee, 1982). Alternatively, individuals could join groups known as *collegia* to which they would regularly contribute in order to ensure that their own funeral was properly funded (CIL XIV 2112, 20-41).

Analysis of the Necropoleis

The Necropolis at the Plaça Vila de Madrid

Location and Chronology

The archaeological site located at the Plaça Vila de Madrid correlates to a Roman necropolis along a sepulchral road which, based on the ceramic elements recovered, was used between the middle of the 1st and the beginning of the 3rd centuries AD. After this period, the area would go practically unused until the end of the middle ages (Busquets & Pastor, 2005). The necropolis would have bordered the road that would have led to the Northern gate of the city and would have been located North-West of the Ibero-Roman colony of Bàrcino, outside of its city walls, corresponding to Roman regulations surrounding necropolis locations (fig. 7). The necropolis would have been somewhat distant from the city (approximately 1480 Roman feet) which indicates that it was most likely used by poorer individuals derived from more humble backgrounds.

Recovered Archaeological Materials

The excavation efforts at the Plaça Vila de Madrid necropolis has led to the recovery of an array of archaeological materials both from the tombs themselves, and the surrounding stratigraphy of the site. The objects that accompanied the individuals were typically very simple, and in some cases the inclusion of materials was entirely absent which further supports the argument that these individuals were derived from humble backgrounds. Ceramic vessels were the most commonly found items in the burials, typically *Terra Sigiliata* of Italic, Hispanic, and Gallic workshops, African cooking ceramics, and local productions (Beltran de Heredia Bercero, 2007). In burial contexts, they were often found to be placed beside the head of the individual, by their knees, or on their lap (Busquets et al., 2004). Simple glass vessels, typical to Roman funerary contexts, were also found on multiple occasions. The water drop shaped vessels are known as ‘lacrymatories’ which is derived from the Latin word *lacrima* meaning ‘tears’, relating to the tears that would have been shed by the family and friends of the deceased (Beltran de Heredia Bercero, 2007).

Objects attributed to the clothes of the deceased were scarcely found; only several bronze pieces that have been thought to be from shoes, some simple bronze bracelets and rings, and some small bells associated phallic amulets known as *tintinnabulae* (Busquets et al., 2004). The *tintinnabula* would be affixed to children’s attire, either as a pendant of bracelet and their sound was believed to ward off evil (Beltran de Heredia Bercero, 2007).

One particularly notable find is that of a silver pendant found to be hanging on the neck of a young girl (A672). This piece of jewelry was reserved to be worn only by children and would be known as *bulla* when given to boys, or a *lunula* for girls (Graumann, 2016). They served a protective purpose for bringing good luck and warding away any evil that might come to individuals wearing them (Graumann, 2016). As an example of a ‘social age’ in Roman context, when children reached a certain age, they would offer the amulet to the gods as a symbol that they

were leaving childhood and entering adolescence with boys offering theirs to the *Lares* or to Hercules, while girls would offer theirs to Juno (Beltran de Heredia Bercero, 2007).

Iron nails were a reoccurring item in the interments, having been found in eight graves, often times in multiples. The simplest answer to their presence is that they served a functional purpose, as a means of affixing the wooden containers in which the deceased were placed. However, no more than a few were found at a time, which would not have been enough for the construction of a coffin. They have been, however, interpreted in several different ways, perhaps holding a ritualistic value to protect the dead from bad luck (Vaquerizo, 2001), or as a means to fix the dead to the ground so to prevent them from returning to world of the living (Ceci, 2001; Castanyer, 2003). There is also a possibility that they held a religious value as a symbol for Christianity due to the use of iron nails in the Crucifixion of Christ (Dungworth, 1997).

Funerary and Burial Evidence

The Plaça Vila de Madrid necropolis is characterized by the appearance of both cremation and burials. A total of 52 burials were excavated, of which, 45 were interred in simple pits without any type of container. This evidence, or lack thereof, provides strong indication that the inhumed inhabitants were derived from lower socioeconomic statuses who could not otherwise afford more elaborate burial accommodations. Five of the recorded burials were interred in *tegulae* containers, arranged both in box formations (fig. 8), and in gable-wise arrangements (fig. 9). Additionally, there was one child of approximately 1.5 years of age found to be buried in an *amphora*, and, quite curiously, a single adult was uniquely buried within what has been regarded as a ‘ritual silo’ (Comín & Morera, 2007).

A particularly notable aspect of the Plaça Vila de Madrid necropolis is that it was used very nearly to its maximum capacity, to the extent that some of the newer burials were superimposed

on the older. This density resulted in some of the osteological and archaeological material to become intermingled over the course of nearly two millennia of stratigraphical change. Another explanation for this mixture of material, however, could be that it is instead the result of burial plots either being reused, or successive family members being added to the tombs of their predecessors, perhaps to alleviate the costs of buying a new plot of land to bury their loved ones.

A particularly interesting note is of the 52 interred individuals at the necropolis, slightly over 73 percent (n=38) were found to be buried so that their head was oriented facing either directly east, northeast, or southeast. Of these 38 individuals, 18 have been determined to be subadults, 14 adults, and 6 of unknown age. Inversely, 23 percent (n=12) were instead found to be with their head oriented either west, northwest, or southwest. Of this number, 4 were subadults, 6 adults, and 2 were of unknown age. Finally, 1 subadult was found with their head oriented south, and the remaining individual, who was of unknown age, was found buried directly north. The clear bias for eastern burial orientation at the Plaça Vila de Madrid necropolis corresponds with Christian traditions, who buried their dead to face where the sun is born as it represents a symbol of rebirth to the afterlife they anticipated (Herrán & Hernando, 2012; Thomas, 1981).

The excavated area of the Plaça Vila de Madrid comprised of a total of eight instances of cremation. Of these cases, seven were simple incineration pits in which the remains deposited. One ceramic urn was also found however that, based on its style and the stratigraphy it was found, has been dated between the end of the 2nd century and the beginning of the 3rd CE (Busquets et al., 2004). Six of the cremations were estimated to have been from adult individuals, while one was estimated to have been a young person, and the other was indeterminable. The destructive nature of cremation, however, means that the possibility exists that subadult remains are present, but are

simply indistinguishable. Like in the inhumations, Charon's payment was found also in some of the cremation urns to fund their voyage into the afterlife (Beltran de Heredia Bercero, 2007).

Funerary Monuments

A total of five types of memorial structures (fig.10) were found during the excavations of the necropolis: *cupae*, *aras*, *steles*, conical *tumuli*, as dubbed by Duran and Sanpere (1963), and two-stepped bases, which are suspected to have contained an *ara* or *stela* at one point in time. Other, more modest funerary monuments such as stone piles to indicate a location where an individual was interred were sure to also have existed, though were not recorded to be found during the early excavations. These structures, conforming to Roman customs, would have lined the sepulchral route.

The semi-cylindrical monuments known as *cupae* are of particular significance as the Plaça Vila de Madrid is the only site in which they have been found *in situ* (Tupman, 2005). Five *cupae* were recovered from the excavations along with nine roughly semi-cylindrical masonry tombs (Busquets et al., 2004). The *cupae* derive their name from a funerary inscription found outside of Barcelona (Fabre et al., 1997: no. 219;):

D(is) M(anibus) Valerio Melippo Caelia Quartula fecit patri cupa(m) bene mer(enti)
et Caelia Saturnina uxor m(arito) o(ptimo)

‘To the spirits of the departed. To Valerius Melippus, Caelia Quartula set up the cupa for her well-deserving father, and his wife Caelia Saturnina (set it up) for her excellent husband.’

Cupa, however, is the Latin term for “barrel” which implies that they are stone representations of wooden objects. These monuments are thought to have originated in the North-African Roman

colonies but have been found throughout the Iberian Peninsula in locations such as Barcino, Merida, Tarragona, Zaragoza, and Sintra (Tupman, 2005; Vaquerizo, 2006). There have been many studies conducted on this particular grave marker (Julià, 1965; Bonneville, 1981; Tupman, 2005), and, corresponding to other evidence derived from the necropolis the Plaça Vila de Madrid, they are usually associated with freed men, slaves, the children of freed men, or people with a general humble background. Despite their name, only one *cupa* in Barcelona was found to have a hollow compartment inside (like an actual barrel) unlike those found in Sintra which were used as containers for the ashes of the deceased. All those that were found at the Vila de Madrid necropolis instead acted only as coverings for the tombs they denoted (Tupman, 2005). A notable aspect of the *cupae* found at the Plaça Vila de Madrid is that some include Christian iconographic elements such as the Chi-Rho, and pigeons (fig.11; Beltran de Heredia Bercero, 2007). Furthermore, similarly inscribed *cupae* used by Christians have also been found in Tarragona and Zaragoza (Izquierdo, 2008; Vaquerizo, 2006). The appearance of this iconography provides confirmation that Christianity was likely the reason for the predominantly east-oriented burials.

Spatial Organization of the Necropolis

By analyzing the layout of the necropolis and the location in which each interred individual was found, there appears to be no particular organization by sex or age, however there does seem to be a distinct separation between burials. As mentioned above, a notable aspect of the necropolis is that subadults are found in all areas of the necropolis. This is significant with respect to neonatal individuals as they would often be buried in domestic contexts, instead of in formal cemeteries (Hope, 2007). The seemingly unorganized distribution of individuals can be interpreted by two different explanations: either the inhabitants of the area dug a new grave whenever necessary based on the available space, thereby mixing the different age and sex groups, or instead graves were

dug for kinship reasons with men, women, and children being buried in particular areas due to familial relations. Despite the plausibility of this second explanation, it could only be determined by the employment of a palaeogenetic study of the site.

The Necropolis at the Santa Caterina Market

Location and chronology

The necropolis located at the Santa Caterina market would have been, in its time of use, North-East of the Barcino colony. Its situation would have been approximately 200 metres, or 675 Roman feet, from the city walls, making it relatively close to the city. Its proximity to the city may indicate an elevated socioeconomic status in comparison to that of the Vila de Madrid, as closer cemeteries were more desirable and therefore required more wealth for access (Toynbee, 1982). The necropolis would have been adjacent to the branch of the Via Augusta that left Porta Principalis Sinistra gate at the Eastern end of the Cardo Maximo which, today, is currently the Plaza de l'Àngel (fig. 12). This important connection would have been crucial for trade and transport as it was the main road that linked Barcino to other important cities in the Iberian Peninsula meaning it would have received many travelers passing by frequently, further increasing its appeal.

Spatial Organization of the Necropolis

The necropolis occupies a preserved area of approximately 1,350 square metres. A notable aspect of the necropolis is the use of mortar, stone, and ceramic elements to divide the space in which the individuals were interred. As a result of this of this clear division, we see two well-defined areas, both by location and by interment typologies, which have been named zones A and B (fig. 13). There is a row of burials that draw a clear boundary line dividing zones A and B. The

appearance of this division has been hypothesized to be indicative of a change in ownership which would have in turn resulted in a shift in spatial organization (Aguelo Mas & Huertas Arroyo, 2009). The burials of the necropolis don't seem to overlap which would have implied that some sort of method external signaling would have been in place like the funerary monuments found at the Vila de Madrid, so not to accidentally exhume previously buried individuals. However, no evidence of funerary markers have survived due to the construction of a convent in the 12th century CE (Aguelo Mas & Huertas Arroyo, 2009).

Zone A on the northern-most side of the necropolis is comprised of only simpler burials with no appearance of any types of physical structures. In zone B on the southeastern side of the necropolis, we see instead the appearance of complex funerary structures. It is the presence and appearance of these more grandiose funerary structures that is particularly notable, as it signifies that this necropolis would have been of relative importance, containing individuals with above average wealth. Moreover, this particular zone would have been located closer to the road during its time of use which may have been sign of prestige as its proximity would have meant a higher likelihood of being noticed. The clear demarcation noted between the more elaborate burials and the simpler further reinforces this differentiation between different social classes or at the very least, economic differences.

Funerary and Burial Evidence

The Santa Caterina necropolis was comprised of a mixture of both simple burials and more elaborate funerary structures. Interestingly, there were not reported instances of cremation within the necropolis. This however is in line with the fact that burial was predominantly practiced the empire after the 3rd century CE. The burials of zone A were all relatively simple, with the appearance of simple pits, amphorae, gable-wise *tegulae* tombs, and box formation *tegulae* tombs.

All burials in this area were found to be positioned either northeast-southwest, or southeast-northwest and were all found to be positioned so that they were laying in a supine position with their hands either on their waist or hips; the five amphorae burials however were positioned primarily in the fetal position. The orientation in which the individuals were interred in zone A may be ascribed to a religious motive, particularly Christianity, though no other evidence to indicate this religious alignment has been recovered (Aguelo Mas & Huertas Arroyo, 2009). Zone B instead was comprised of several simpler burials like those found in zone A, along with some funerary structures of a more elaborate typology. These structures, although damaged by the construction of the foundations of a convent built in the 13th century, contained some preserved coloured pictorial decorations made from panels that mimic a thinly sliced stone motif known as *opus sectile*. Interestingly, the structures seem to have been labeled with Roman numerals for designation and identification purposes during their time of use.

Materials Recovered

A series of amphorae belonging to the Keay typology from the excavation of the site. These ceramics are of a very simple typology and date between the end of the 3rd century and the first half of the 5th century AD. Scrutiny of the reports does not explicitly indicate any materials found in the excavation of this particular time period aside from apart from a single simple die made from bone.

Data Analysis

Methods

The osteological data was collected at the collection facilities of the Museum of the History of Barcelona in accordance to the standardized methods devised by Buikstra and Ubelaker (1994).

Of the long bones, one femur and one tibia were measured and analyzed from each individual. All available dentition was recorded and macroscopically analyzed for any appearance of linear enamel hypoplasias. Additionally, some aspects of the cranium, when intact, were also surveyed for other palaeopathologies: the roofs of the eye orbits were examined for any indication of cribra orbitalia, and the ectocranial surface was examined for any instance of porotic hyperostosis.

Age estimates for each individual were derived through two means: maximum long bone lengths, and dental eruption stages. The dental age estimations were calculated with the London Tooth Atlas of Human Tooth Development and Eruption (2010). This comprehensive guide very clearly demonstrates the progressive stages of human dental eruption starting at 38 weeks in-utero, up to 23 years of age (fig. 14). The significance of the Atlas for deriving age estimates comes from the fact that it uses short intervals for the first year of life when changes in dental development and eruption are occurring at accelerated rates. Age categories of one month are used for the last trimester, two weeks perinatally, three-month intervals during the first year, and then one-year intervals thereon. The dentition, when available, was assessed for each individual in the samples with analysis being made to the level of apical closure and crown development, root resorption, and stages of tooth eruption through the alveolar bone for both single and multirrooted teeth. Analysis of these criteria yielded a dental age value for each individual, with an error range of up to one year in the older individuals.

The long bone age estimations were calculated using the maximum length measurements of each femur and tibia which were applied to the regression formulae derived by Cardoso, Abrantes, & Humphrey (2014). Due to the expeditious nature of human growth in the first two years of life, two separate formulae were devised: one for individuals below two years of age, and

another for those above two years. The age values were calculated with a 95% confidence interval upon the application of the appropriate standard errors.

The values from the dental age estimates were compared to the estimates derived from the tibiae and femora separately, each with a “below two years of age” comparison, and an “above two years of age” comparison. Individuals who were calculated with their age to be approximately two years were included in both age group comparisons to avoid misplacing them. Age estimates were overlaid on a scatterplot to reveal any underlying discrepancies between the values. A significant difference in values may indicate that a particular individual suffered from environmental stress which would have led to a retardation in long bone growth. Additionally, the age values derived from the tibiae were compared to those derived from the femora to look for indication of tibial plasticity, a phenomenon in which the tibiae will slow their growth in the face of nutritional stress to allocate those nutrients to more vital areas of the body, such as the brain (Scheuer, Black, & Christie, 2010).

The information derived from comparing the calculated age values were consolidated with supplementary information such as estimated sex, macroscopic evidence of palaeopathologies, material evidence included with their burial, burial orientation, and manner of interment. This was done in order to examine whether instances of compromised growth could be correlated to any particular factor to elucidate any trends or notable circumstances within the data.

Results

A comparison of the age values calculated from the femoral (figs 15 and 16) and tibial lengths (figs. 17 and 18) to those calculated from the London Tooth Atlas showed compromised growth in a considerable portion of the individuals in both the younger and older age categories of

the Vila de Madrid and Santa Caterina samples.¹ An interesting case that runs counter to the rest of the sample can be seen in individual A836, whose skeletal age was calculated instead to be above their dental age.

The assertion that the majority of the individuals within the sample suffered from compromised growth can be asserted also by the fact that eight of the seventeen individuals also show the appearance of cribra orbitalia or linear enamel hypoplasias. The presence of these palaeopathologies indicate that for a period of time in their lives, the individual suffered a period of stress. Additionally, in the individuals who had both the femur and tibia available for analysis, the comparison of ages estimated by each bone length showed that 4/4 of the individuals calculated to be over two years of age (fig. 19), and 6/11 of the individuals under the age of two (fig. 20) had a tibial age lower than their femoral age. Based on what we know about the greater plasticity that the tibia has in comparison to the femur in regard growth rate in the face of nutritional stress, we can see that this is reflected in some of the individuals within these samples. This evidence might be an indication to further support the argument that some of these children suffered environmental stress that lead to both their compromised growth and premature deaths.

In the examination of differential long bone lengths and dental versus skeletal age estimates with respect to sex using the sex estimates established by the Museum of the History of Barcelona, no disproportionate representations were found, suggesting the levels of environmental stress were comparable between males and female children in this sample. However, this analysis did reveal that there existed a considerable imbalance in mortality between male and female representation with respect to age. Of the individuals with an estimated sex, 7/10 of those estimated to be under

¹ A mention must be made to the fact that several individuals were included in both the younger and older age categories. This is because their age was estimated to be approximately two years with the London tooth atlas. Since they could not be confidently placed in one category or the other, they were included in both.

2 years of age were female (fig. 21), while only 1/4 were estimated to be female in the older than 2 years category (fig. 22).² The overrepresentation of females under the age of two may reflect cultural preference for males. As a patriarchal society, Roman families may have committed more investment into their male children over their female children in times of hardship. This preference may have then led to higher female mortality during their most fragile period of life. It must be remembered, however, when considering this data that sex estimation in juveniles is generally not as reliable as in older individuals. It must be mentioned, however, that sex estimation methods among juvenile individuals are still quite unreliable. This analysis was conducted with the Museum of the History of Barcelona's sex estimations and, based on which method they used to attain these results, they may be misrepresentative to the actual distribution of sex in these samples.

Discussion

With the results of this study, I argue that the majority of the individuals from these two samples suffered some manner of environmental stress that influenced their overall growth, and possibly contributed to their premature deaths. This argument can be further supported when taking into account the archaeological evidence of the site. First is the location of the cemeteries, which, considering their distance from the city, suggest that they were primarily utilized by individuals of more humble backgrounds. Next are the types of burials, which primarily constitute simple pits, or crude *tegulae* tombs. Lastly are the archaeological materials, which are consistently modest with the exemption of individual A672 who had a silver pendant interred with them. A single piece of jewelry, however, is not strong evidence that they were not indeed derived from a lower socioeconomic status. With consideration being made to Barcino's history, the chronologies

² It must be noted that that individual A672 was included on both age estimations as their age was calculated to be too close to two years to confidently place them in one single category. Interestingly, their sex was estimated to be female, meaning if she was in fact under two years of age, males would comprise 100% of the 'over two years' category.

of the cemeteries correspond also roughly to the time in which the city increased its fortifications. The invasions that lead to these fortifications may have had some influence on the overall levels of stress in the city and in turn also the mortality rates.

In regard to the presence of palaeopathologies, a mention must be made to two of the issues raised by the osteological paradox (Wood et al, 1992) when making conclusions in bioarchaeology, particularly that of *selective mortality* and *differential frailty*. Differential frailty takes into consideration the fact that everyone responds differently to a given disease, and while some will die, others will survive. The fact that several of the individuals in these samples do not show any macroscopic indication of palaeopathologies but do show compromised growth is expected. Universal patterning should not to be anticipated since it takes longer for pathologies such as cribra orbitalia and linear enamel hypoplasias to develop on the skeleton in comparison to the amount of time it takes for growth to become compromised (Cardoso, 2007). Selective mortality instead asserts that despite the fact that several of the individuals within this sample do not show any macroscopically visible indication of these particular palaeopathologies, that does not necessarily mean that they were healthy. In reality, it may indicate that they were the *least* healthy of the group, as they were the ones who did not survive an acute encounter with some type of stress. The individuals that show evidence of palaeopathologies in the samples from the Vila de Madrid and Santa Caterina necropoleis instead could be considered to be the more robust of the group, as they were the individuals who survived a chronic stress which subsequently materialized on their skeleton. It must be remembered, though, that these samples are comprised of children who died as children, thereby failed to thrive.

Due to the fact that pathologies typically take time to develop on the skeleton, the neonatal individuals who show signs of possible palaeopathologies or compromised growth allow comment

to be made on maternal health. Having not been alive long enough for these pathologies to have developed outside of the womb, it is likely that the mothers of these children suffered from malnourishment or other stress during gestation. Their deficiencies were then translated to their babies as a result of not being able to provide them with the necessary amount of nutrition for adequate growth and nutritional store development in utero.

A particular caveat to consider with the interpretation of the ages calculated from long bone lengths is the fact that they were calculated using formulae derived from a 19th century collection of Portuguese human skeletal remains, the Lisbon Collection, and then applied to a Roman sample. Despite the temporal distance between these two populations, there is a tighter population control considering that they are both derived from the Iberian peninsula, rather than a completely geographically separated population, for example Australian aborigines or North American indigenous populations.

As mentioned earlier in this paper, despite the fact that teeth are robust in the face of malnutrition, they do in fact show some plasticity. However, they are not as susceptible to growth delay as the skeleton is. Therefore, teeth still act as good indicators of age though this issue should be considered when assessing individuals derived from lower socioeconomic statuses, as is most likely the case in samples analyzed in this study.

Conclusion

This study used two methods of age estimation in order to infer the overall health of two samples of children derived from Roman Barcino. Long bone age estimations were derived using formulae derived by Cardoso, Abrantes, & Humphrey (2014), while dental age estimates were calculated using the London Atlas of Human Tooth development and Eruption (Alqahtani, Hector, & Liversidge, 2010). Through the examination and comparison of these two age estimations, the

studied juvenile individuals from the Praça Vila de Madrid and Santa Caterina necropoleis showed considerable signs of compromised growth in their lower limbs, namely the tibiae and femora. The additional consolidation of archaeological materials and burial contexts suggests that these individuals were most likely derived from lower socioeconomic statuses, and therefore they were most likely subject to environmental stresses that resulted in their growth to be compromised. Whether this stress was physiological, psychological, or nutritional cannot be determined without further analysis of these individuals. However, considering the dietary evidence from the Praça Vila de Madrid and the various instances of palaeopathologies in both samples, there is a strong indication that nutritional deficiency played a significant role in the compromised growth in these two samples.

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Figures

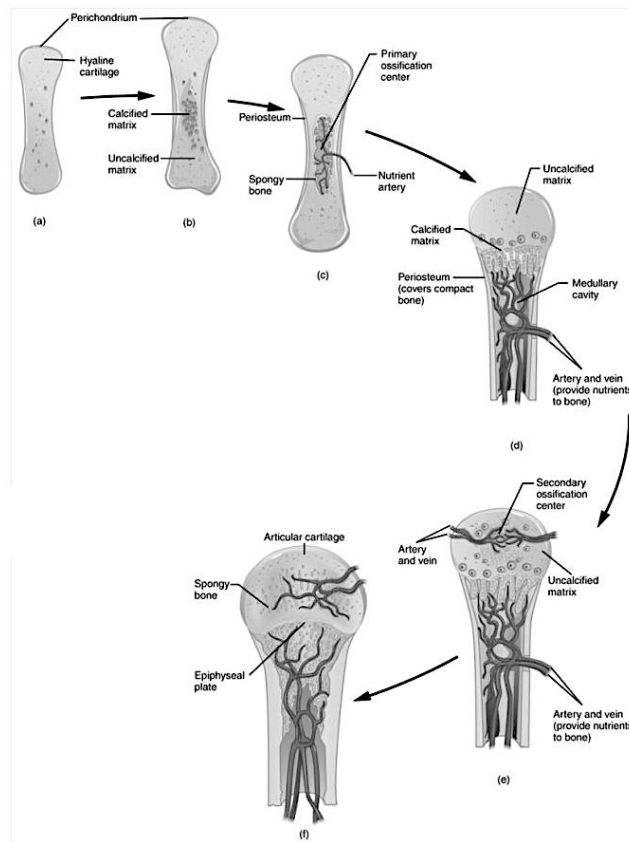


Figure 1. The Process of endochondral ossification in long bones which follows five steps: (a) Mesenchymal cells differentiate into chondrocytes that produce a cartilage model of the future bony skeleton. (b) Blood vessels on the edge of the cartilage model bring osteoblasts that deposit a bony collar. (c) Capillaries penetrate the cartilage and deposit bone inside cartilage model, forming a primary ossification centre. (d) Cartilage and chondrocytes continue to grow at the ends of the bone while the medullary cavity expands and remodels. (e) Secondary ossification centres develop after birth. (f) Hyaline cartilage remains at the epiphyseal (growth) plate and at the joint surface as articular cartilage. From *Anatomy & Physiology* (p. 351), by OpenStax College, 2013, Houston, TX: OpenStax.

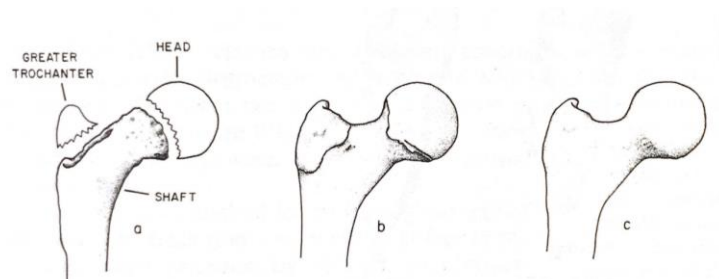


Figure 2. The three stages of epiphyseal union exemplified in the femoral head., a, nonunion; b, partial union; c, complete union. From *Human Skeletal Remains: Excavation, analysis, interpretation* (p. 75), by D. H. Ubelaker, 1999, Washington: Taraxacum.

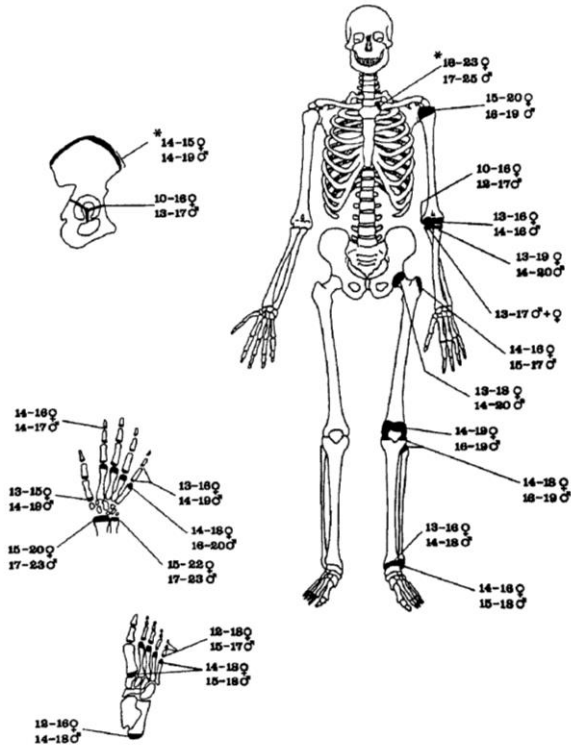


Figure 3. Epiphyseal fusion. The lower ends of the age ranges are the ages at which fusion of epiphysis to diaphysis was first noted, the upper ends those at which completely unfused epiphyses were last noted. From *The Archaeology of Human Bones* (p. 58), by S. Mays, 2010, New York: Routledge.

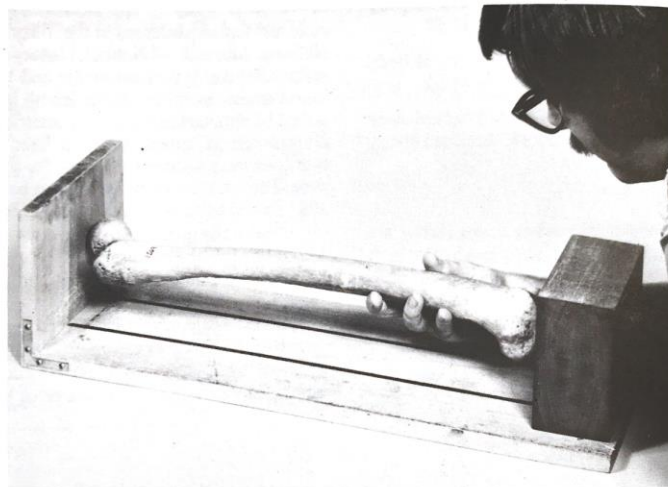


Figure 4. Measuring the maximum length of a femur with an osteometric board. The black lines are the scale; the vertical left board is fixed permanently, while the right is moved to determine the length of the bone. From *Human Skeletal Remains: Excavation, analysis, interpretation* (p. 62), by D. H. Ubelaker, 1999, Washington: Taraxacum.

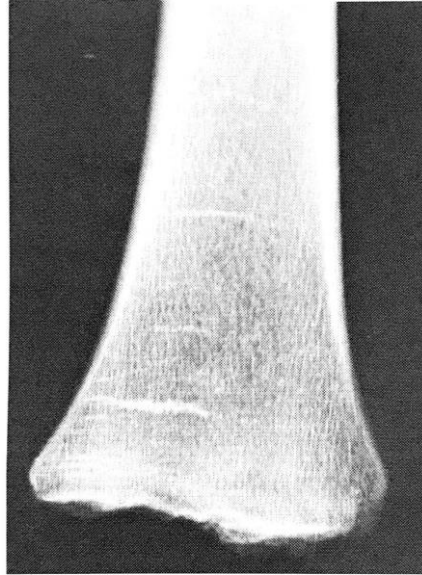


Figure 5. A series of radiopaque Harris lines on the distal tibia of a subadult from later medieval St.-Helen-on-the-Walls in York, England. From *Paleopathology of Children* (p. 272), by M. E. Lewis, 2018, London: Academic Press.

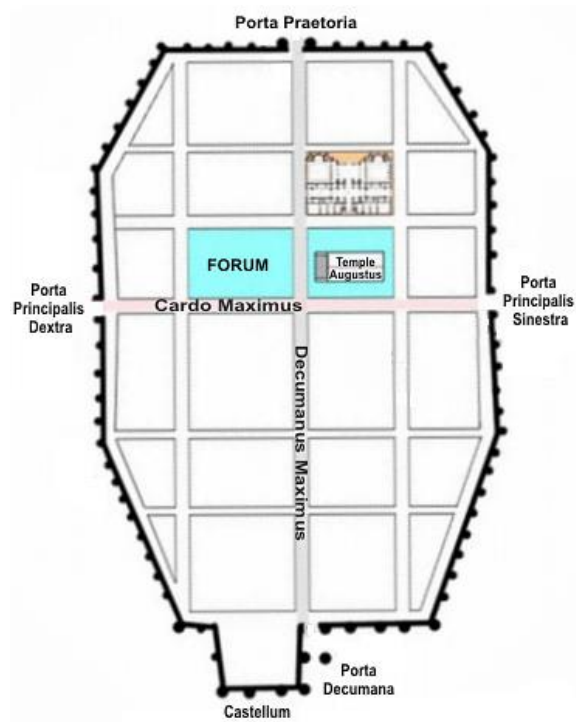


Figure 6. Roman Barcino in the *castrum* style plan with the *Cardo Maximus* and *Decumanus Maximus* intersecting at the forum. From <https://www.barcelonayellow.com/bcn-photos/427-pictures-roman-walls-barcelona-barcino>. Copyright (2011) by Barcelona Yellow.

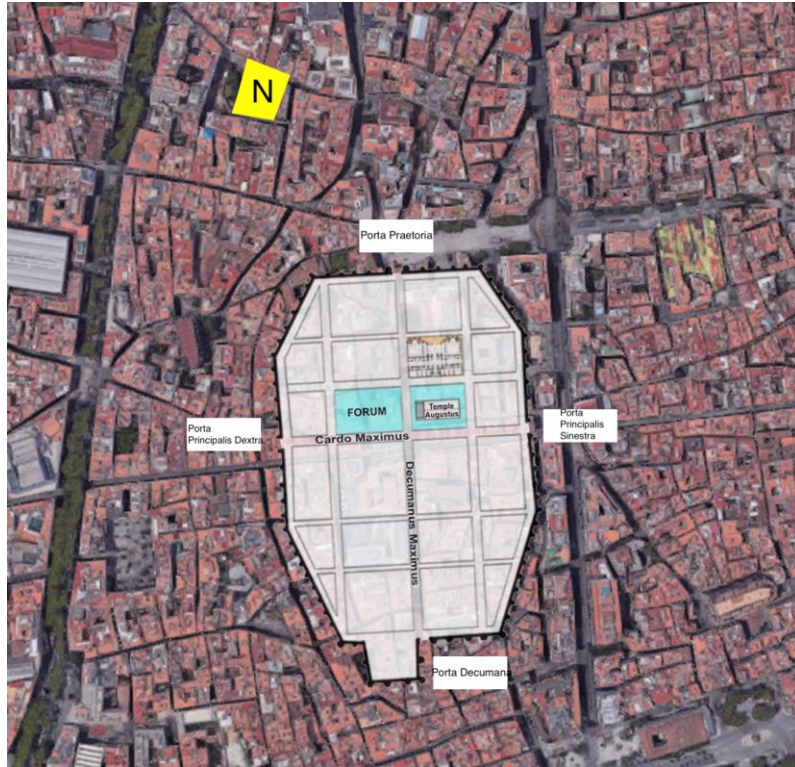


Figure 7. Roman *Barcino* overlaid on modern Barcelona. "N" denotes the location of the necropolis of the Plaça Vila de Madrid with respect to the city.



Figure 8. *Tegulae* (roof tiles) and *imbrices* (semi-cylindrical covers) arranged into a box to be used a crude coffin. From <https://hiveminer.com/Tags/death%2Cromano>.



Figure 9. Tegulae and imbrices arranged gable-wise to be used as a crude coffin. From *Death and Burial in the Roman World* (p.69), by J. M. C. Toynbee, 1982, London: Thames and Hudson.



Figure 10. The different types of funerary monuments found at the necropolis at the Plaça Vila de Madrid: (1) *Cupa*, (2) *Ara*, (3) *Stele*, (4) Two-stepped monument, (5) Conical *tumulus*. From *La "via sepulchralis" de la plaza Vila de Madrid: un ejemplo del ritual funerario durante el Alto Imperio en la necrópolis occidental de "Barcino"*, by J. Beltran de Heredia Bercero (2007).



Figure 11. Christian iconographic elements included on funerary monuments. From *La "via sepulchralis" de la plaza Vila de Madrid: un ejemplo del ritual funerario durante el Alto Imperio en la necrópolis occidental de "Barcino"*, by J. Beltran de Heredia Bercero (2007).

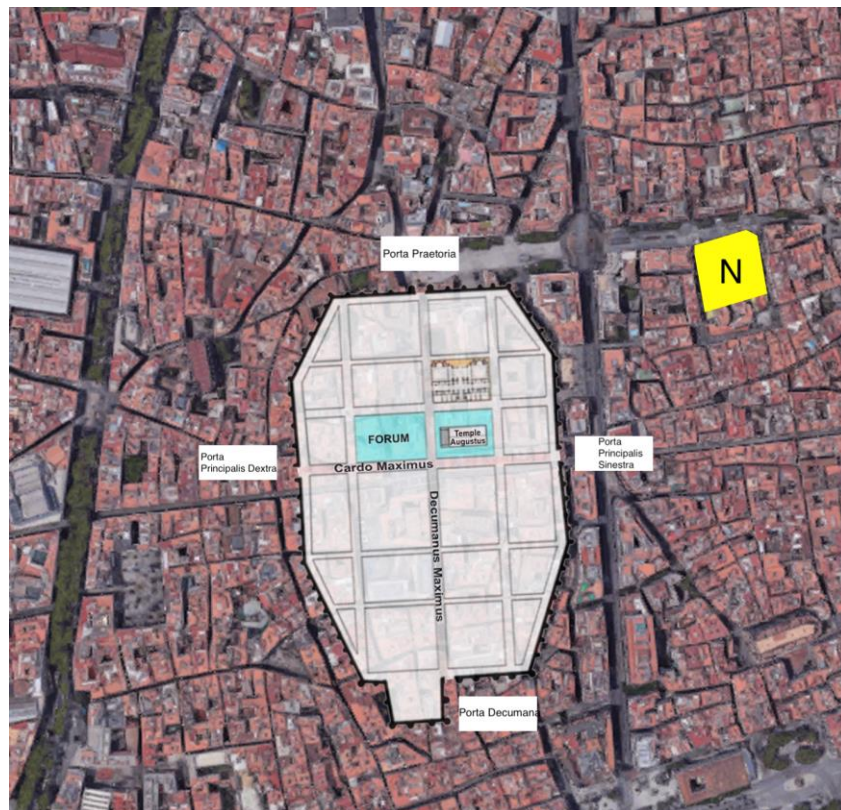


Figure 12. Roman *Barcino* overlaid on modern Barcelona. "N" denotes the location of the Santa Caterina necropolis with respect to the city.

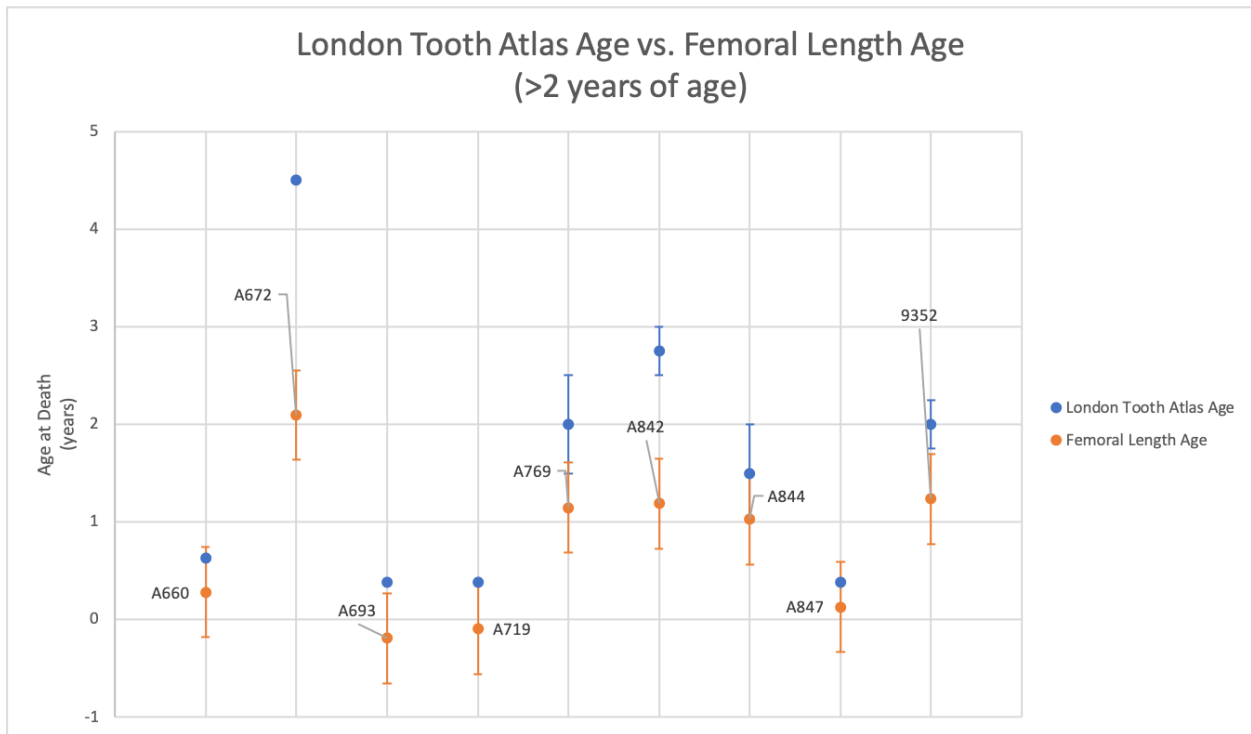


Figure 15. Dental age estimates compared to femoral age estimates for individuals calculated to be *under* two years of age.



Figure 16. Dental age estimates compared to femoral age estimates for individuals calculated to be *over* two years of age.

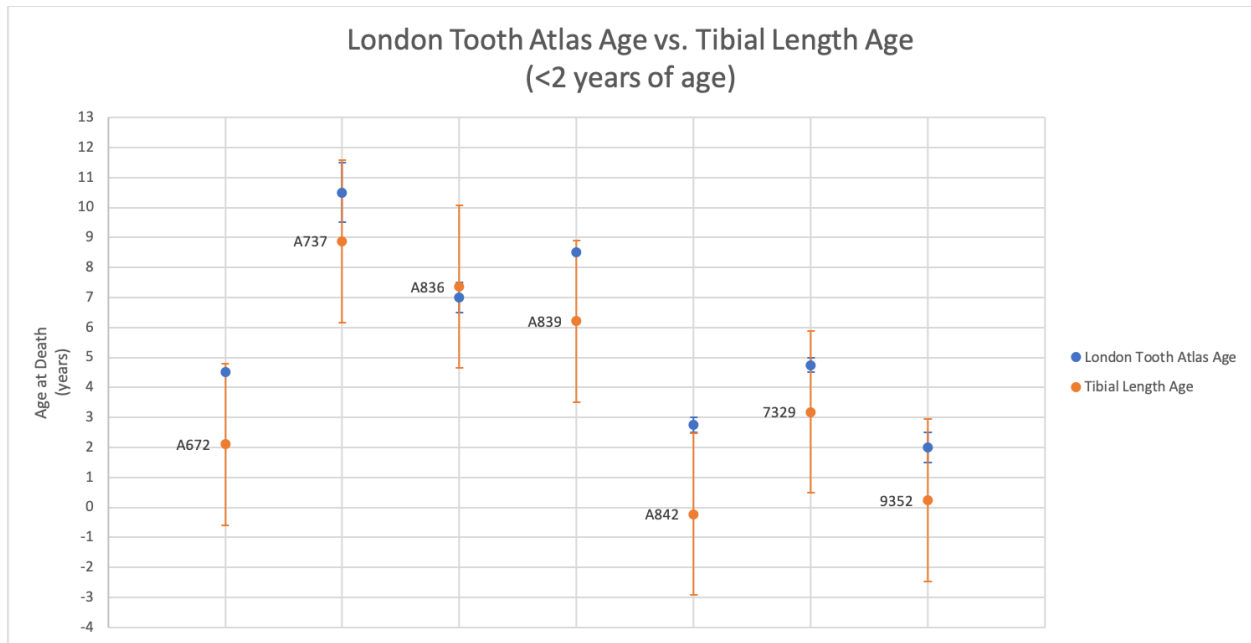


Figure 17. Dental age estimates compared to tibial age estimates for individuals calculated to be over two years of age.

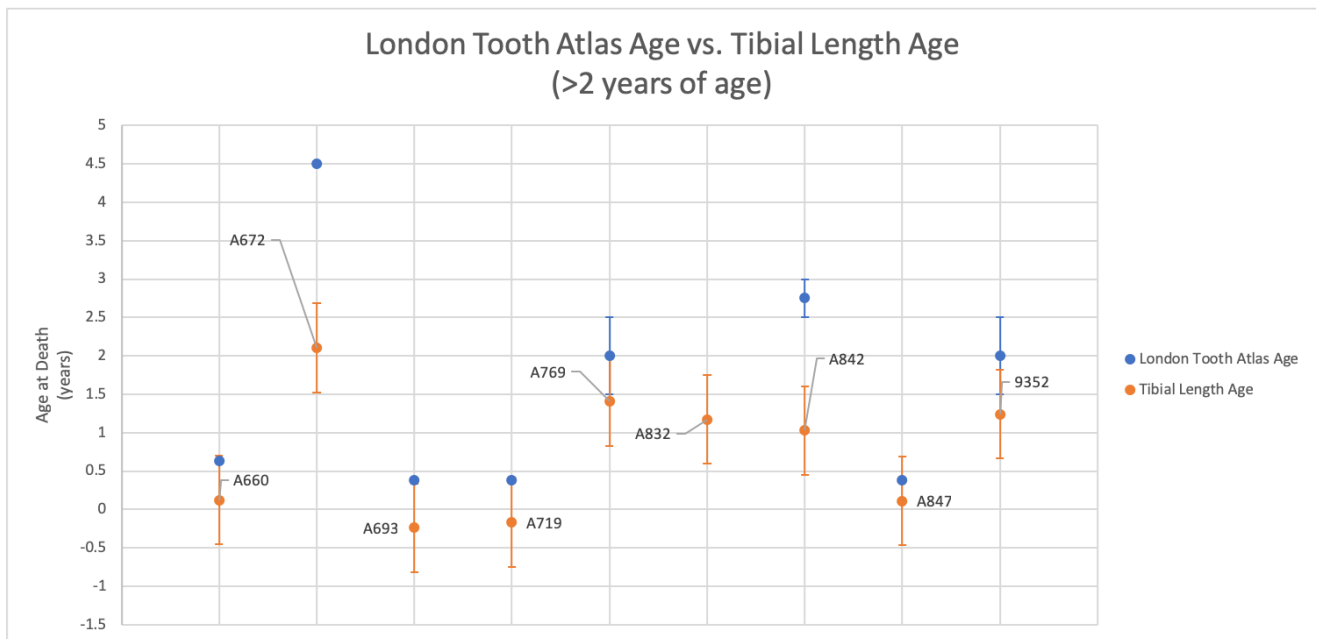


Figure 18. Dental age estimates compared to tibial age estimates for individuals calculated to be under two years of age.

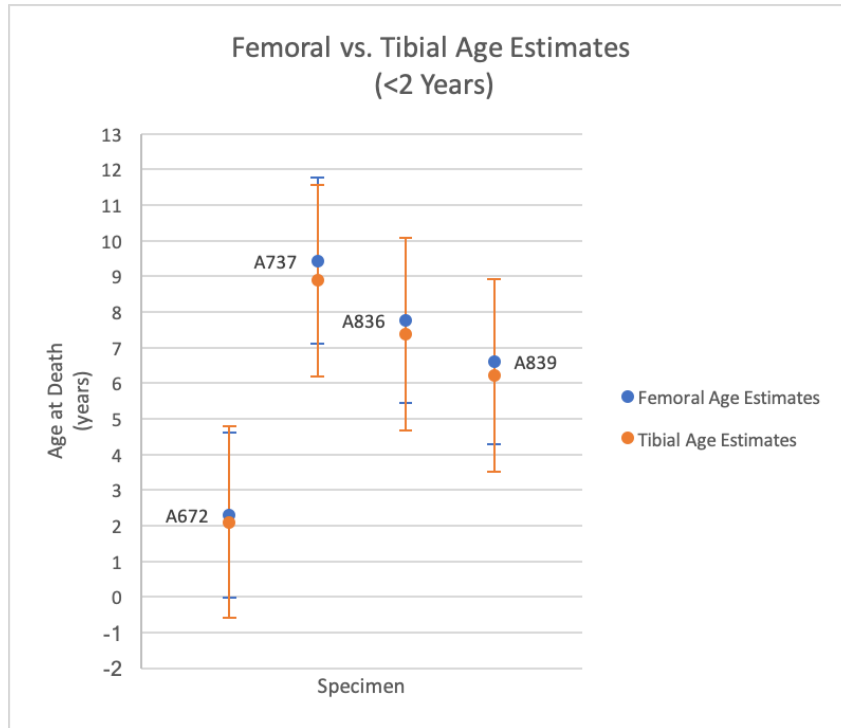


Figure 19. Femoral and tibial age estimates of individuals calculated to be **older** than two years of age compared with each other demonstrating tibial plasticity in the face of nutritional stress.

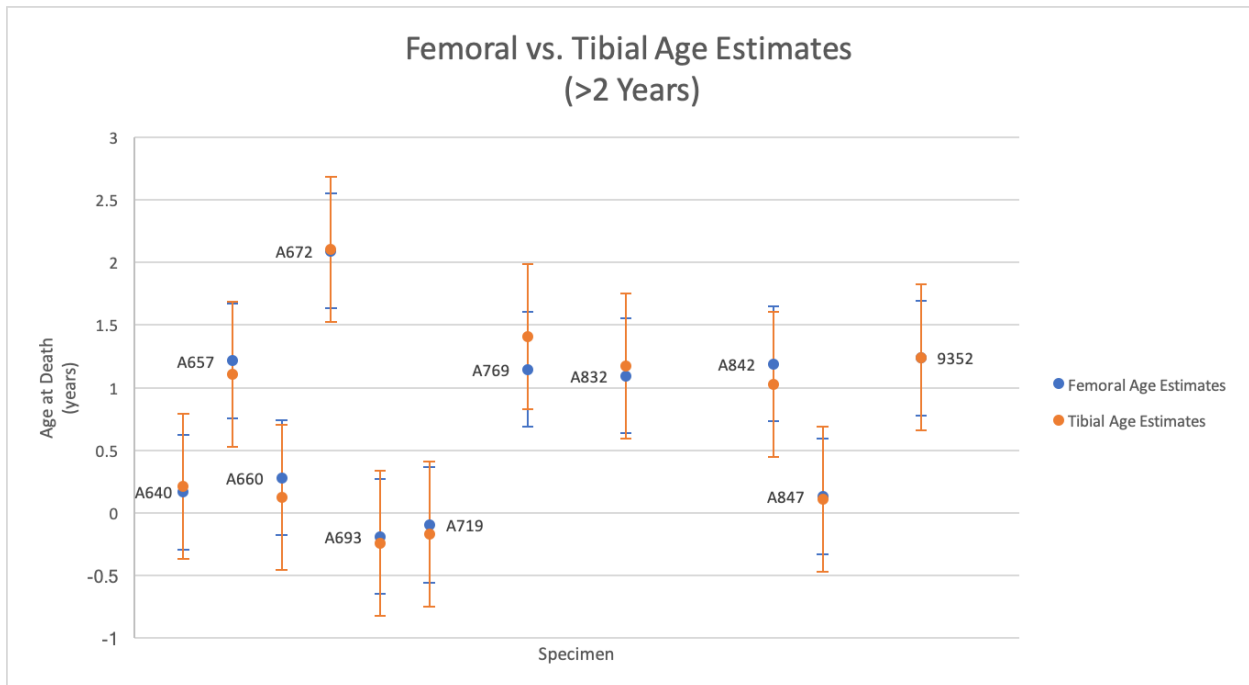


Figure 20. Femoral and tibial age estimates of individuals calculated to be **younger** than two years of age compared with each other demonstrating tibial plasticity in the face of nutritional stress.

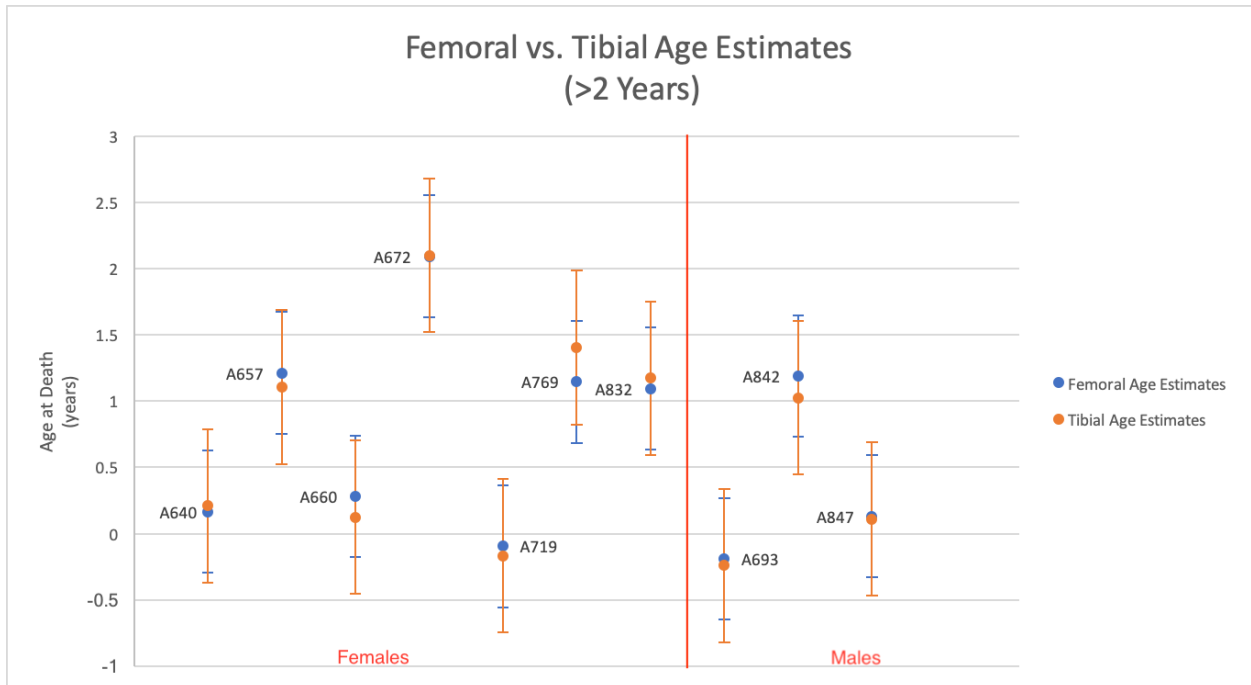


Figure 21. Femoral and tibial age estimations of individuals calculated to be **under** two years of age showing the prevalence of *female* representation.

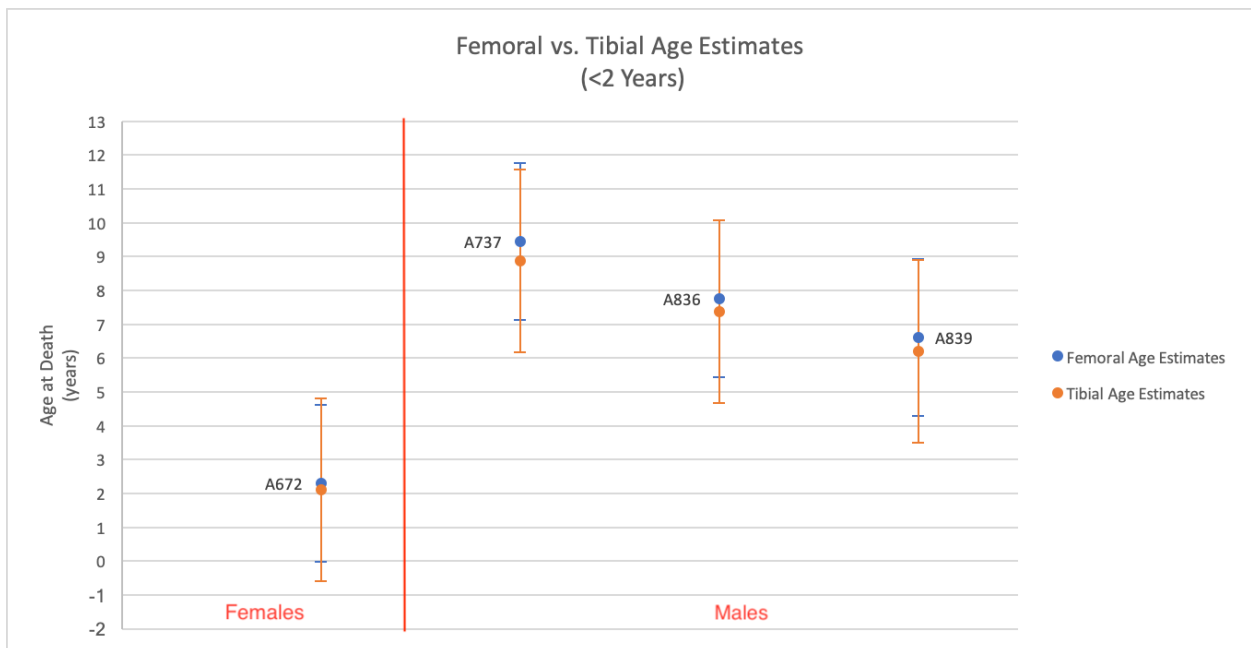


Figure 22. Femoral and tibial age estimations of individuals calculated to be **over** two years of age showing the prevalence of *male* representation.

Addendum

Description of Moorrees' stages (1963)
used to identify tooth developmental stages of single-rooted teeth

	Cc: initial cusp formation	Rc: initial root formation with diverge edges
	Coc: Colicrescence of cusps	R1/4: root length less than crown length
	Coc: Cusp outline complete	R1/2: root length equals crown length
	C1/2: crown half completed with dentine formation	R3/4: three quarters of root length developed with diverge ends
	C3/4: crown three quarters completed	Rc: root length completed with parallel ends
	Cc: crown completed with defined pulp root	A1/2: apex closed (root ends converge) with wide PDL
		Ac: apex closed with normal PDL width

Description of Moorrees' stages (1963)
used to identify tooth developmental stages of multirooted teeth

	Cc: initial cusp formation	Rc: initial root formation with diverge edges
	Coc: Colicrescence of cusps	R1/4: root length less than crown length with visible bifurcation area
	Coc: Cusp outline complete	R1/2: root length equals crown length
	C1/2: crown half completed with dentine formation	R3/4: three quarters of root length developed with diverge ends
	C3/4: crown three quarters completed	Rc: root length completed with parallel ends
	Cc: crown completed with defined pulp root	A1/2: apex closed (root ends converge) with wide PDL
		Ac: apex closed with normal PDL width

Description of modified Bengston's stages
used to identify tooth eruption

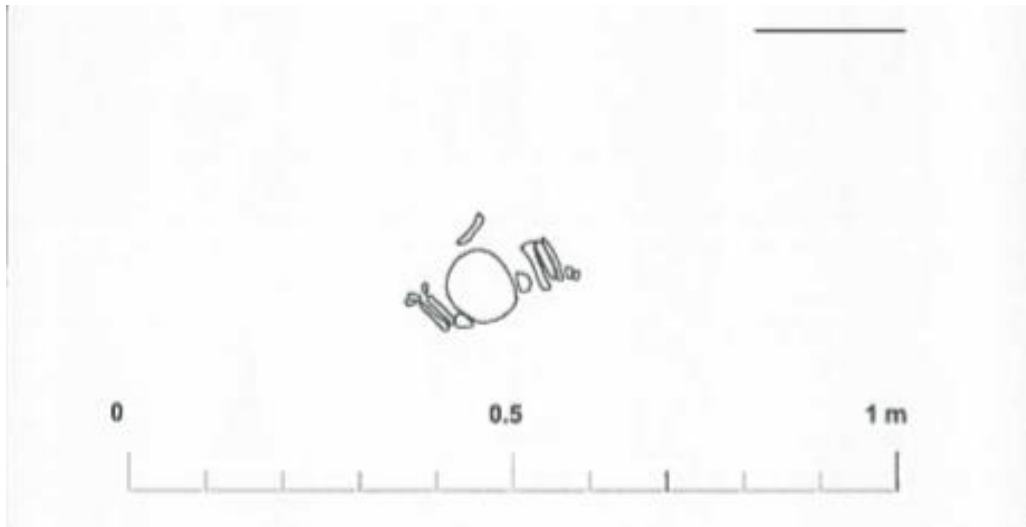
	position 1: when the occlusal or facial surface is covered entirely by bone	
	position 2: when the occlusal or facial surface breaks through the root of the alveolar bone	
	position 3: when the occlusal or facial surface is at the same level as the alveolar bone and the occlusal plane	
	position 4: occlusal or facial surface is in the occlusal plane	

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The dentition of the individuals within these two sample was assessed using the London Atlas of Human Tooth Development and Eruption (2010). Stages of development (Moorrees' stages) and eruption (Bengston's stages) for both single and multi-rooted were evaluated using the chart listed above. The charts were split into four quadrants, each representing the left (LQ) or right side (RQ) of the maxillary and mandibular dental arcade. The outer, fainter coloured squares represent spaces for the deciduous dentition, while the inner solid coloured squares represent spaces for the permanent. Any item in red text denotes a tooth that, despite being properly identified, could not be sided confidently.

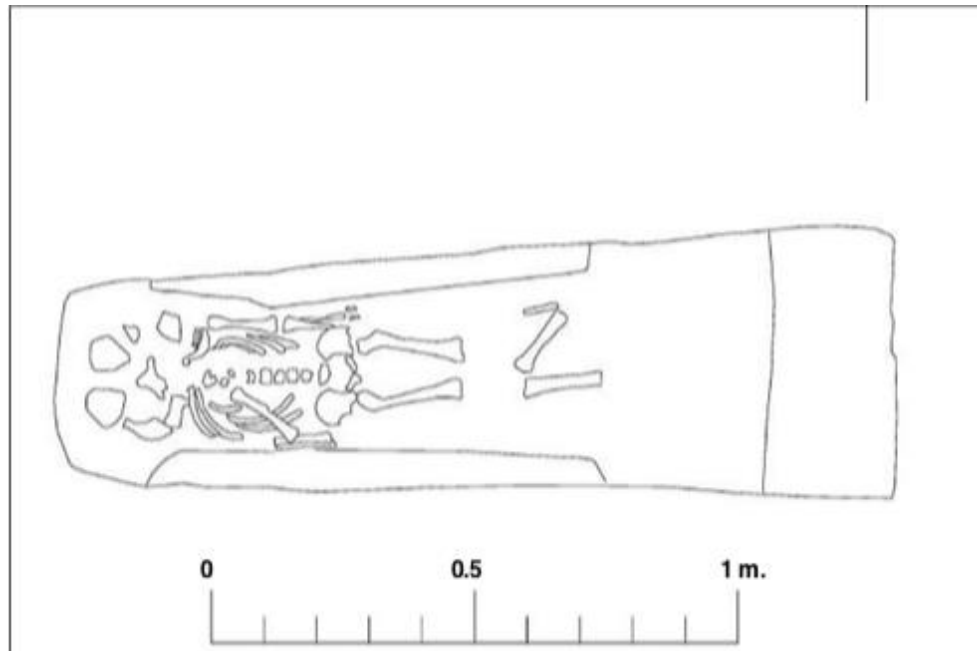
Burial ID	A640				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Not localized	Burial Positioning	Arranged to be sitting		
Burial Orientation	East – West	Est. Sex	Female	Est. Stature (cm)	54.4
Observed Palaeopathologies					
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.29 – 0.63	Tibial Age (years)	-0.37 – 0.79	No available dentition	
Dentition Notes					
Additional Notes					
Dental Inventory					

Archaeological Drawings



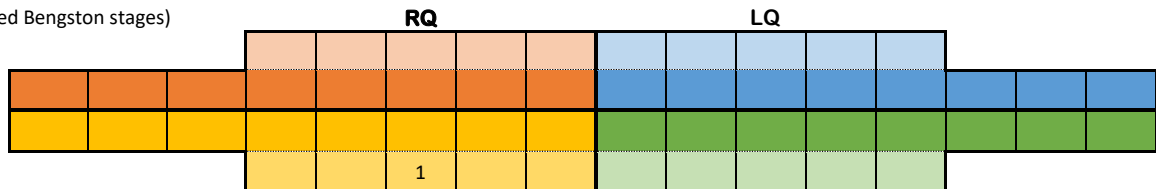
Burial ID	A657				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Tegulae Box Tomb	Burial Positioning		Supine	
Burial Orientation	West - East	Est. Sex	Female	Est. Stature (cm)	80
Observed Palaeopathologies					
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	0.75 – 1.67	Tibial Age (years)	0.53 – 1.68	No available dentition	
Dentition Notes					
Additional Notes					
Dental Inventory					

Archaeological Drawings

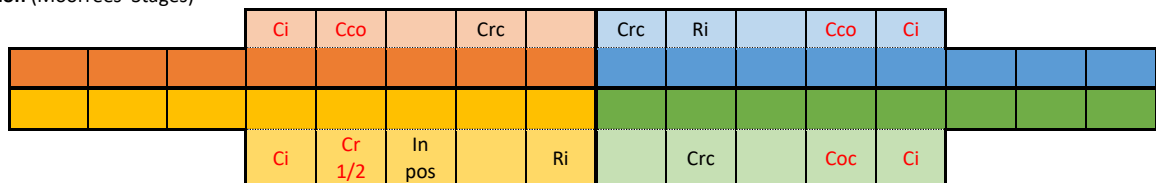


Burial ID	A660				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Stone Structure	Burial Positioning		Fetal position	
Burial Orientation	East – West	Est. Sex	Female	Est. Stature (cm)	53.7
Observed Palaeopathologies					
Recovered Materials	A single ceramic cooking pot lid				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.18 – 0.73	Tibial Age (years)	-0.46 – 0.70	0.63 (7.5 months)	
Dentition Notes					
Additional Notes					
Dental Inventory					

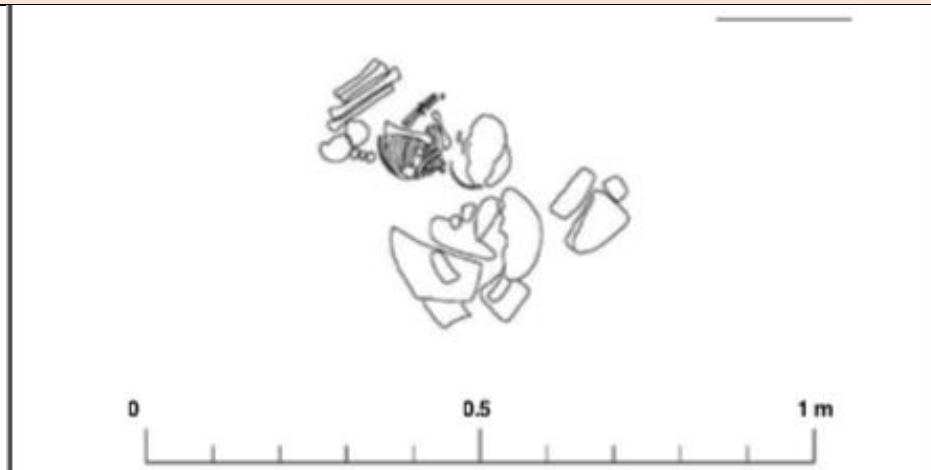
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

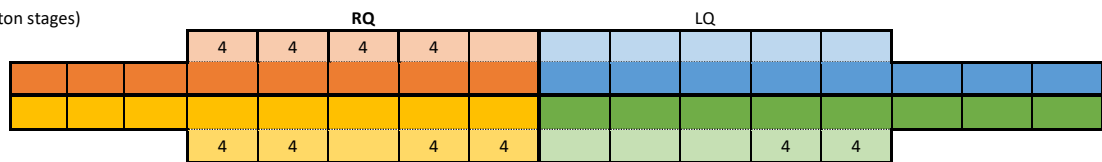


Archaeological Drawings

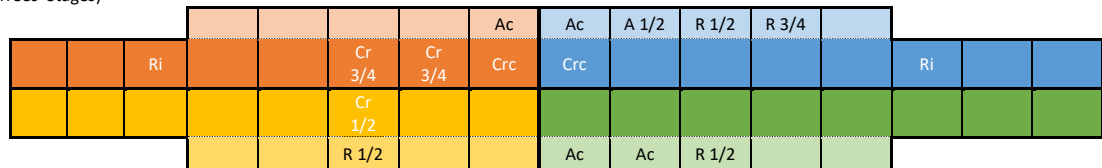


Burial ID	A672				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Rectangular trench	Burial Positioning	Supine		
Burial Orientation	Southeast - Northwest	Est. Sex	Female	Est. Stature (cm)	98.2
Observed Palaeopathologies					
Recovered Materials	Silver <i>bull</i> a (childhood pendant), a silver bead				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	(Y) 1.63 – 2.55 (O) -0.01 – 4.62	Tibial Age (years)	(Y) 1.52 – 2.68 (O) -0.59 – 4.80	4.5	
Dentition Notes					
Additional Notes					
Due to the fact that this individual cannot be placed into either the 'younger than two years' or 'older than two years' category for the determination of long bone age, they have been placed into both. (Y) denotes the age range when applied to the 'younger' category, while (O) denotes the range for the older.					
Dental Inventory					

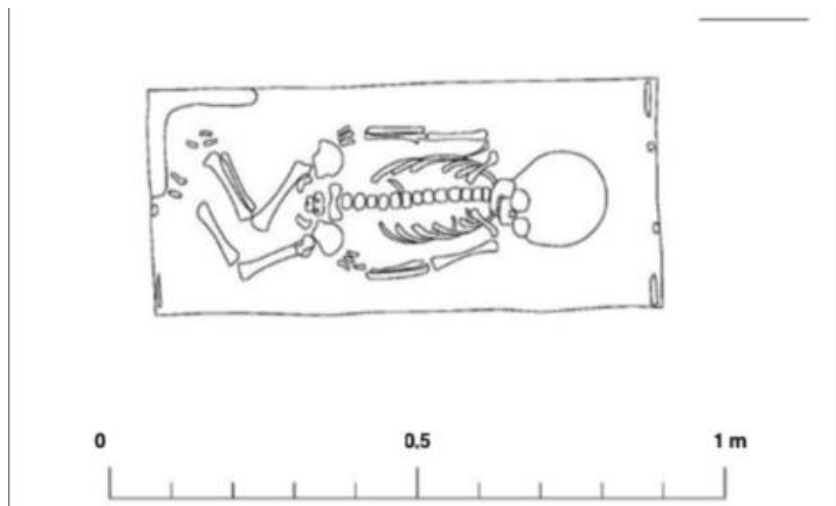
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

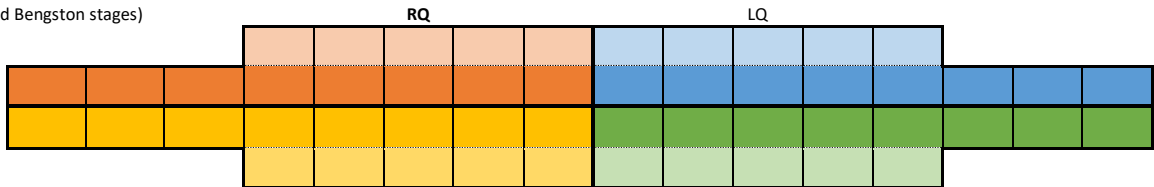


Archaeological Drawings

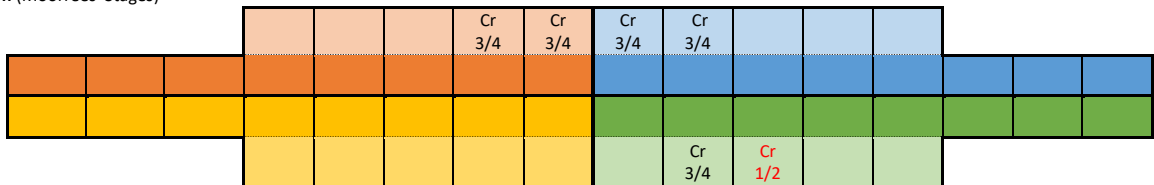


Burial ID	A693				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Simple Pit	Burial Positioning	Supine		
Burial Orientation	East – West	Est. Sex	Male	Est. Stature (cm)	45.8
Observed Palaeopathologies					
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.65 – 0.27	Tibial Age (years)	-0.82 – 0.33	0.38 (4.5 months)	
Dentition Notes					
Additional Notes					
Dental Inventory					

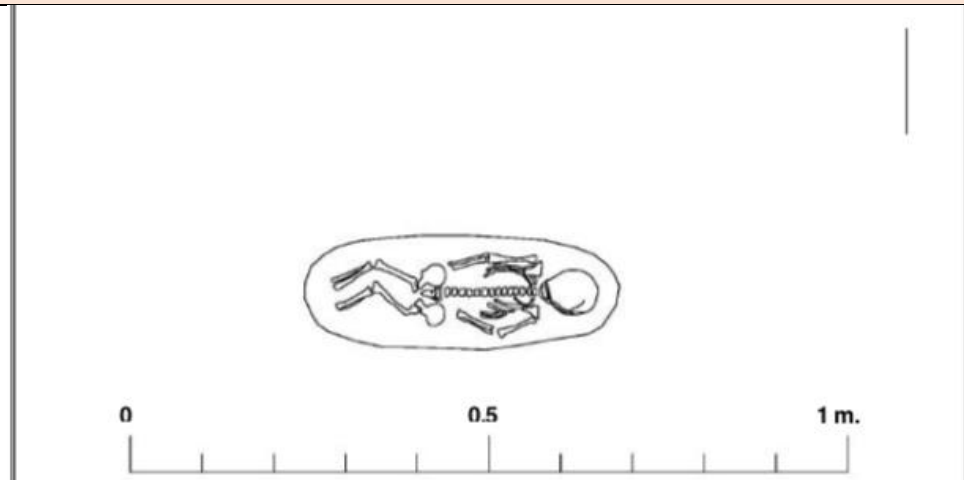
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

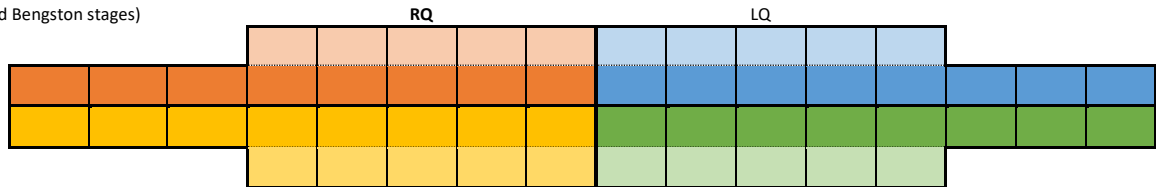


Archaeological Drawings



Burial ID	A719				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Simple Pit	Burial Positioning	Fetal Position		
Burial Orientation	Northeast - Southwest	Est. Sex	Female	Est. Stature (cm)	48.2
Observed Palaeopathologies					
Recovered Materials	A single button made from bone				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.56 – 0.36	Tibial Age (years)	-0.74 – 0.41	0.38 (4.5 months)	
Dentition Notes					
Additional Notes					
Dental Inventory					

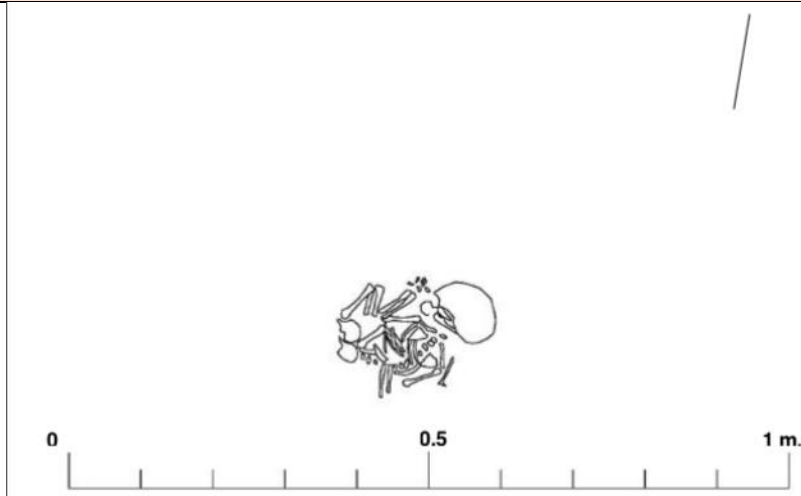
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)



Archaeological Drawings



Burial ID	A737				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Simple Pit	Burial Positioning	Supine		
Burial Orientation	Northeast - Southwest	Est. Sex	Male	Est. Stature (cm)	137
Observed Palaeopathologies	Linear enamel hypoplasias, Cribra Orbitalia				
Recovered Materials	Iron nails (number not specified)				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	7.11 – 11.76	Tibial Age (years)	6.17 – 11.57	9.5 – 11.5	
Dentition Notes					
Based on the development of the Maxillary M3's (Cr 3/4 development), along with the retention of the deciduous maxillary and mandibular p1 and p2's (roots show signs of resorption, but they were still retained by individual at time of death), along with retention of both maxillary and mandibular canines (again, they show significant resorption but they were still retained at the time of death) this individual would have been in the scope of 9.5 to 11.5 years of age.					
Additional Notes					
Dental Inventory					

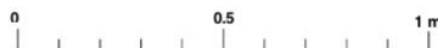
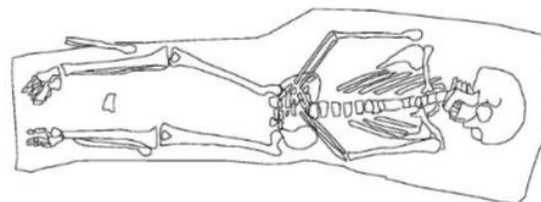
Emergence
(Modified Bengston stages)

RQ						LQ							
1	4	4	4	4	4	4	3	1	1	1	4	3	1
4	4	4	1	4	4	4	4	1	1	4	4	4	4
4	4	4								4			

Formation (Moorrees' Stages)

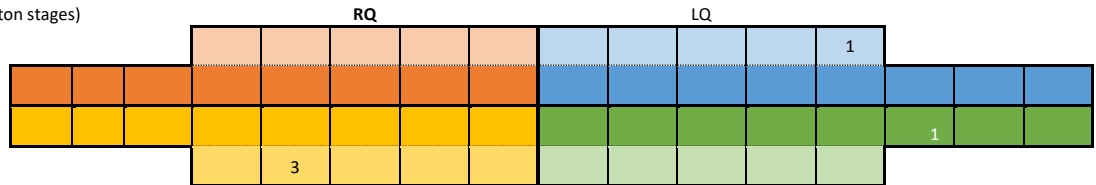
Cr 1/2				R 1/2	Ac	Ac	Ac	Ac	R 1/2					Cr 1/2
					Ac	Ac			R 1/2					

Archaeological Drawings

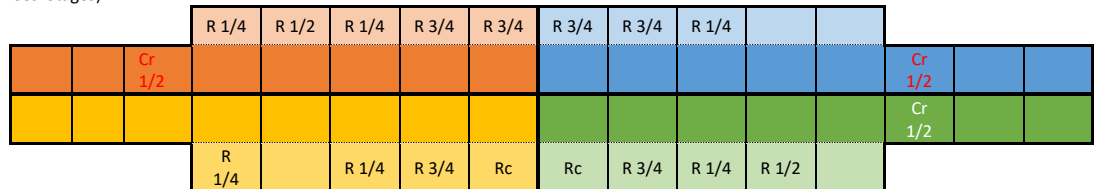


Burial ID	A769				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Simple pit	Burial Positioning	Prone		
Burial Orientation	East – West	Est. Sex	Female	Est. Stature (cm)	80
Observed Palaeopathologies	Known vitamin D deficiency, Cribra Orbitalia				
Recovered Materials	Iron nails (number not specified), Faunal material (not specified exactly what type)				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	0.68 – 1.60	Tibial Age (years)	0.82 – 1.98	1.5 – 2.5	
Dentition Notes					
Based on the development of the roots of mandibular left P1 (only about 1/2 developed), right p2 (just under 1/4 developed, but they have started to form), and M1 (about 3/4 of the crown is developed), this individual would be between 1.5 and 2.5 years of age.					
Additional Notes					
Dental Inventory					

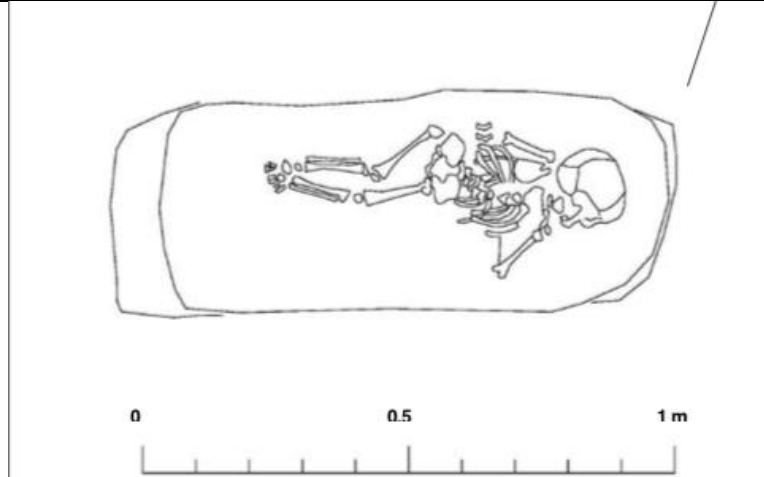
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

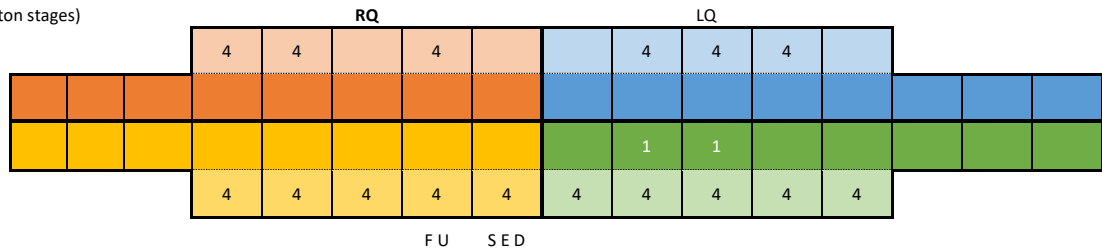


Archaeological Drawings

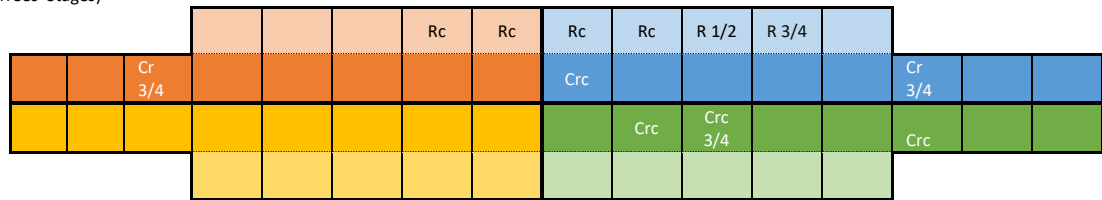


Burial ID	A829				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Rectangular Trench	Burial Positioning		Supine	
Burial Orientation	East - West	Est. Sex	Female	Est. Stature (cm)	91
Observed Palaeopathologies	Linear enamel hypoplasias				
Recovered Materials	Three iron nails				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.95 – 3.69	Tibial Age (years)	n/a	3.5 – 4.5	
Dentition Notes					
Based on the development of the Left and Right Maxillary M1 (No appearance of the roots yet), this individual would most likely be between 3.5 and 4.5 years of age					
Additional Notes					
Individual had a dental anomaly in which the right mandibular i1 and i2 are fused					
Dental Inventory					

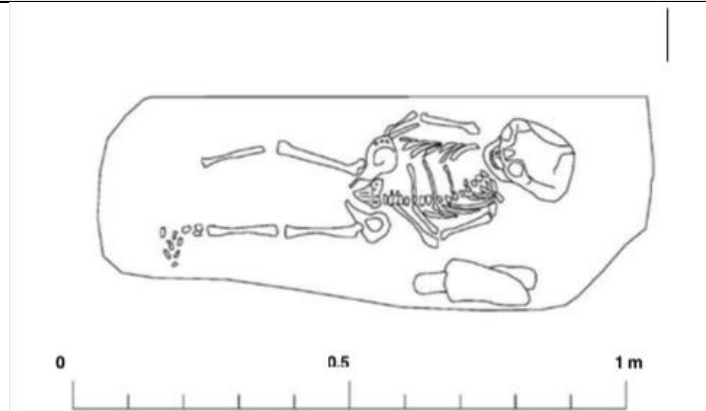
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

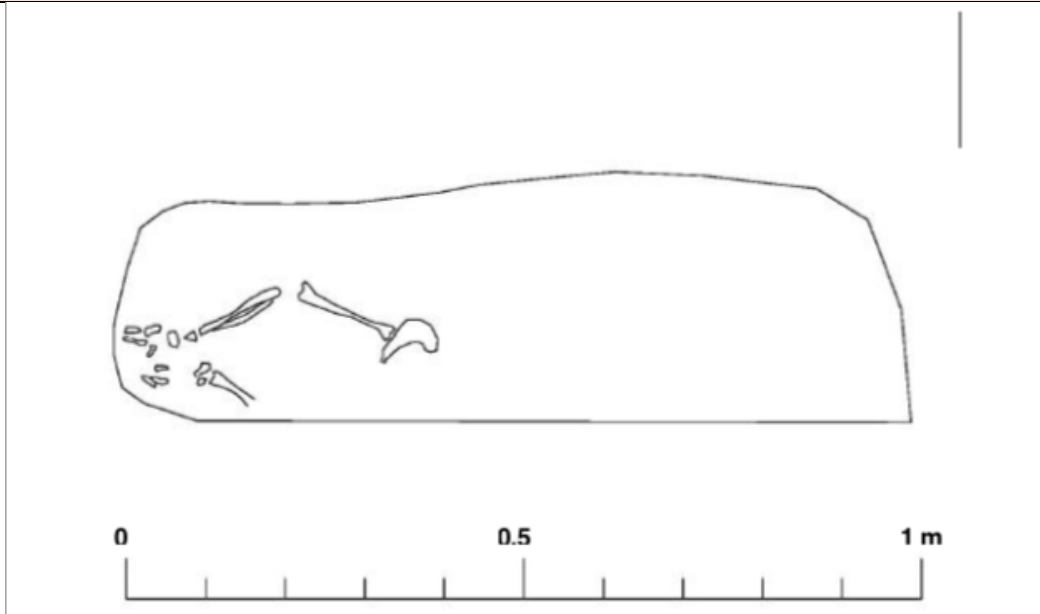


Archaeological Drawings



Burial ID	A832				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Rectangular Trench	Burial Positioning	Supine		
Burial Orientation	East - West	Est. Sex	Female	Est. Stature (cm)	n/a
Observed Palaeopathologies					
Recovered Materials	Three iron nails,				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	0.63 – 1.56	Tibial Age (years)	0.82 -1.98	No available dentition	
Dentition Notes					
Additional Notes					
Dental Inventory					

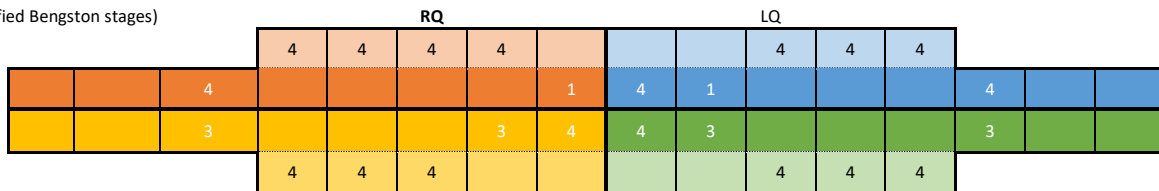
Archaeological Drawings



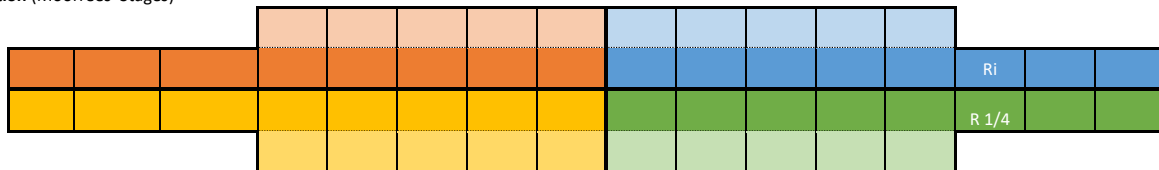
Burial ID	A836				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Rectangular Trench	Burial Positioning		Supine	
Burial Orientation	East - West	Est. Sex	Male	Est. Stature (cm)	129.4
Observed Palaeopathologies	Cribra orbitalia, linear enamel hypoplasia, pitting				
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	5.43 – 10.07	Tibial Age (years)	4.66 – 10.06	6.5 – 7.5	
Dentition Notes					
Based on the development and eruption of the permanent maxillary and mandibular I1's, and the semi eruption of the maxillary and mandibular I2's, and the complete eruption of the maxillary and mandibular M1 being in the occlusal plane, this individual is most likely between the age of 6.5 and 7.5 years of age.					
Additional Notes					
Dental Inventory					

Emergence

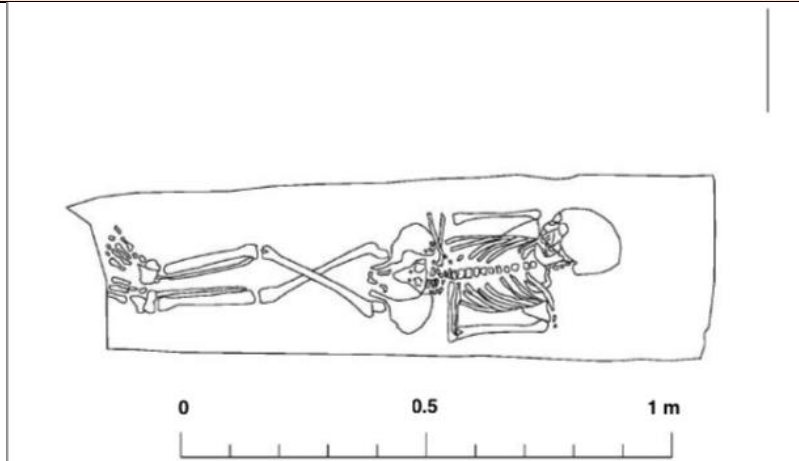
(Modified Bengston stages)



Formation (Moorrees' Stages)

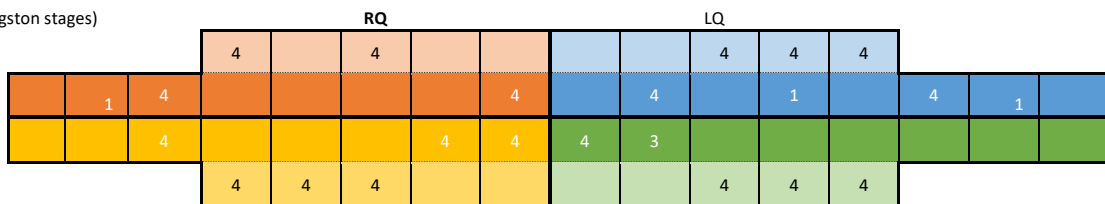


Archaeological Drawings

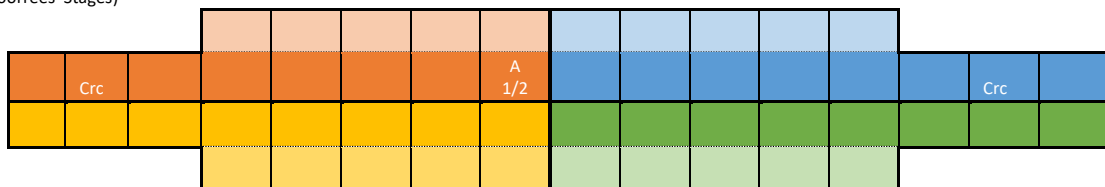


Burial ID	A839				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Rectangular trench	Burial Positioning		Supine	
Burial Orientation	East - West	Est. Sex	Malw	Est. Stature (cm)	125
Observed Palaeopathologies	Linear enamel hypoplasias, significant caries				
Recovered Materials	Four iron nails				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	4.27 – 8.91	Tibial Age (years)	3.50 – 8.91	8.5	
Dentition Notes					
Based on the development of the maxillary M2's, along with the eruption of the maxillary and mandibular incisors, this individual would be around 8.5 years of age, just as the atlas estimates. Pictures were not taken of root development.					
Additional Notes					
Dental Inventory					

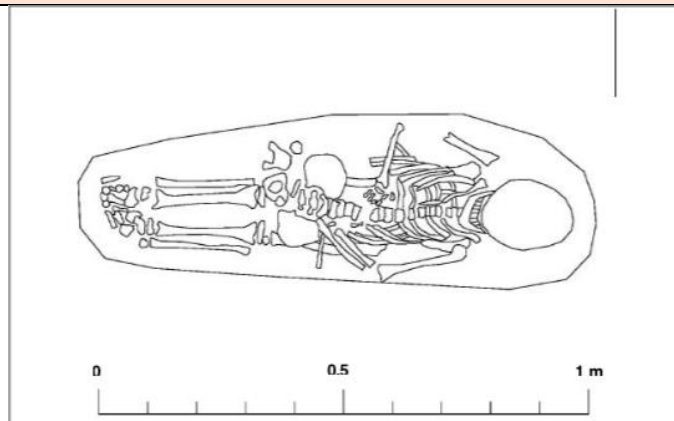
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)



Archaeological Drawings

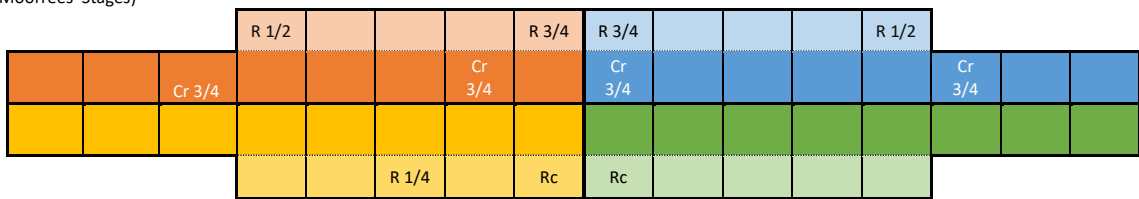


Burial ID	A842				
Necropolis	Plaça Vila de Madrid	Chronology	Mid 2 nd – Mid 3 rd CE		
Interment Type	Rectangular Trench	Burial Positioning	Prone		
Burial Orientation	East - West	Est. Sex	Male	Est. Stature (cm)	78.2
Observed Palaeopathologies	Cribra Orbitalia				
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	(Y) 0.73 – 1.65 (O)-2.22 – 2.42	Tibial Age (years)	(Y) 0.44 – 1.60 (O) -2.93 – 2.47	2.5 - 3	
Dentition Notes					
Based on the development of the Maxillary M1's, and the incomplete root development of m2, this individual would be around 2.5-3 years of age.					
Additional Notes					
Due to the fact that this individual cannot be placed into either the 'younger than two years' or 'older than two years' category for the determination of long bone age, they have been placed into both. (Y) denotes the age range when applied to the 'younger' category, while (O) denotes the range for the older.					
Dental Inventory					

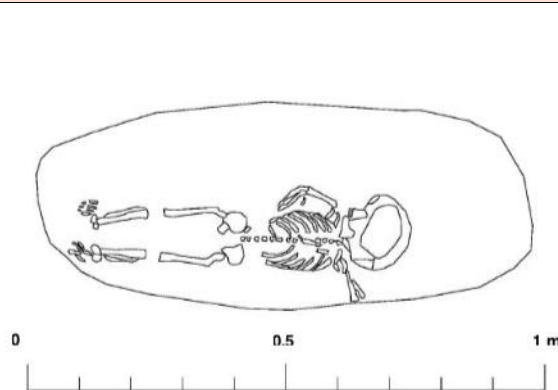
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

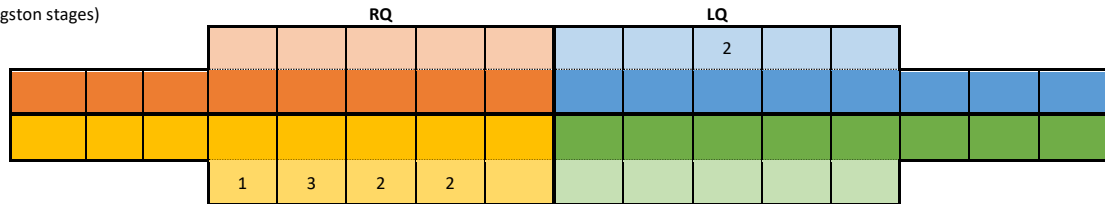


Archaeological Drawings

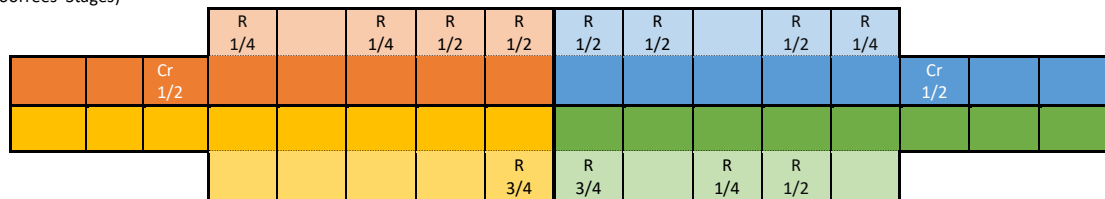


Burial ID	A844				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Simple pit	Burial Positioning		supine	
Burial Orientation	East - West	Est. Sex	n/a	Est. Stature (cm)	n/a
Observed Palaeopathologies	Porotic hyperostosis				
Recovered Materials	Iron nails (unspecified amount), a single shell				
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	0.5 – 1.48	Tibial Age (years)	n/a	1 - 2	
Dentition Notes					
Based on the development of the Maxillary M1's (Approximately half of the crown is developed), and the development of the maxillary p1's and p2's, this individual would be from 1 -2 years of age.					
Additional Notes					
Dental Inventory					

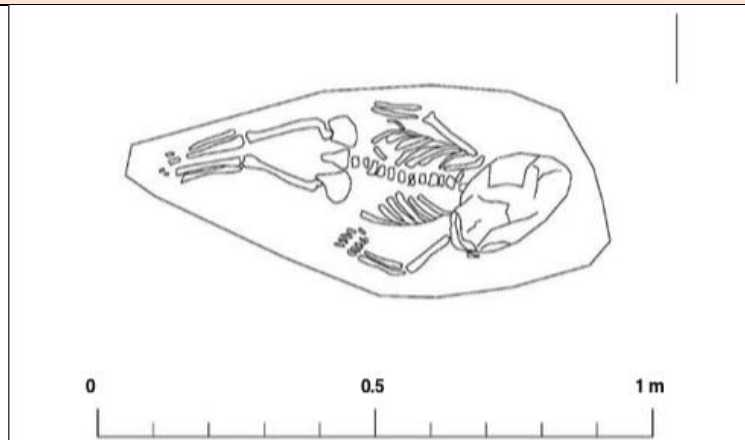
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)

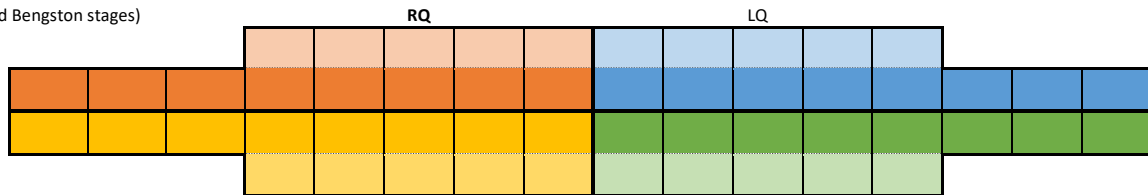


Archaeological Drawings

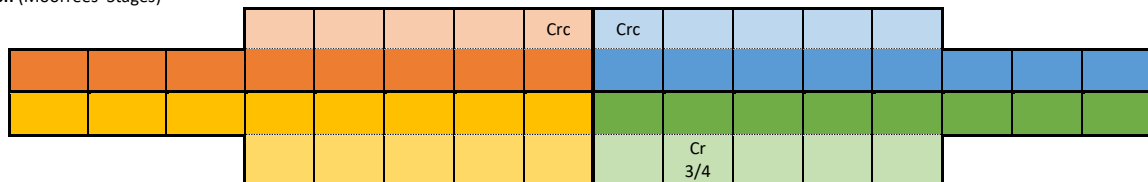


Burial ID	A847				
Necropolis	Plaça Vila de Madrid	Chronology		Mid 2 nd – Mid 3 rd CE	
Interment Type	Simple Pit	Burial Positioning		Fetal position	
Burial Orientation	East - West	Est. Sex	Male	Est. Stature (cm)	53.7
Observed Palaeopathologies					
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	-0.33 – 0.59	Tibial Age (years)	-0.46 – 0.69	0.38 (4.5 months)	
Dentition Notes					
Lack of available dentition makes it difficult to estimate an age for this individual. Based on the fact that minimal dentition were found may suggests that they had not developed significantly yet and what had developed was lost in the excavation process. The development of the Central maxillary incisors (specifically their lack of any roots) suggests that this individual was around 4.5 months old.					
Additional Notes					
Dental Inventory					

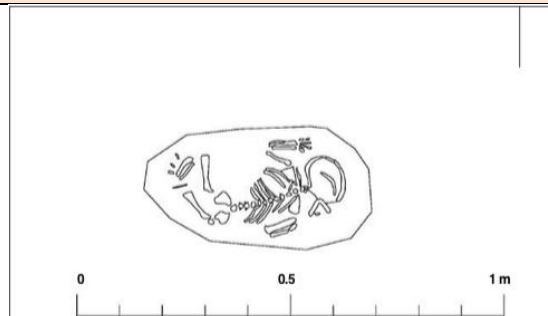
Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)



Archaeological Drawings



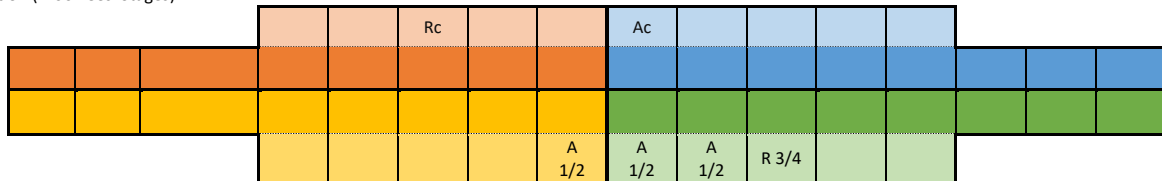
Burial ID	7329				
Necropolis	Mercat de Santa Caterina	Chronology	Late 3 rd – mid 5 th CE		
Interment Type	Ampohra	Burial Positioning	Fetal position		
Burial Orientation	Northeast - Southwest	Est. Sex	n/a	Est. Stature (cm)	n/a
Observed Palaeopathologies	Cribra orbitalia				
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	0.73 – 5.38	Tibial Age (years)	0.48 – 5.88	4.5 - 5	
Dentition Notes					
Based on the development of the maxillary M1's and their eruption (you can see them peeking through the alveolar bone), this individual would have most likely been around the age of 4.5 - 5 years of age. The only trouble I have in attributing this age is the fact the apical end of the Left mandibular canine is not fully closed, which it should be for this age since it is too young to be resorbing for the eruption of the permanent canine, and too old to be open for deciduous standards.					
Additional Notes					
Dental Inventory					

Emergence

(Modified Bengston stages)



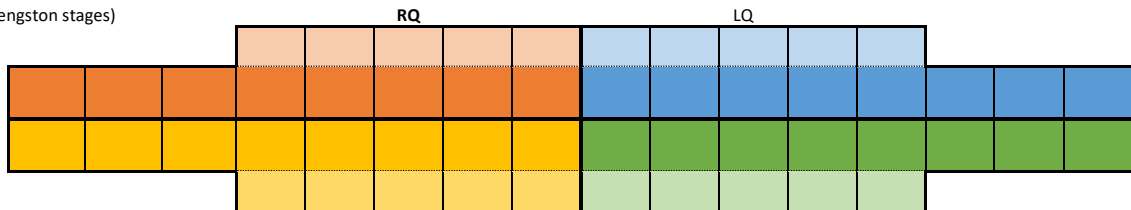
Formation (Moorrees' Stages)



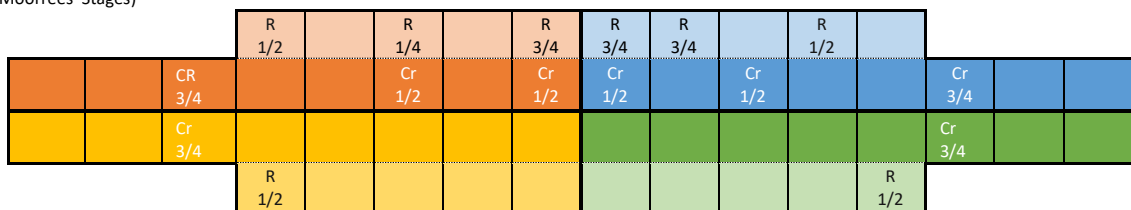
Archaeological Drawings

Burial ID	9352				
Necropolis	Mercat de Santa Caterina	Chronology	Early 4 th – Mid 6 th CE		
Interment Type	Amphora	Burial Positioning	Supine		
Burial Orientation	Northwest - Southeast	Est. Sex	n/a	Est. Stature (cm)	n/a
Observed Palaeopathologies					
Recovered Materials					
Long Bone Age Estimation			Dental Age Estimation (years)		
Femoral Age (years)	(Y) 0.77 – 1.69 (O) -2.11 – 2.53	Tibial Age (years)	(Y) 0.66 – 1.822 (O) -2.46 – 2.93	1.5 -2.5	
Dentition Notes					
<ul style="list-style-type: none"> - Four of the eight roots of the deciduous premolars were broken, though the ones which were not could be distinguished by the number of roots they contained and therefore be assigned to maxilla or mandible. Crown shapes were used for determination of p1 versus p2. - based on the development of the central maxillary incisors, the development of the p2 roots (only about 1/2 developed), and the development of the mandibular and maxillary M1's, this individual would be between the ages of 1.5 - 2.5 years of age. 					
Additional Notes					
Due to the fact that this individual cannot be placed into either the 'younger than two years' or 'older than two years' category for the determination of long bone age, they have been placed into both. (Y) denotes the age range when applied to the 'younger' category, while (O) denotes the range for the older.					
Dental Inventory					

Emergence
(Modified Bengston stages)



Formation (Moorrees' Stages)



Archaeological Drawings