Intramural child burials in Iron Age Navarra: How ancient DNA can contribute to household archaeology

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Zusammenfassung

Intramurale Kinderbestattungen im eisenzeitlichen Navarra: Wie alte DNA zur Archäologie von Hausgemeinschaften beitragen kann

Am Übergang von der späten Bronze- zur Eisenzeit vollzog sich auf der Iberischen Halbinsel ein Wandel in der Bestattungspraxis von der bis dahin überwiegenden Körperbestattung zur Brandbestattung. Die schlechten Erhaltungsbedingungen verbrannter Knochen haben molekulare Analysen wie Isotopen- und aDNA-Analysen von endbronze- und eisenzeitlichen Bevölkerungen bislang verhindert. Gelegentlich wurden jedoch Kleinkinder, oft Neugeborene, von dem vorherrschenden Brandbestattungsritus ausgenommen und stattdessen unverbrannt innerhalb von Gebäuden bestimmter Siedlungen beigesetzt. Die Diskussion über die Bedeutung und Interpretation dieses besonderen Bestattungsritus hat sich in der iberischen Archäologie über einen langen Zeitraum hinweg entwickelt, wurde aber immer durch die begrenzten anthropologischen, archäologischen und molekularen Daten, die von diesen intramuralen Körperbestattungen zur Verfügung standen, behindert. Im vorliegenden Artikel untersuchen wir die Genome von 37 intramural bestatteten Kindern aus drei früheisenzeitlichen Siedlungen (ca. 800–450 v. Chr.). Populationsgenetische Analysen haben unser Verständnis der genetischen Vielfalt auf der vorgeschichtlichen Iberischen Halbinsel erweitert, weil eine bis dahin nicht gekannte genetische Vielfalt – mit viel weniger mediterranem Einfluss, als in den bisher veröffentlichten eisenzeitlichen Individuen aus derselben Region – identifiziert werden konnte. Wir liefern ebenfalls Erkenntnisse zu Geschlecht und biologischer Verwandtschaft der Kinder und erhellen so verschiedene Aspekte des Bestattungsritus intra muros *und der Nutzung von Gebäuden in Siedlungen. Die genetischen Daten dieser Individuen füllen eine wesentliche Lücke in der Archäologie Nordspaniens und bieten die einzigartige Gelegenheit, die genetische Zusammensetzung und Veränderungen innerhalb der Bevölkerung von der Bronzezeit bis zur Antike zu untersuchen.*

Summary

The transition from the Late Bronze to the Iron Age on the Iberian Peninsula saw a shift in mortuary customs from mainly inhumation to cremation of the deceased. The poor preservation characteristic of cremated skeletal remains has hindered molecular analyses (isotope analyses, ancient DNA) of the Iberian Final Bronze and Iron Age communities of Iberia. Incidentally, a limited number of young children, often newborns, were exempt from the predominant cremation ritual, in favour of intramural inhumations inside buildings at certain settlements. The discourse surrounding the meaning and interpretation of this particular burial rite has developed over a long time in Iberian archaeology but has always been hampered by the limited anthropological, archaeological, and molecular data from these intramural inhumations. Here, we study the genomes of 37 intramurally buried children found in three Early Iron Age settlements, dated between c. 800–450 BC. Population genetic analyses on the newly reported individuals extend our understanding of ancient Iberia by revealing previously unsampled genetic diversity as well as showing a lesser influence of Mediterranean ancestry than on previously published Iron Age individuals from northern Spain. We also provide insights into the sex and biological relatedness of the children, and in so doing, elucidate different aspects of the intramural burial ritual and building use in settlements. More broadly, the genetic data from these individuals fill an important gap in the archaeogenetic record of northern Spain and offer a unique opportunity to study the genetic makeup and population changes from the Bronze Age to Antiquity.

Introduction

Although intramural burials represent a relatively rare funerary practice in human societies, they offer a unique opportunity to explore the relationship between certain members of a community and specific living spaces and buildings. A recurrent aspect of this practice, since its earliest known practice at the beginning of sedentary life in stable settlements, is its restriction to a relatively small subset of society, while the majority of a community's deceased were granted a different mortuary ritual or remain invisible in the archaeological record[1]. The number of intramural

1 Borić/Stefanović 2004; Boroneant/Bonsall 2012; Boz/Hager 2013; Cavanagh/Mee 1998; Lull 2000; Lichter 2001.

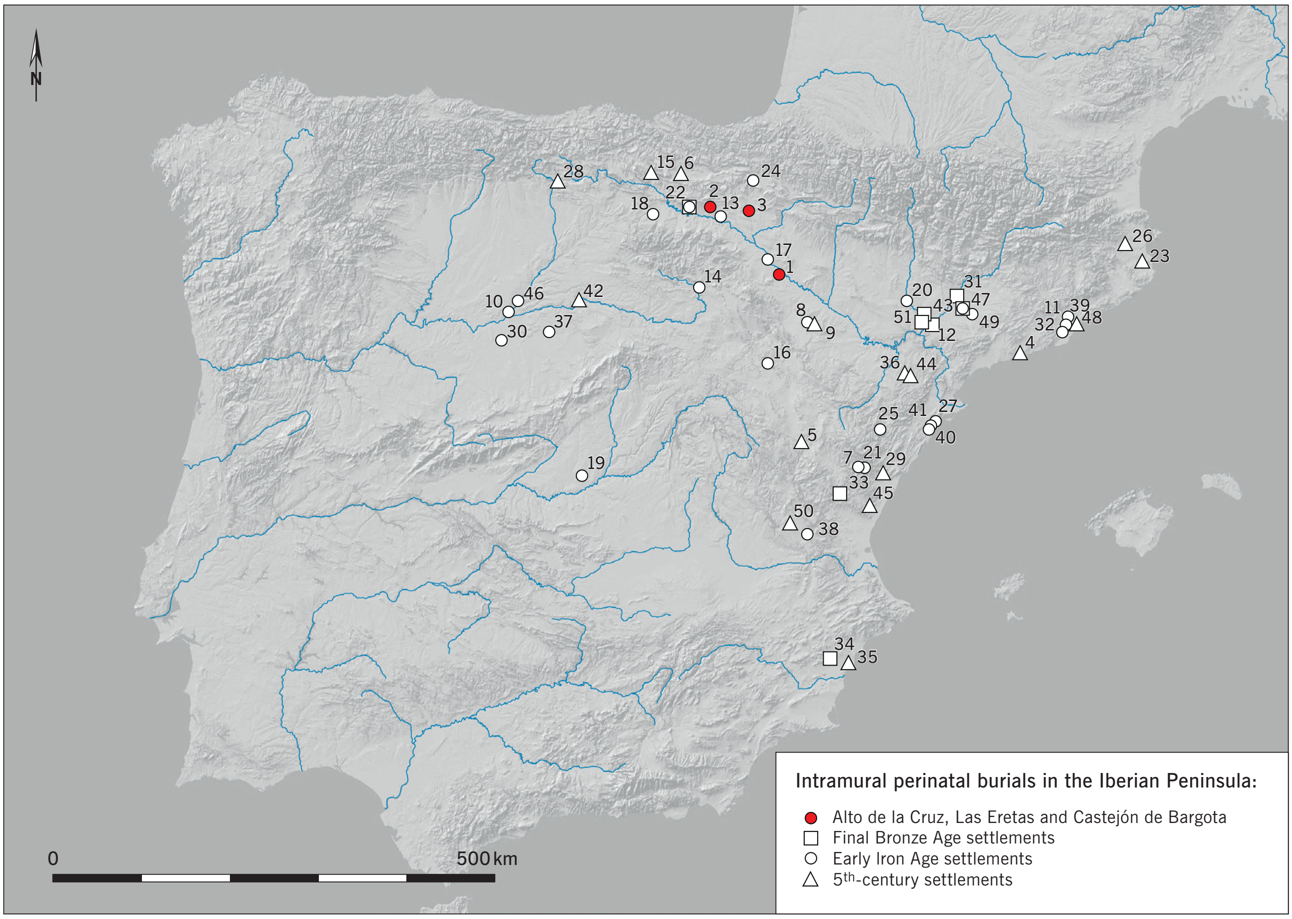

Fig. 1 Map of Final Bronze Age, Early Iron Age and 5th-century settlements with intramural perinatal burials in the Iberian Peninsula. 1 Alto de la Cruz (Cortes, Navarra); 2 El Castejón (Bargota, Navarra); 3 Las Eretas (Berbinzana, Navarra); 4 Alorda Park (Calafell, Tarragona); 5 Alto Chacón (La Muela, Teruel); 6 Atxa (Vitoria-Gasteiz, Alava); 7 Los Cabañiles (Zucaina, Castellón); 8 Cabezo de la Cruz (La Muela, Zaragoza); 9 Cabezo de las Minas (Botorrita, Zaragoza); 10 Calle Atrio de la Iglesia (Simancas, Valladolid); 11 Can Roqueta (Sabadell, Barcelona); 12 Carretelà (Aitona, Lleida); 13 El Castillar (Mendavia, Navarra); 14 El Castillejo (Fuensaúco, Soria); 15 Los Castros de Lastra (Caranca-Càrcamo, Alava); 16 Cerro de Santa Barbara (Cubel, Zaragoza); 17 Cerro de Santa Bàrbara (Tudela, Navarra); 18 Cerro Piquillo (Libia) (Herramélluri, La Rioja); 19 Cerrocuquillo (Villaluenga de la Sagra, Toledo); 20 La Codera (Alcolea de Cinca, Huesca); 21 La Escudilla (Zucaina, Castellón); 22 La Hoya (Laguardia, Alava); 23 Illa d'en Reixac (Ullastret, Girona); 24 Leguin Chiqui (Echauri, Navarra); 25 La Lloma Comuna (Castellfort, Castellón); 26 Mas Castellar (Pontós, Girona); 27 La Moleta del Remei (Alcanar, Tarragona); 28 Monte Bernorio (Villarén, Palencia); 29 Montmirà (Alcora, Castellón); 30 La Mota (Medina del Campo, Valladolid); 31 La Pedrera (Vallfogona de Balaguer-Térmens, Lleida); 32 Penya del Moro (Sant Just Desvern, Barcelona); 33 Peña de la Dueña (Teresa, Castellón); 34 Peña Negra (Crevillente, Alicante); 35 La Picola (Santa Pola, Alicante); 36 Piuró del Barranc Fondo (Valdeltormo, Teruel); 37 Plaza del Castillo (Cuellar, Segovia); 38 Plaza del Castillo (Requena, Valencia); 39 Puig Castellar (Montcada i Reixac, Barcelona); 40 Puig de la Misericordia (Vinaròs, Castellón); 41 Puig de la Nau (Benicarló, Castellón); 42 Rauda (Roa de Duero, Burgos); 43 Safranals (Fraga, Huesca); 44 San Antonio (Calaceite, Teruel); 45 Sant Josep (Vall d'Uixó, Castellón); 46 El Soto de Medinilla (Valladolid, Valladolid); 47 Tossal de les Tenalles (Torregrossa, Lleida); 48 Turò de ca n'Olivé (Cerdanyola, Barcelona); 49 Els Vilars (Arbeca, Lleida); 50 Los Villares (Caudete de las Fuentes, Valencia); 51 Vincamet (Fraga, Huesca).

Abb. 1 *Karte der Siedlungen mit intramuralen perinatalen Bestattungen aus der späten Bronze-, frühen Eisenzeit und dem 5. Jh. v. Chr. auf der Iberischen Halbinsel. 1 Alto de la Cruz (Cortes, Navarra); 2 El Castejón (Bargota, Navarra); 3 Las Eretas (Berbinzana, Navarra); 4 Alorda Park (Calafell, Tarragona); 5 Alto Chacón (La Muela, Teruel); 6 Atxa (Vitoria-Gasteiz, Alava); 7 Los Cabañiles (Zucaina, Castellón); 8 Cabezo de la Cruz (La Muela, Zaragoza); 9 Cabezo de las Minas (Botorrita, Zaragoza); 10 Calle Atrio de la Iglesia (Simancas, Valladolid); 11 Can Roqueta (Sabadell, Barcelona); 12 Carretelà (Aitona, Lleida); 13 El Castillar (Mendavia, Navarra); 14 El Castillejo (Fuensaúco, Soria); 15 Los Castros de Lastra (Caranca-Càrcamo, Alava); 16 Cerro de Santa Barbara (Cubel, Zaragoza); 17 Cerro de Santa Bàrbara (Tudela, Navarra); 18 Cerro Piquillo (Libia) (Herramélluri, La Rioja); 19 Cerrocuquillo (Villaluenga de la Sagra, Toledo); 20 La Codera (Alcolea de Cinca, Huesca); 21 La Escudilla (Zucaina, Castellón); 22 La Hoya (Laguardia, Alava); 23 Illa d'en Reixac (Ullastret, Girona); 24 Leguin Chiqui (Echauri, Navarra); 25 La Lloma Comuna (Castellfort, Castellón); 26 Mas Castellar (Pontós, Girona); 27 La Moleta del Remei (Alcanar, Tarragona); 28 Monte Bernorio (Villarén, Palencia); 29 Montmirà (Alcora, Castellón); 30 La Mota (Medina del Campo, Valladolid); 31 La Pedrera (Vallfogona de Balaguer-Térmens, Lleida); 32 Penya del Moro (Sant Just Desvern, Barcelona); 33 Peña de la Dueña (Teresa, Castellón); 34 Peña Negra (Crevillente, Alicante); 35 La Picola (Santa Pola, Alicante); 36 Piuró del Barranc Fondo (Valdeltormo, Teruel); 37 Plaza del Castillo (Cuellar, Segovia); 38 Plaza del Castillo (Requena, Valencia); 39 Puig Castellar (Montcada i Reixac, Barcelona); 40 Puig de la Misericordia (Vinaròs, Castellón); 41 Puig de la Nau (Benicarló, Castellón); 42 Rauda (Roa de Duero, Burgos); 43 Safranals (Fraga, Huesca); 44 San Antonio (Calaceite, Teruel); 45 Sant Josep (Vall d'Uixó, Castellón); 46 El Soto de Medinilla (Valladolid, Valladolid); 47 Tossal de les Tenalles (Torregrossa, Lleida); 48 Turò de ca n'Olivé (Cerdanyola, Barcelona); 49 Els Vilars (Arbeca, Lleida); 50 Los Villares (Caudete de las Fuentes, Valencia); 51 Vincamet (Fraga, Huesca).*

interments is restricted by the physical limitations of a settlement or constructed space in which they are placed, meaning socially established criteria likely governed who was granted such a burial. Criteria may have been based on sex, age, class, or other socially recognised indicators. They may have also derived from astronomical or meteorological observations, relating ritual practices to specific years, months, or days. In any case, the interment of individuals in specific living spaces likely signalled a relationship between the individual and the space, which presumably needed to be ritually and socially sanctioned. This study explores these relationships and rituals by combining archaeological, anthropological, and genetic data from Early Iron Age (c. 800–450 BC) Navarra, northern Spain, where this intramural funerary rite was restricted to some perinates or children of a very young age. We study ancient DNA data from 37 intramurally-buried children from the Early Iron Age villages of Alto de la Cruz (n = 29), Las Eretas (n = 6), and El Castejón (n = 2), which allows a better understanding of the social criteria governing these funerary practices. We provide insights into the sex and biological relatedness of these children, as well as the mating patterns and genetic affinities of the communities they belonged to. We discuss the implications of our results on the interpretations of this burial rite and social organisation at these sites, as well as the population genetic changes in northern Spain more broadly.

Intramural child burials in Iron Age western Mediterranean

Intramural child burial was a funerary ritual practised during the Final Bronze Age and Iron Age in the western Mediterranean coastal regions, from Murcia in the southwest to the Languedoc in the northeast, including the entire Ebro Valley and parts of the Spanish northern Meseta (Fig. 1)[2]. Absolute dates confirm that infants started to be interred in settlements around 1000 BC in the Ebro Valley (Moya et al. 2015, 44), although a slightly earlier date can be proposed based on stratigraphic observations[3]. The ritual continued to be practised at least until the end of the 1st millennium BC, when the Iberian Peninsula came under Roman rule after a series of wars and violent repression. In certain settlements, intramural child inhumations have been documented even at the beginning of the 1st millennium AD (e.g., Mínguez 1990; Rodrigo 2022). Despite widespread evidence of dense human occupation during the Iron Age, the low number of known intramural and inhumation burials implies the existence of other funerary practices. While low, the precise rate of intramural interments remains difficult to infer.

Given its introduction to a region where cremation became the dominant funerary ritual, the intramural interment of children has often been linked to the influence, or even presence, of central European »Urnfield Culture« groups (Gusi/Muriel 2008; Armendáriz/de Miguel 2006; Lorrio et al. 2010). In contrast, it has also been speculated that this practice was an influence of the Phoenician and Greek colonisation of the Iberian Peninsula after 900 BC[4]. However, neither the spatiotemporal distribution, nor the funerary practice itself seem entirely compatible with either hypothesis. While newborns were cremated in the Eastern Mediterranean derived *Molk* sacrificial ritual, the Iberian communities inhumated their bodies in pits. No intramural burials are found in colonial settlements[5]. Anthropological data has also not provided evidence for violent sacrificial rituals. Finally, intramural child burials appeared in Catalonia and the Ebro Valley well before the Phoenician presence in Andalusia or in the founding of Greek colonies along the coast of Catalonia and Languedoc.

Archaeological evidence indicates that perinatal infants in settlements emerged as a funerary practice at the end of the 2nd millennium BC among communities settling in the north-western Mediterranean regions and the Ebro Valley. Later, by the middle of the 1st millennium BC, it became a distinctive funerary practice of populations identified in archaeology as »Iberian«, based on their settlement pattern, artefact typology, the Northeastern Iberian script, and pre-Roman toponymy of the Iberian Peninsula and southern France.

So far, around 800 intramural burials of young children have been identified in nearly 90 Final Bronze Age and Iron Age settlements, mostly in the north-eastern part of the Iberian Peninsula (Fig. 1). While the site of La Hoya, Álava, has provided an exceptionally large number of intramural inhumation burials (n = 260), in more than half of the known sites only one or two intramural burials have been found. Less than 20 settlements present 10 or more intramural burials. Even in larger and extensively excavated settlements, such as Els Vilars, Lleida (0.26 ha) or Alto de la Cruz, Navarra (0.75 ha), a maximum of between 16 and 45 infant burials have been found, respectively. In other Final Bronze Age and Iron Age settlements, no inhumation burials have been identified so far, as some authors have pointed out (Moya et al. 2015, 42). Considering the timespan over which this burial rite was regularly used (c. 800–200 BC), as well as the number and size of the settlements excavated, c. 800 individuals can only represent a small fraction of the Final Bronze Age and Iron Age population in that age group. Even taking into account that some burials probably passed unnoticed during excavations due to poor preservation and the small size of perinatal skeletons, or due to the applied excavation method (no sieving of sediments, etc.), the total number of children who died at a young age in this time period must have been considerably larger, leaving the majority of perinatal deaths unaccounted for.

A common trait of these intramural burials, which indicates the existence of a shared funerary rite for the whole area, is the young age of the children. Anthropological studies reveal that the majority of the individuals who were interred intramurally were perinatal infants, who either died before reaching full term, or during the first months of extra-uterine life. Most of the c. 70 skeletons that have been studied anthropologically died around 40 weeks of intrauterine life, probably during or shortly after birth[6]. Children older than six months of age were rarely interred in the set-

2 Gusi 1970; Gusi 1992; Gusi/Muriel 2008; Dedet 2008a; Dedet 2008b; Armendáriz/de Miguel 2006; Lorrio et al. 2010; Belarte 2010.

3 This is the case in the Late/Final Bronze Age settlements of La Pedrera, Vallfogona de Balaguer-Térmens, Lleida (Gallart/Junyent 1989) and La Hoya, La Guardia, Álava (Galilea/García 2002).

4 Oliver/Gómez 1989; Barrial 1990; Ruiz Cabrero 2008; Gusi/Murial 2008.

5 No such burials have been detected in extensively excavated colonies such as Villaricos, Almería, or Morro de Mezquitilla, Toscanos, or Cerro del Villar, in Málaga (Siret 1906; Schubart/Maass-Lindemann 2017; Schubart 2002; Delgado/Aubet 2003).

6 Risch/Carbonell 1986; Guérin/Martínez 1988; Gómez/Oliver 1989; Gracía et al. 1989; Maluquer de Motes et al. 1990; Augustí et al. 2000; Lorrio et al. 2010; Armandáriz/de Miguel 2006; de Miguel 2009; Carnicero-Caceres/Torres-Martínez 2021.

Fig. 2 The Ebro Valley at the height of Tudela (Navarra). In the background, on the right, the town of Alto de la Cruz.

Abb. 2 Das Ebrotal auf der Höhe von Tudela (Navarra). Im Hintergrund rechts die Stadt Alto de la Cruz.

tled areas. Although anthropological studies of cremations are still not sufficient to account for the majority of deceased children (e.g., Gómez 2011; Uroz/Uroz 2010), the available information suggests that these were rarely cremated, especially if one takes into account that child mortality in Later Prehistory probably affected between one quarter and one third of the population. If this is confirmed in future studies, it follows that young children buried in settlements or in cremation necropoleis probably received special ritual attention compared to most of the children who died at a young age and received no archaeologically recognisable burial. Regardless, the main question concerning the Iron Age intra-mural burials of Eastern Iberia remains: *what made these few children »special« to so many communities and over such an extended spatial and temporal range?*

Another aspect shared by most of the perinatal intramural inhumations is their placement in simple pits under the floors of living quarters[7]. Only in the Spanish Levante were they occasionally buried in pottery vessels (Gómez/Oliver 1989; Moneo 2003, Fig. 6; 19). Careful excavations have confirmed that human remains are usually found in a primary position. The disturbances observed in some cases are probably the result of post-depositional processes. Their identification and excavation are further hampered by the fact that these tombs were rarely marked in an archaeologically visible way, although stone settings have been identified in some cases (e.g., Risch/Carbonell 1986; García et al. 1989; Armandáriz/de Miguel 2006; etc.). Grave goods, such as bronze rings and bracelets, appear in a small number of cases, even accompanying premature children, as in Alto de la Cruz, Navarra (Maluquer de Motes et al. 1990). The presence of young animals, particularly ovicaprines, seems to have been more frequent (Gómez/Oliver 1989; Nieto 2013). Complete animals, or parts thereof, have been found either in direct association with, or in close proximity to, the infant burials. However, animals were also interred individually with no relation to perinatal burials, suggesting that different, but related rituals, were carried out inside the settlements and buildings (Belarte/Valenzuela-Lamas 2013).

The spatial location of the burials has been studied in order to gain insights into the meaning of this ritual practice. Although some buildings or rooms contain more interments than others, no common pattern has been identified concerning their size, architecture, or the function of the spaces. Constructions interpreted as domestic realms, storage rooms, or as specialised workshops, such as tanneries, metal workshops, winepresses etc., as well as buildings with a possible ritual use, were chosen as funerary spaces in an apparently arbitrary way. So far, it has not been possible to recognise any pattern or logic behind the spatial distribution of the skeletons within the settlements. In the case of the extensively excavated site of Els Villars, Lleida, children and horse foetuses were buried in mutually exclusive sides of the fortified settlement, at least during its occupation phase II, dated between 550/525–425/400 BC (Nieto 2013). However, the reasons behind such a spatial segregation remain unclear. Furthermore, the number of burials in each building and the number of individuals interred in each burial pit does not seem to follow any obvious rule. While most tombs contained single inhumations, double and triple burials, which are well-documented in c. a dozen settlements, have been interpreted by some authors as twins or triplets, who died more or less simultaneously at a perinatal age[8]. However, such a hypothesis becomes less likely in the rare cases where more individuals have been found together, such as in a possible ritual building of La Moleta del Remei, Tarragona, where five newborns were buried in the same pit (Gracia et al. 1989). In this and similar contexts, a lethal epi-

7 A burial in fillings during the preparation of the floors of living quarters in the building cannot be excluded. However, the identification of the pit features and their limits is not always easy in archaeology, especially if the fillings are indistinguishable from the surrounding sediment.

8 Augustí et al. 2000; Armandáriz/de Miguel 2006; de Miguel 2009; Lorrio et al. 2010; Subirà/Molist 2016; Blasco/Montón 2019.

Fig. 3 Aerial view of Alto de la Cruz during the 1989 excavation campaign.

Abb. 3 *Luftaufnahme von Alto de la Cruz während der Ausgrabungskampagne 1989.*

demic outbreak might provide a plausible explanation for the simultaneous death of a larger number of newborns.

The apparent randomness concerning the number of tombs, the number of inhumations per tomb, and their location inside the settlements suggests that the event or circumstances leading to intramural burial practices were unforeseeable or erratic, as well as selective in view of the limited number of skeletons found in living spaces. Different interpretations have been proposed, but none accounts for the rareness, restricted age, and the widespread chronological and geographical practice of intramural inhumation during the Final Bronze Age and Iron Age of eastern Iberia. Sacrificial rituals have been suggested for a long time (Gusi 1970), but these are not supported by available anthropological evidence. Human sacrifices could be expected in the ritual buildings identified in many Iron Age settlements, but are less likely to have taken place in simple houses, and even less so in workshops or storage rooms. Some authors have related the burials to offerings during the construction or remodelling of buildings, as this would account for the regular placement of the burials next to the house or fortification walls (Guérin/Martínez 1988; Dedet/Schwaller 1990). A third way to interpret these interments is simply to consider them as a selection of children who died of natural causes during or shortly after birth (Armendáriz/de Miguel 2006, 41; Lorrio et al. 2010). So far, no archaeogenetic investigation has been conducted to determine the circumstances under which, perinates and children younger than one year old, were given special burial rites in built areas of settlements.

The Early Iron Age villages of Alto de la Cruz, Las Eretas and El Castejón

The intramural child burials studied here come from the archaeological excavations carried out in three fortified villages located in northern Spain, in the modern towns of Cortes, Berbinzana and Bargota, in present-day Navarra. They were recovered in the archaeological levels of the Early Iron Age and are dated in a chronological range between the 8th and 5th centuries BC (c. 800–450 cal BC).

The three sites are typical of a new occupation pattern emerging in the northeast of the Iberian Peninsula during the last stage of the Final Bronze Age under the influence of the local Urnfield Culture and which developed during the Early Iron Age: fortified villages with blocks of rectangular houses organised around a central street, and extramural cremation necropolis, sustained by a largely agricultural economy. Els Vilars d'Arbeca, Lleida, located in the alluvial plain of the lower Segre, is the best studied site in the Ebro Valley and a paradigmatic example of this phenomenon (Alonso et al. 2018). In a relatively short time this model of territorial setting expanded up the Ebro River throughout the valley until reaching Navarra in its upper course, with numerous intermediate examples, such as the most recently studied Cabezo de la Cruz in La Muela, Zaragoza (Picazo/Rodanés 2009) and La Codera in Alcolea de Cinca, Huesca (Montón 2004).

In Navarra this new territorial planning took place somewhat later than in Catalonia, but it was quickly implemented in the alluvial plains of the Ebro River (Fig. 2) and its main tributaries in the 8th century BC. Hilltop settlements – *castra* – were also established at the foot of mountains and interfluves that close and structure this great fluvial basin (Armendáriz 2008). While Alto de la Cruz and Las Eretas are good examples of exquisitely fortified villages in plains located at the bottom of valleys next to the Ebro and Arga Rivers, respectively, El Castejón de Bargota is a fortified hilltop settlement that occupies one of the heights in the southern foothills of the Cantabrian Mountains.

Alto de la Cruz (Cortes)

Better known internationally as »Cortes de Navarra«, this Iron Age town is located just over 4.5 km from the current course of the Ebro, next to the Huecha River, which runs only 1.5 km away and is a tributary of the Ebro on its right bank (Fig. 3; UTM: 629.007/4.462.981). It occupies the centre of a wide alluvial plain at 260–267 m a.s.l., formed by deep,

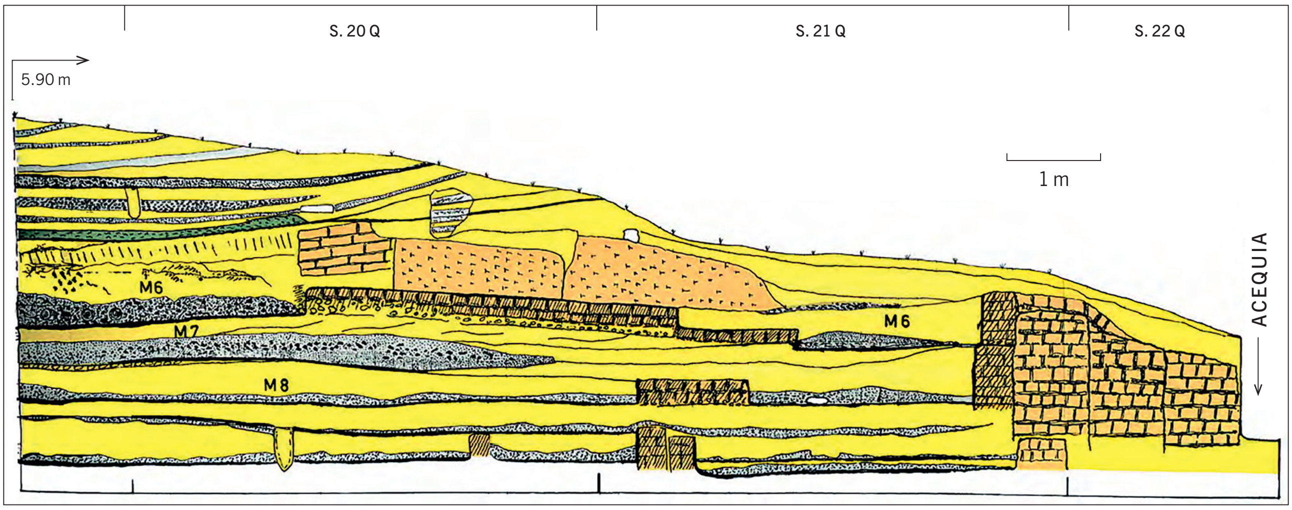

Fig. 4 Stratigraphic section of the Early Iron Age layers and mud brick wall of Alto de la Cruz. M8 corresponds to settlement phase PIIIb, while M6 is PIIb.

Abb. 4 *Stratigrafischer Abschnitt der früheisenzeitlichen Schichten und der Lehmziegelmauer von Alto de la Cruz. M8 entspricht der Siedlungsphase PIIIb, während M6 PIIb ist.*

humid and highly fertile soils, which are highly agriculturally productive both today as well as in the past. Technically, the site can be defined as a »tell«, which is an accumulation of archaeological levels that reaches a stratigraphic record of 6.25 m high, and that developed from the Late Bronze Age (10th–11th centuries BC) to the beginning of the Middle Iron Age in the 4th century BC (García et al. 1994). This tell is actually the result of the superposition of 14 building phases on the same site, which makes it the widest and most representative sequence of all the settlements of this type that have been studied so far in the Ebro Valley. It was the habitat of a peasant population, specialised in the production of cereals, although it also had an important livestock, artisanal and metallurgical development.

Discovered accidentally in 1946 during clearing works on the southern slope of the hill for the construction of a rural hut, a year later the Provincial Council of Navarra began its systematic research, which continued until 1957. Initially excavated by B. Taracena and O. Gil (1951; Gil 1953), the responsibility later passed to J. Maluquer de Motes (1958). Three decades later Maluquer resumed fieldwork in Cortes in 1985, with the purpose of excavating the lower levels of the site, which were scarcely explored in the first campaigns (Maluquer de Motes et al. 1988). After his death in 1988, F. Gracia and G. Munilla (1996) continued the work. They opened a new stratigraphic survey (C1) in the core of the site, which was excavated to the bedrock, in whose profiles (Fig. 4) a complete chrono-stratigraphic sequence of the first construction phases, or moments of occupation, of the site was recognised. These were added to the one established by Maluquer in 1958 (García et al. 1994). No further excavations have been carried out on the site since 1992.

In general, the architecture of the town follows an *a priori* design, since it reproduces the same model seen in Els Vilars d'Arbeca: a fortified oval enclosure of about 7500 m^2 with blocks of attached houses built against the peripheral wall and another block of houses of identical type in the centre, delimited by a street that provides access to all the houses of the town (Fig. 5; Armendáriz 2008, Cat.-N°. 244). The fortification is less studied because excavations focused mostly on the inner space. It consists of a solid adobe with a width that varied between 1.20 m (in phase PIIIa, 9th century BC) and 2.50 m (PI, 4th century BC). Solid adobe bastions or equidistant towers of c. 3 m deep must have been attached to the wall. An outer ditch was dug into the ground around the wall, though it has not been possible to prove if it was floodable. The population of Alto de la Cruz had at least one cremation necropolis (La Atalaya), which was discovered in a hill of the land less than 1 km away from the town in a southerly direction (Maluquer de Motes/Vázquez de Parga 1956).

Maluquer, in his famous synthesis published after the last campaign of the first period of excavations (Maluquer de Motes 1958), concluded that the chronological sequence of the site was roughly articulated in three major construction phases, separated by destruction levels caused by generalised fires, which required the integral reconstruction and new urban planning of the hamlet: Village PIII (850–700 BC), Village PII (700–500 BC), and Village PI (550–350 BC). The new radiocarbon dates obtained from the infant remains studied here mostly correspond to these levels, except for perhaps the initial period (phase PIIIa), confirming a chronology between c. 800–400 cal BC *(infra)*. According to the new radiocarbon results, one child burial excavated in 1949 dates to 992–1032 cal AD. Unfortunately, nothing is known about the archaeological context. Although the ^{14}C date fulfils the usual quality standards[9], a new sample of the same individual is being prepared for radiocarbon dating.

What characterises the domestic architecture of these three superimposed villages and their different intermedi-

9 C:N ratio: 3.2; C: 24.1 %; Collagen: 3.6 %.

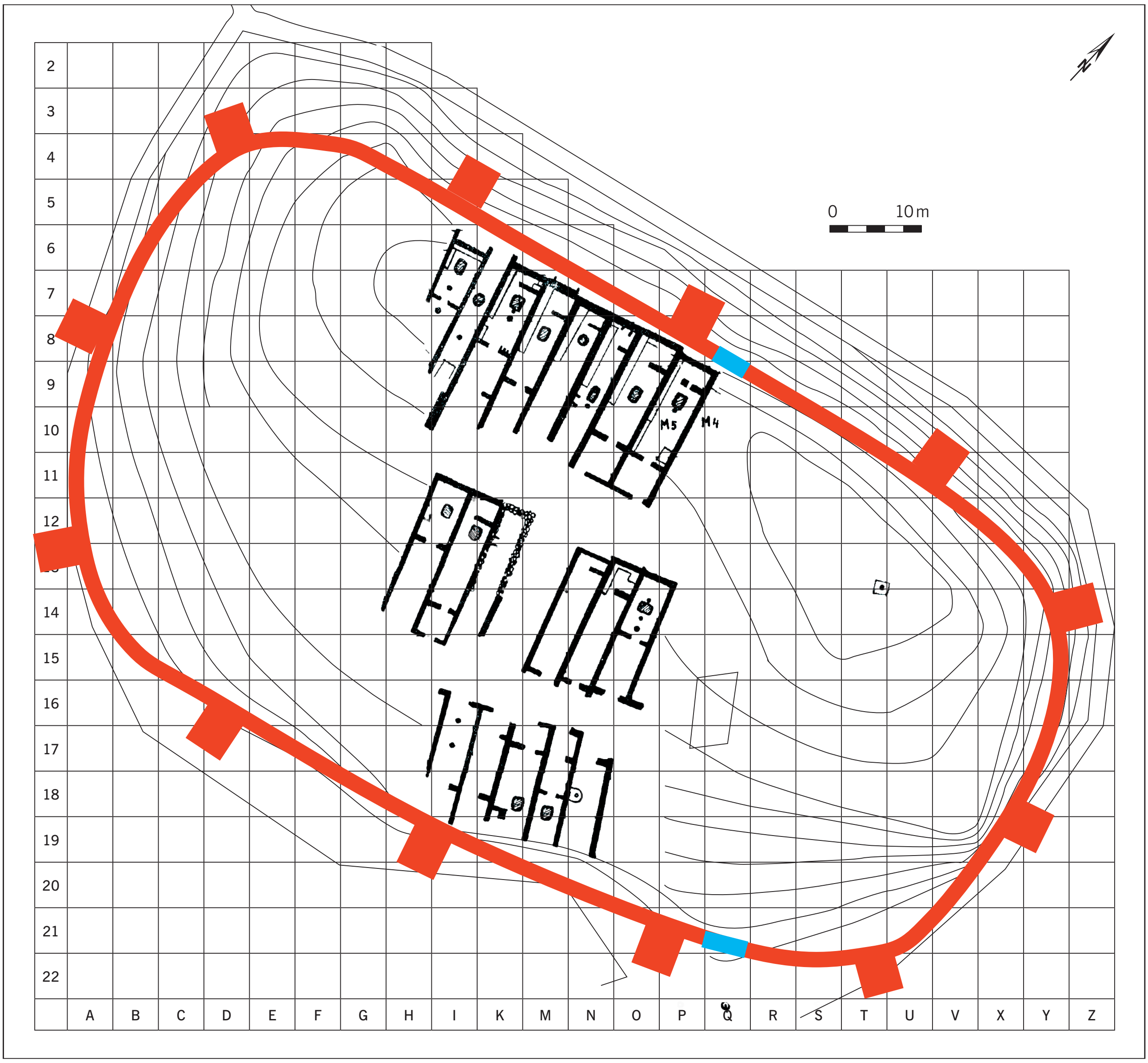

Fig. 5 General plan of Alto de la Cruz Village PIIb with our proposal for the reconstruction of its possible fortification. Blue: documented parts of the wall; red: proposed layout.

Abb. 5 *Gesamtplan des Dorfes Alto de la Cruz PIIb mit unserem Vorschlag für die Rekonstruktion seiner möglichen Befestigung. Blau: dokumentierte Teile der Mauer; rot: der vorgeschlagene Grundriss.*

ate remodelling phases is that they all reproduce the same house model (Fig. 6) with a rectangular ground plan of tripartite division, involving a lobby at the entrance, a central room and a pantry in the back, and this model hardly changed over time. If anything, there was a loss of the isometry of the ground plans of the most recent phases of the settlement (García 1994). However, the last excavation seasons (1989–1992) identified three new construction phases below Village PIII, in the lower levels of the stratigraphic cuts C1. Therefore, in the Final Bronze Age layers, called PIV, PV and PVI, a very different building pattern developed. This consisted of a dispersed habitat pattern (or unstructured village) made up of huts of square or trapezoidal ground plan, built with small intestate posts vertically covered by mud (García 1994), which are typical in the region during the Bronze Age. Therefore, in the period between Villages PIV and PIII (around the 9th century BC) an evident social change occurred among its inhabitants that led to the construction of a fortified town with clusters of houses of rectangular ground plan (PIII). The lack of continuity in the investigation of the lower levels of Alto de la Cruz since 1992

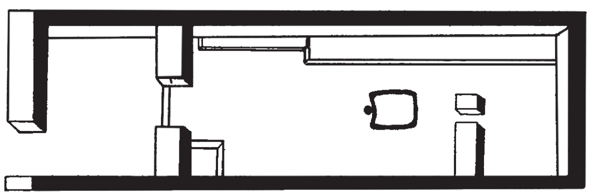

Fig. 6 Plan of the house M5 of the PIIb.

Abb. 6 *Grundriss des Hauses M5 der Phase PIIb.*

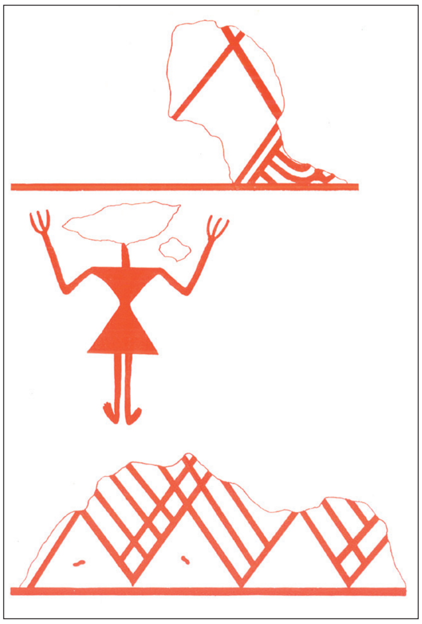

Fig. 7 Detail of the plaster of the whitewashed wall painted with red motifs of the lobby of house 8 of the PIIb.

Abb. 7 *Detail des Putzes der weiß getünchten, mit roten Motiven bemalten Wand dem Eingangsbereich des Hauses 8 der Phase PIIb.*

Fig. 8 Wall painting at Alto de la Cruz Iron Age house.

Abb. 8 *Wandmalerei im eisenzeitlichen Haus von Alto de la Cruz.*

prevents us from verifying how this change occurred. However, it introduced new ways of life and a shift from the hut to the house in a fortified and urbanised town. Whether this implied a break in continuity of the previous Bronze Age communities, and whether there were contributions from migratory settlers of trans-Pyrenean origin remains a debated issue, which this study will start to address from an archaeogenetic perspective.

Of all the research carried out in Alto de la Cruz perhaps the best-known feature is the internal structuring of their houses. These were rectangular in shape with only one entrance from the street. The houses were organised around a central room that had one or more hearths and sometimes an oven with a clay vault attached to the walls. In some cases, benches appear along the walls at the back of the house, where the roof is higher and a loft, mezzanine or a first floor might have been raised. The walls were plastered and whitewashed, and sometimes decorated with colourful geometric decorative motifs painted in red and black (Fig. 7–8). Few variations of this building scheme are observed between the different phases of the town

From the first excavation campaigns, infant burials in simple pits were detected under the floor of these houses, some of which were accompanied by personal ornaments and funeral offerings (Fig. 9). Although not all of these burials were well defined because of the methods used in earlier excavations, this was not the case for burials recovered in the last excavation campaigns (1985–1992). In any case, from all of the data collected to date, a continuous practice of burying children of perinatal age from the levels of Village PIIIb (8th century BC) to Village PIb (5th–4th centuries BC) has been attested.

Fig. 9 Perinatal inhumation with large limestone bead, which could correspond to individual CRU016.

Abb. 9 *Perinatale Bestattung mit großer Kalksteinperle, die dem Individuum CRU016 entsprechen könnte.*

Fig. 10 Arga River Valley from the south (Miranda de Arga). In the background, next to the river, is the town of Berbinzana.

Abb. 10 *Arga-Flusstal von Süden (Miranda de Arga). Im Hintergrund, neben dem Fluss, liegt die Stadt Berbinzana.*

Las Eretas (Berbinzana)

The site of Las Eretas is located in the middle-lower stretch of the Arga River, which provides the Ebro with an important water flow on its left bank. It is in a valley bottom that is characterised by its deep and well-drained soils of high agricultural productivity (Fig. 10; UTM: 596.082/4.709.202). Located on the right bank, at the edge of the first alluvial terrace next to the town of Berbinzana, the hilltop settlement rises 310 m a.s.l. Discovered originally in 1991 during the works prior to an urbanisation project, the archaeological excavations began in the same year and continued for five years. In the year 2000 excavations resumed. These excavations have allowed us to study the defensive structures and several houses of a fortified town founded *ex novo* around the 8th century BC and which was continuously inhabited until the 1st century BC, although the levels corresponding to the final phase of the Iron Age are preserved in a testimonial way. It is estimated that it may have occupied an interior area of about 4500 m^2, of which only 600 m^2 have been excavated (Armendáriz 1998; Armendáriz 2007; Armendáriz 2008). At present its ruins have become an archaeological park containing a monographic museum[10].

Like Alto de la Cruz, Las Eretas is a fortified lowland village showing the same defensive pattern and a similar urban plot. Its robust outer stone wall with foundations made of large 1.60 m wide dry stone blocks was reinforced on the outside with solid square towers raised with dry ashlar stone masonry. On the outside to the west there must have existed a defensive ditch dug in the gravels of the land, while to the east the Arga River offered a natural defence to the village. The urban structure featured a central street, initially paved with boulders and then with stone slabs, around which a rectangular line of attached houses was built against the outer wall.

The stratigraphic analysis of the site allows us to conclude that, unlike at Alto de la Cruz, Las Eretas was not occupied before the construction of the town, as both the wall and the houses are directly built on the natural terrain. Stratigraphic observations confirm that the first houses were already attached to the interior side of the fortification wall. This indicates a planned founding of the site adhering to the well-known village pattern in the Ebro Valley. Initially, the houses were isolated from each other and were built in the traditional manner with small wooden posts driven into the ground covered with mud (Village I, late 9th entury or early 8th century BC), but they were already elongated and rectangular, although soon they were destroyed by fire. The hamlet was rebuilt on the ashes, with the new houses leaning against the wall (Villages II and III, 8th–5th century BC) and with different construction phases and partial adaptations on the same road axis. This settlement was also subsequently destroyed by fire. The superficial erosion due to pressure from human occupation in historical times has hampered preservation of the settlements of the Late Iron Age (4th–1st centuries BC), although this site's continuous occupation is documented by a few remains until the first third of the 1st century BC, when there is a level of destruction that can be associated with the Sertorian wars.

In total, four houses have been completely excavated (Fig. 11), and many others partially, and these correspond to the two lower (earlier) levels of the stratigraphic record. The typical house of Las Eretas is a replica of those of the Alto de la Cruz, if perhaps even more formal and repetitive, as they are also divided into three rooms that are separated by light internal partitions connected by doors and include: a vestibule, where the oven is usually placed; the central room, which has a square fireplace of clay plate with a flange in the centre and at the side of the door and in the back of the room, next to the wall, a storage area that

10 <https://eretas.es/es/informacion/introduccion.php> (14.06.2023).

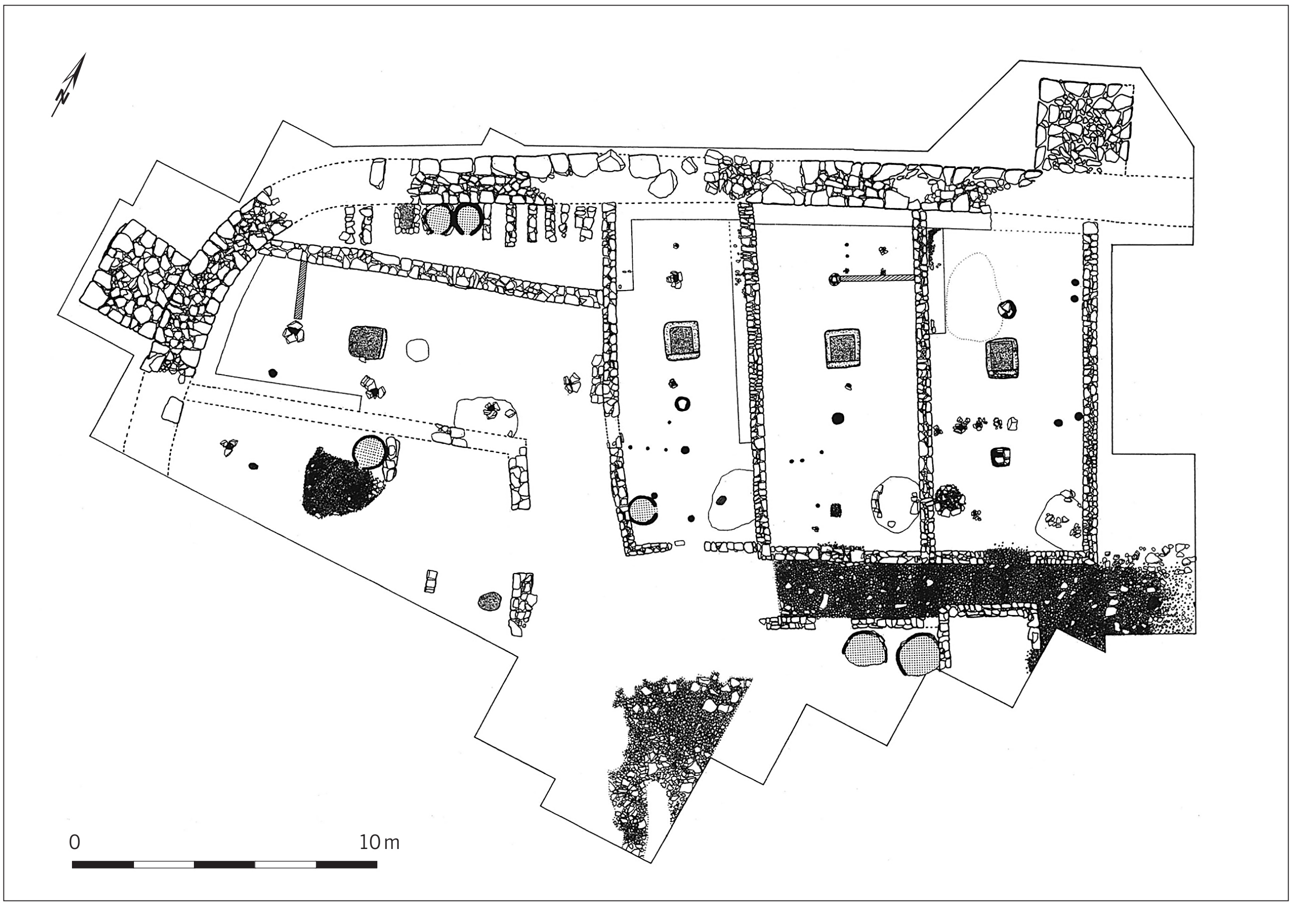

Fig. 11 Ground plan of the area excavated in Las Eretas.

Abb. 11 *Grundriss der ausgegrabenen Fläche in Las Eretas.*

always has a bench running in the background and sometimes makes an angle to the central room. In terms of construction, they are based on a continuous stone plinth about 60 cm high on which the dividing walls between houses and the façade are raised with a wooden framework and adobe or earth wall work. Two large central posts in the interior supported the wooden beams on which the roof was held and this was made of clay and organic materials. It was arranged with a slope so that rain could drain to the street. A loft is believed to have existed above the storage area in the back of the houses. Like at Alto de la Cruz, the houses had their inside walls plastered with mortar and were painted white; decorative motifs coloured in black and red have been preserved on the lateral benches.

In Las Eretas five child graves have been recovered under the floor of two houses belonging to the second construction phase of the town (Armendáriz/de Miguel 2006). These tombs were excavated as single pits in different parts of the house. The first contained a double, simultaneous burial (Fig. 12), while the rest contained single individuals. Recently, these burials have been ^{14}C-dated to between 800 and 550 BC *(infra)*. The care with which tomb 5 (inhumation 6) was constructed in the pantry of house 2 is striking, because there was a stone slab closing the tomb of a child aged just a few months and to whom a ceramic cup was offered as funerary *trousseau*.

El Castejón (Bargota)

El Castejón is a fortified and artificially plateaued hilltop settlement located on a steep rocky mountainous elevation of the piedmont of the Yoar and Cantabrian Mountains (Fig. 13), between the ravines of Cornava and Marimañas. Its outstanding topographical position (635–649 m a.s.l.; UTM: 557.125/4.711.677) gives it an exceptional perspective of its immediate surroundings, which allows it to exercise long-distance control of the territory and to establish visual contact with other fortified villages and other contemporary settlements in the region.

Unfortunately, the site has not been well preserved due to several factors. In particular, this is due to the opening of several quarry sites in historical times, the reforestation of the site in the 20th century, which destroyed much of the western sector of the *castrum*, the agricultural exploitation of the site, natural erosion, and plundering since ancient times. Even so, it preserves part of the eastern side of the fortification that follows the natural perimeter of the hill where the wall that rests on the bed was cut along the defensive perimeter to increase the fortification's height. The access ramp to the enclosure is also visible on the eastern slope (Armendáriz 2008).

The site presents an occupation sequence from the Early to the Late Iron Age (8th–2nd century BC), as attested by the recovered archaeological remains. No preceding material

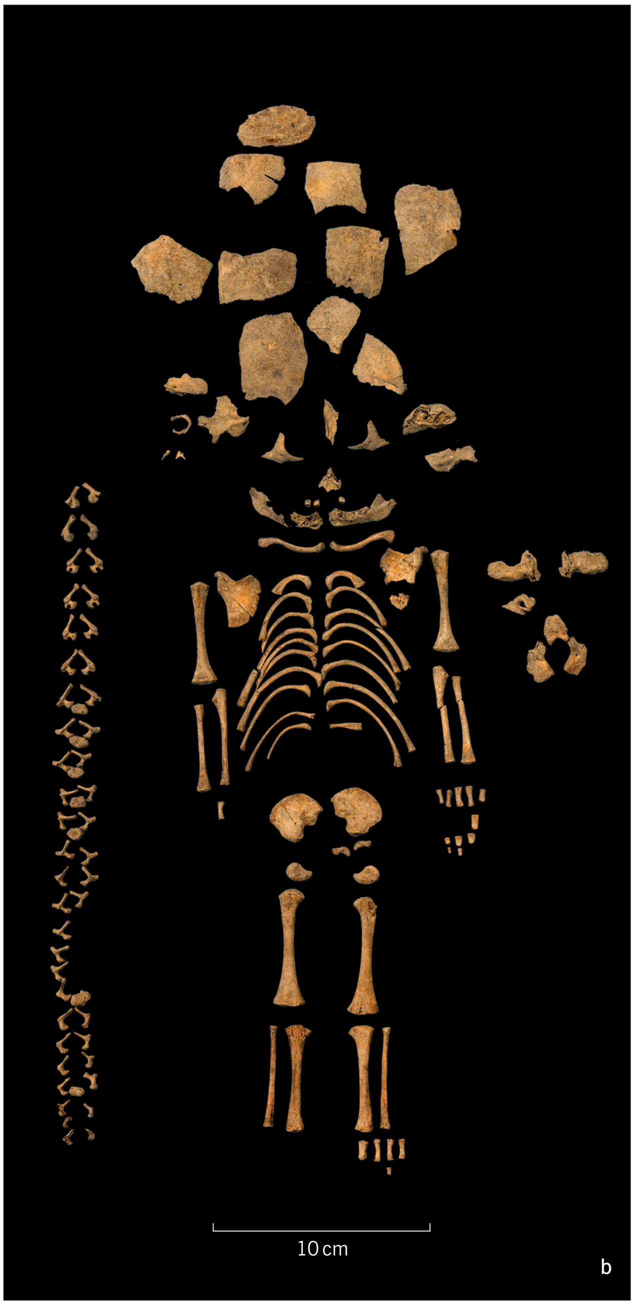

Fig. 12a–b Burial 1 of Las Eretas. a Excavation of the infant double burial; b Skeletons 1 and 2.

Abb. 12a–b *Grab 1 von Las Eretas: a Ausgrabung der Säuglingsdoppelbestattung; b Skelette 1 und 2.*

dating to the Final Bronze Age has been identified so far. Based on the topography of the relief, an area close to 7700 m^2 could have been occupied during the site's zenith in the Late Iron Age.

Between 1992 and 1994, A. Castiella led his archaeological team from the University of Navarra in the excavation and investigation of this site (Castiella et al. 2009). An excavation was undertaken in an area of about 500 m^2 in which, on the one hand, confirmed the very poor conservation of the western part of the site, where numerous intrusions and loss of its architectural structure occurred. On the other hand, it allowed the study of parts of its urban layout, documented and recorded the occupational sequence throughout the Iron Age, and, lastly, recovered representative domestic material culture of the Early Iron Age and the Celtiberian Late Iron Age.

The excavations confirmed that only the eastern sector of the settlement was relatively well preserved, including a 2.60 m wide ashlar stone wall. Rectangular houses were leaning against the inner side of this fortification (Fig. 14a), of which only two could be – partially – delimited. Houses were raised on a stone plinth to keep the accommodation dry and the roof was supported by internally divided walls and central posts that aligned along the axis of the house. The preserved surface of house 1 is only 44 m^2 and in house 2 it is estimated that it could have reached 70 m^2. Inside, hearths and numerous post holes have been discovered. They would have supported the roof, although they do not follow the regular placement that has been seen in the houses of Alto de la Cruz or Las Eretas. Unfortunately, the doors of the houses and the entrance hall have not been preserved, nor has the street from which they would have been accessed because this area of the site has been completely lost. Despite the above caveats, we believe that the urbanism of the *castrum* must have been interconnected by a central street that would have followed the longitudinal axis of the hill, as has been seen in other contemporary settlements in the region.

The double child burial that we analysed in this work was located next to the wide door of the entrance space of house 1 (Fig. 14b–c), which is a compartment of 8.50 m^2 that is attached to the fortification wall and is separated from the eastern part of the house by a masonry wall. The burial was a circular pit of 70 cm in diameter, delimited by an alignment of stones. Apparently, in the course of the excavation two fragments of Celtiberian ceramics were associated with this burial, and this allowed dating to the Late Iron Age (Castiella et al. 2009, 95–96; 111; de Miguel 2009). However, the absolute dates (^{14}C) of both children *(infra)*, provide calibrated dates between 790 and 546 BC, therefore corresponding to the Early Iron Age of El Castejón and contemporary with the graves of the towns Alto de la Cruz and Las Eretas.

Fig. 13a–b View of El Castejón from the east (a) and south (b).

Abb. 13a–b *Ansicht von El Castejón von Osten (a) und Süden (b).*

The anthropology of intramural child burials

Alto de la Cruz

The 36 intramural child burials from the Alto de la Cruz site have been studied, 9 of these from the excavations carried out in the 1980s, of which a detailed report is available (Mercadal et al. 1990). The remains of the excavations performed between 1948 and 1957 have been identified from the references found in the database of the storeroom of the Archaeological Service of the Government of Navarra. The surviving data (they lacked the documentation recovered at the time of the excavation) have frequently provided imprecise information on the levels and location of the remains. However, it is almost exceptional that such remains of children from archaeological excavations should still survive, as researchers in the first half of the 20th century generally regarded children's remains as not providing relevant information on past populations.

The state of preservation is good in those remains recovered in the campaigns of the 1980s (Mercadal et al. 1990), in which it is obvious that the bones were recovered with great care. When it comes to materials from the oldest excavations, different bones are represented among the various individuals. The material preserved ranges from a single bone to various sets of bones, in which it was possible to differentiate at least two individuals, generally in a partial form. One individual was split between two sets with two different labels (with fragments of the same bone found in each set). It must be pointed out that in some cases animal bones and elements from the grave goods were recovered along with the human remains. No burnt bones have been identified, nor have bones of persons older than 2 or 3 years been found.

Determining the minimum number of individuals (MNI) has been complicated by the coexistence of at least two individuals in some sets, and by the presence of remains with imprecise references regarding their location. This latter fact hinders the possibility of unequivocally asserting or refuting whether the loose remains or the barely represented sets of bones correspond to the missing remains in some of the better-preserved burials. This is why one must take into account that there may be limitations when determining the MNI.

Fig. 14a–c (right page) a Ground plan of the excavated area of El Castejón settlement; b excavation of the twin child burial of house 1; c Skeleton 1 and 2.

Abb. 14a–c (rechte Seite) *a Grundriss der ausgegrabenen Fläche der Siedlung El Castejón; b Ausgrabung der Zwillingskinderbestattung von Haus 1; c Skelett 1 und 2.*


auxiliary room 1
House 1
auxiliary room 2
House 2
0
5 m
a
b
10 cm
10 cm
c

The identification of two individuals in several bone assemblages needs to be highlighted, as it would imply their interment in the same funerary feature, either simultaneously or successively (CRU013.1–CRU013.2, CRU015.1–CRU015.2, CRU020–CRU021, and CRU030.1–CRU030.2; Tab. 1). In all cases a certain asymmetry of skeletal development is observed, an aspect which is particularly marked in the case of CRU015.1 and CRU015.2, where the age difference is more than two years. Of these double burials, only in the case of CRU020 and CRU021 both individuals could be genetically analysed.

The difficulty in determining age stems from the variety of available methods. For early ages, such as moments linked to foetal life and full-term pregnancies (37/40 weeks), bone measurements are viewed as giving a reliable approximation of age. In this study we have used two methods to determine age, one of them being that proposed by I. Fazekas and F. Kósa (1978), which includes common and easy to establish parameters. Their proposals stem from the forensic study of a high number of children all of whose skeletal bones were measured, establishing averages by gestational weeks, on the basis of their classification according to lunar months, which identifies 40 weeks of gestation with the 10 lunar months. Likewise, this method discriminates by sex, even if we rarely have this information in archaeology. Although the biological sex has been identified for most of the individuals included in this study, we have opted to use the general tables for age assignment in order to make the work comparable to other studies. For age determination, we have given priority to the measurements obtained from the humeri and femora; whenever we had no valid measurements for these other bones were used. A second method has been proposed by P. Jeanty et al. (1984), who made use of the radiological record of foetuses to create tables in which the lengths of the long bones are differentiated into three categories in accordance with the foetal development percentiles currently available in the perinatal diagnosis. In our study we used the 50th percentile (P50), as we were aware of the errors implied because foetal development can be subject to considerable variation. Given the inherent difficulty in predicting the age of the infants, we made a mean age estimation with the parameters from Jeanty et al. (1984), and we decided to use the guidelines of Fazekas and Kósa (1978) whenever possible.

The data recovered from the burials indicate that a considerable portion of the individuals correspond to children with an age above that of birth. In such cases we have taken into account the length of the long bones as an age-discriminatory element, using the values offered by M. Maresh (1970), taken from L. Scheuer and S. Black (2000). Further considerations should be made when adopting these methods. The determination of age derived from dental development, for which we have used D. Ubelaker (1994, 64) as well as S. AlQahtani et al. (2010) should be considered. Occasionally, we found evidence of ossification phases indicating older ages than those suggested by the length of the long bones, and this was viewed as the most accurate value, along with that of dentition, particularly for infants who have survived beyond the first month of life. The most relevant markers considered were the fusion of the mental symphysis of the mandible and the presence of fused vertebral arches.

Another parameter we took into consideration is that of size, applied to perinatal individuals and on the basis of the formulae proposed by V. Balthazard and H. Dervieux (1921). In our case, they make it possible to contrast the differences in size both in relation to developmental age and to the verified evidence of asymmetries between the bones of the upper and lower limbs of some of the individuals.

The presence of clear pathological signs in several of the individuals studied is noteworthy. Hyperostosis and periostitis are the main signs that allow us to identify health status. It is difficult to relate these alterations to a specific pathology; however, the most common causes are nutritional deficit, with various ultimate causes (malnutrition, anaemia, infections etc.; Lewis 2018, 131–223).

The early death of the infants can be related to possible pregnancy complications for those who died before reaching gestational maturity (less than 37 weeks). Those who died at the end of gestation, a possible cause of death might be related to birth complications. However, some skeletons show pathologies possibly linked to pregnancy problems. During the first month of extra-uterine life, deaths are frequently related both to the after-effects of a complicated birth, and to genetic and congenital alterations that limit the development of the babies, leading to their death. It is also during the first year of life that there is a higher mortality rate both in weakened infants, as a result of poor adaptation to life, and due mainly to respiratory and digestive infectious disease states. Identifying the reasons for the death of those who survive the first year of life is complex, although they are often related to infectious causes.

Some individuals show discrepancies in bone development, occasionally with several months of *decalage*, which must be related to health conditions that prevented normal bone development. In these cases, we have prioritised dental age over bone age for their classification. Similarly, in some individuals, differences in bone development have been observed, generally between the humeri and femora, although the specific cause of these asymmetries has yet to be determined. In the case of CRU013.1, morphological anomalies were identified in the humerus and femur, as well as in the scapula and one hemi-vertebra, and in another incomplete bone, probably a fibula, initially indicating a clear alteration in body morphology. It was difficult to relate these bone pathologies to a specific syndrome, having raised the possibility of osteogenesis imperfecta. As we shall see below, the genomic study of this individual revealed a case of trisomy of chromosome 18, or Edward's syndrome, the first documented in archaeological contexts.

On the basis of the minimum number of 36 child remains in Alto de la Cruz (cf. Tab. 1), we obtain a demographic profile which, despite possible limitations, we believe may be representative of the population buried in the settlement. The distribution of the age of death is significant due to the limited representation of individuals who died before the age of foetal maturation (37 weeks).

In the light of the data obtained, we believe that the distribution of age and sex could be explained by complications arising during pregnancy and the first weeks of life

(Tab. 2; Fig. 15). More difficult to explain is the slight increase of children over six months of age, some of whom were noted for a clear asymmetry between dental and bone development.

Las Eretas (Berbinzana)

The presence of perinatal burials in the Las Eretas site was documented during the excavations made under the supervision of one of the authors J. Armendáriz, a published initial study being already available (Armendáriz/de Miguel 2004). Recently, the possibility of carrying out genetic studies that make it possible to obtain data on sex and kinship relationships has led us to revise the initial data and modify some of the results in order to make them comparable to those obtained at the sites of Alto de la Cruz (Cortes de Navarra) and Castejón de Bargota (de Miguel 2009).

Following the same methodology to determine the approximate age of death, we have created a table with the data obtained from the length of the humerus and the femur, using the parameters proposed by Balthazard and Dervieux (1921) and Fazekas and Kósa (1978). The results obtained from the genetic study have been included, as has the determination of the sex, the identification of two twin brothers and a case of trisomy 21 (Down's syndrome) (Tab. 3–4).

El Castejón (Bargota)

Excavations at this Iron Age site obtained partially preserved skeletal remains of two young children. They were preserved partially in the anatomical position, although most of the bone remains were moved from their original position.

In order to determine their ages, the measurements of various long bones – such as tibiae, a femur, a humerus and two clavicles – were used. The determination of which remains belonged to which individual proved challenging as the skeletons were found in a disordered state. Subsequently, the complexity of laboratory assignment of some of the remains to each one of the individuals limited the measurement of bone sizes and estimation of ages (de Miguel 2009).

On the basis of the results, we verified the presence of two individuals who had been buried under the floor of the house, close to each other. The data available allow us to regard them as primary deposits, close to each other in time, though it was not possible to determine whether the deposits were simultaneous or separated by a period of time – clearly, however, it was a short time-period judging from the approximate ages documented. From the measurements recovered, it is obvious that both very probably survived for some time following birth (Tab. 5).

The results obtained from the available analyses of different bones indicate that the age of both new-born children was above that of the expected 40 weeks of gestation. Likewise, the size, independently of the correspondence between one individual or the other, indicates figures of above 51 cm. This leads us to believe that both individuals survived for an undetermined period of time after birth. It is likely that they died during the first month of life. In the study of the surviving remains, there were no signs of any significant alterations that might offer clues as to the cause of death.

The genetic analysis of the Early Iron Age infant burials

A total of 37 Iron Age (800–40 BC), intramurally buried children were sampled from Alto de la Cruz (CRU, n = 29 individuals), Las Eretas (ERE, n = 6), and Castejón de Bargota (BGO, n = 2) in the Navarra region of present-day northern Spain.

Preferentially, petrous parts of the temporal bone (Gamba et al. 2014; Pinhasi et al. 2015; Parker et al. 2020) were sampled for ancient DNA (aDNA), after which single-stranded non-UDG treated libraries (Gansauge/Meyer 2013; Rohland et al. 2015) were generated and screened for aDNA preservation on an Illumina HiSeq machine. Endogenous human aDNA preservation was exceptional (Tab. 6), meaning only a subset (n = 10) of the libraries needed to be 1240K captured (Mathieson et al. 2015) before deeper Illumina sequencing. All sequencing data produced were processed using nf-core/eager version 2.4.5[11]. Briefly, the sequenced reads were preprocessed with AdapterRemoval (v2.3.2) and mapped to the human reference genome (hs37d5) using bwa-aln (v0.7.17-r1188). Duplicates originating from PCR amplification during laboratory processing were then removed using picard MarkDuplicates (v2.26.0). Pseudohaploid genotypes were called using pileupCaller (from sequenceTools v1.5.2)[12] by randomly sampling one allele at each 1240K site. To eliminate the effects of deamination damage on the resulting genotypes the additional parameter ›--singleStrandMode‹ was used, which restricts the reads used when calling transitions to only forward- or reverse-mapped reads, depending on the alleles of the genotyped SNP. Enough data was produced from 35 children (> 40 000 1240K SNPs) for downstream autosomal, Y-chromosomal, and mitochondrial analyses (Tab. 6).

Population genetic analysis

In order to assess the genetic affinities of the newly studied Iron Age individuals from Navarra (n = 35), we conducted a principal components analysis (PCA; Fig. 16) on modern-day west Eurasian genetic diversity onto which ancient Bronze Age and Iron Age individuals from northern Spain were projected[13].

The new Iron Age Navarra individuals plot closely to previously published Bronze Age and Iron Age individuals from northern Spain (Fig. 16). The Bronze Age individuals (green) form a cline along PC2, which has been shown to be correlated with steppe-related ancestry. This is most plausibly indicative of recent admixture between Spanish Chalcolithic individuals, who are lower on PC2, with incoming central European individuals carrying steppe-related ancestry, who

11 <https://github.com/nf-core/eager/tree/2.4.5> (14.06.2023).

12 <https://github.com/stschiff/sequenceTools> (14.06.2023).

13 Lazaridis et al. 2014; Günther et al. 2015; Valdiosera et al. 2018; Olalde et al. 2019; Patterson et al. 2022.

LabID	Archaeological label	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
CRU001	1948	mm	58.3	58.4			38 w	M	TIL: 59.3 mm (38 w; 47.04 cm (Balthazard/Dervieux 1921) Asymmetric development between humerus/tibia Down's syndrome
		Fazekas/Kósa 1978 (w)	36	36					
		Balthazard/Dervieux 1921 (cm)	45.89	45.96					
CRU002	1948. Hab saliente piso D. 23.III.48	mm	68.5				0/1 m	F	
		Fazekas/Kósa 1978 (w)	> 40						
		Balthazard/Dervieux 1921 (cm)	52.52						
		Maresh 1970 (m)	< 1.5						
CRU003	1949. 8.10.49. Estrato C-2. Esqueleto infantil al nivel superior de los muros de dicho estrato, junto al ángulo NE.	mm	61.3	61.2	68.8		38 w	M	Hyperostosis
		Fazekas/Kósa 1978 (w)	38	38	38				
		Balthazard/Dervieux 1921 (cm)	47.84	47.78	46.52				
CRU004	1949.10.10.49. C2. Corresponde C1. Junto al muro oriental cerca del ángulo NE	mm	48.3			51.2	31 w	F	Asymmetric development of long bones Hyperostosis
		Fazekas/Kósa 1978 (w)	31			30			
		Balthazard/Dervieux 1921 (cm)	39.39			36.67			
CRU005	10-IX-1949. Estrato B. Hab. 21. Pero enterrado desde el estrato A, inferior	mm	71.3	71.2	82.2	81.8	0/1 m	M	
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	54.34	54.28	54.03	53.80			
		Maresh 1970 (m)	≤ 1.5	≤ 1.5	< 1.5	< 1.5			
CRU006	1949. 17.9.49. Estrato A. Corte norte Cortes. 11.11.48. 2. H.8. C. Relación con R1	mm	65.7	65.4	72.6	72.9	0/1 m	M	Excavated in different seasons
		Fazekas/Kósa 1978 (w)	> 40	> 40	38	38			
		Balthazard/Dervieux 1921 (cm)	50.70	49.86	48.65	48.82			
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5	< 1.5			
CRU007	1949. 14-10-49. Estrato C-2. Hab.6. por encima del suelo C-2	mm	68.5	69	79.9	80.3	0/1 m	F	Hyperostosis
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	52.52	52.85	52.744	52.96			
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5	< 1.5			
CRU008	1949. 6-X-49. Esqueleto infantil. Estrato C-2. Hab. 11. Bajo muro de la habitación 11 a 17. (Corresponde a C-1)	mm	68.3	68.3	80.08	80.07	0/1 m	F	Hyperostosis
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	52.39	52.39	52.84	52.83			
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5	< 1.5			
CRU009	1950. 5.9.50. Hab.15. Estrato A. Sobre suelo						40 w	M	According to teeth ± 40 (Ubelaker 1994 1999, 64) Pars basilaris: 40 w (Scheuer/Black 2000, 62)

LabID	Archaeological label	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
CRU010	1950. 19-IX-1950. B.27. Enterramiento infantil	mm	76.3		88	87.3	0/1.5 m	M	Criba orbitaria, Hyperostosis
		Fazekas/Kósa 1978 (w)	> 40		> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	57.59		57.28	56.88			
		Maresh 1970 (m)	< 1.5		< 1.5	< 1.5			
CRU011	1951.10.9.51. Hab13.Est-rato Z	mm	79.9			≥ 92.4	6/9 m	M	Asymmetric development between long bones and teeth. Teeth/chin 6/9 m Costal notch
		Fazekas/Kósa 1978 (w)	> 40			> 40			
		Balthazard/Dervieux 1921 (cm)	59.93			59.78			
		Maresh 1970 (m)	3			± 3			
CRU012	1952. 52. 1. Hab.56	mm	70.6	71.1	78.5	78.4	± 4.5 m	M	Asymmetric development between long bones and teeth Asymmetric development between long bones Long bones 0/1,5 m Clavicular long 0/6 m (Black/Scheuer 2000) Dentition: ± 4,5 months (AlQahtani et al. 2010) Hyperostosis/periostitis
		Fazekas/Kósa 1978 (w)	> 40	> 40	39	39			
		Balthazard/Dervieux 1921 (cm)	53.89	54.21	51.96	51.90			
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5	< 1.5			
CRU013	1953. 53. Est.A. Corte A-A', esqueleto infantil. 1	mm	64.5	65	71.1		± 40 w	F	Edward's syndrome Asymmetric development between long bones Same assemblage as CRU013.2
		Fazekas/Kósa 1978 (w)	40	40	38				
		Balthazard/Dervieux 1921 (cm)	49.56	50.25	47.81				
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5				
CRU013.2	1953. 53. Est.A. Corte A-A', Esqueleto infantil 2	mm	66.6	67.2	80	80.2	0/1 m	UD	Same assemblage as CRU013.1
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	51.29	51.68	52.8	52.91			
CRU014	1953. 53.m Est.Y.	mm	68.6	69.1	77.2	78.2	0/1 m	F	Hyperostosis
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	52.59	52.91	51.23	51.68			
		Maresh 1970 (m)	< 1.5		< 1.5	< 1.5			
CRU015.1	1955. M6.1	Ubelaker 1994					2/3 y	M	Age according to teeth; Stored together with CRU015.2
CRU015.2	1955. M6.2	mm	68		75.6		0/1 m	UD	Stored together with CRU015.1
		Fazekas/Kósa 1978 (w)	> 40		> 40				
		Balthazard/Dervieux 1921 (cm)	50.3		52.2				

LabID	Archaeological label	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
CRU016	1957. 13.8.57. Sector B (8 metros) sección A-A1-A2	mm		78.3		90.8	6/9 m	M	Asymmetric development between long bones and teeth Age by teeth: 6/9 m Age by long bones: ± 3 m Age by clavicle (D: 57.1 mm): 7/12 m (Black/Scheuer 1996)
		Fazekas/Kósa 1978 (w)		> 40		> 40			
		Balthazard/Dervieux 1921 (cm)		58.89		58.84			
		Maresh 1970 (m)		± 3		± 3/6			
CRU017	1957. 14.8.57. N.1. »Chiquillo de la anilla«	mm	60.3				37 w	F	Possible grave good
		Fazekas/Kósa 1978 (w)	37						
		Balthazard/Dervieux 1921 (cm)	47.19						
CRU018	1957. 29-8-57. »Huesos de Niña/fondo con grafito«	mm	79	78.6	92	91.6	± 3 m	M	Costal notch
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	59.35	59.09	59.52	58.96			
		Maresh 1970 (m)	± 3	± 3	± 3	± 3			
CRU019	1949. Sin número	mm	98.49	98.8	121.25	121.3	18 m	F	Asymmetric development between long bones and teeth; Age by teeth: 18 m Age by long bones 6/12 m
		Maresh 1970 (m)	6/12 m	6/12 m	6/12 m	6/12 m			
CRU020	1949. Sin r eferencia 2	mm			73.3	72.6	40 w	F	Possible double burial (with CRU021).
		Fazekas/Kósa 1978 (w)			40	40			
		Balthazard/Dervieux (cm)			49.04	48.65			
CRU021	21. 1949. Sin referencia 2	mm	70.4	71	77.6	77.5	0/1 m	M	Asymmetric development between long bones, Possible double burial (with CRU020).
		Fazekas/Kósa 1978 (w)	> 40	> 40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	53.76	54.15	51.45	51.4			
		Maresh 1970 (m)	< 1.5	< 1.5	< 1.5	< 1.5			
CRU022	Individuo n.° 1. H. 87/8 N. P.II.a.	mm	63.6	64	75.8	75.8	0/1 m	F	Slight asymmetric development between long bones
		Fazekas/Kósa 1978 (w)	40	40	> 40	> 40			
		Balthazard/Dervieux 1921 (cm)	49.34	49.6	50.44	50.44			
		Maresh 1970 (m)			< 1 m	< 1 m			
CRU023	Individuo n.° 2. H. 87/8. N. P.II.a	mm		62.9	73		39 w	F	
		Fazekas/Kósa 1978 (w)		39	39				
		Balthazard/Dervieux 1921 (cm)		48.88	48.88				
CRU024	Individuo n.° 3: H. 86/19. N. P.III.b	mm	41.1	41.5	47.1	47.1	28 w	F	Down's syndrome; asymmetric development between long bones
		Fazekas/Kósa 1978 (w)	26	26	28	28			
		Balthazard/Dervieux 1921 (cm)	34.71	34.97	34.37	34.37			
CRU025	Individuo n.° 4: H. 87/8. N. P.II.a	mm	80	81.6	96.3	96.7	7 m	M	Asymmetric development between long bones and teeth
		Maresh 1970 (m)	3	3	3	3			

LabID	Archaeological label	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
CRU026	Individuo n.° 6. H. 87/8. N. P.II.a (bajo pavimento)	mm	61.2	61.8	66.1		38 w	M	Asymmetric development between long bones
		Fazekas/Kósa 1978 (w)	38	38	36				
		Balthazard/Dervieux 1921 (cm)	47.78	48.17	45.01				
CRU027	Individuo n.° 7. H. 87/8. N. P.II.a (bajo pavimento).	mm				65.5	37 w	M	
		Fazekas/Kósa 1978 (w)				37			
		Balthazard/Dervieux 1921 (cm)				44.68			
CRU028	Individuo n.° 8 (ver n.° 5). H. 88/21. N. P.III.b (bajo pavimento)	mm			69	69	38 w	M	
		Fazekas/Kósa 1978 (w)			38	38			
		Balthazard/Dervieux 1921 (cm)			46.64	46.64			
CRU029	Individuo n.° 9. H. 88/21. N. P.III.b (17 cm. bajo pavimento)	mm		60.5	63.4	63.5	37 w	M	
		Fazekas/Kósa 1978 (w)		36	37	37			
		Balthazard/Dervieux 1921 (cm)		47.32	43.504	43.56			
CRU030.1	Cortes. 3.11.48. Estrato A. habitación 3.	mm	71.1			77.6	± 1.5 m	UD	Could correspond to the same space of CRU030.2. Remains from two individuals.
		Fazekas/Kósa 1978 (w)	> 40			> 40			
		Balthazard/Dervieux 1921 (cm)	54.60						
		Maresh 1970 (m)	± 1.5						
CRU030.2	Cortes 8.11.48. Estrato A. habitación 3. »Fauna«	mm		67.7	71.8		≥ 40 w	UD	Asymmetric development between long bones could correspond to the same space of CRU030.1. Remains from two individuals
		Fazekas/Kósa 1978 (w)		> 40	39				
		Balthazard/Dervieux 1921 (cm)		52	48.20				
		Maresh 1970 (m)		< 1.5 m					
CRU031	Cortes. 21.10.49. Estrato B. huesos.	mm	73.4				1.5 m	UD	
		Fazekas/Kósa 1978 (w)	> 40 w						
		Balthazard/Dervieux 1921 (cm)	55.71						
		Maresh 1970 (m)	1.5 m						
CRU032	Septiembre 1955. Esqueleto niño. Fuera W a M6 bajo piso	mm	60.2	60.4	68.9		38 w	UD	
		Fazekas/Kósa 1978 (w)	37	37	38				
		Balthazard/Dervieux 1921 (cm)	47.19	47.26	48.58				
CRU033	Cortes. 15.X.49. Habitación 29. Estrato C-2. Bajo muro oriental.	mm		90.5		115	1 y	UD	Asymmetric development between long bones and teeth. Two bronze bracelets
		Maresh 1970 (m)		6/12 m		6/12 m			

Tab. 1 Infant individuals from Alto de la Cruz. Age and height obtained from the long bones and dentition. The formula used to obtain the results is specified. Sex was determined according to genetic analysis. HU: humerus, FE: femur, TI: tibia; R: right, L: left; M: male, F: female; UD: undetermined; w: weeks (gestational age); m: months (postnatal age); y: years (postnatal age).

Tab. 1 Säuglingsindividuen aus Alto de la Cruz. Alter und Größe werden anhand der Langknochen und des Gebisses ermittelt. Die zur Ermittlung der Ergebnisse verwendete Formel ist angegeben. Das Geschlecht wurde anhand genetischer Analysen bestimmt. HU: Humerus, FE: Femur, TI: tibia; R: rechts, L: links; M: männlich, F: weiblich; UD: nicht bestimmt; w: Wochen (Gestationsalter); m: Monate (postnatales Alter); y: Jahre (postnatales Alter).

Age	Undetemined	Female	Male	Total
24–28 weeks		CRU024		1
31–34 weeks		CRU004		1
35–36 weeks				0
37–40 weeks	CRU030.2 CRU032	CRU013.1 CRU017 CRU020 CRU023	CRU001 CRU003 CRU009 CRU026 CRU027 CRU028 CRU029	13
0–1.5 month	CRU013.2 CRU015.2	CRU002 CRU007 CRU008 CRU014 CRU022	CRU005 CRU06 CRU010 CRU021	11
1.5–3 months	CRU030.1 CRU031		CRU018	3
3–6 months			CRU012	1
6–12 months	CRU033		CRU011 CRU016 CRU025	4
2–3 years			CRU015.1	1
Total	**7**	**11**	**17**	**35**

Tab. 2 List of the individuals from Alto de la Cruz according to sex and age at death. Weeks = fetal age; months and years = postnatal age.

Tab. 2 *Liste der Individuen aus Alto de la Cruz, geordnet nach Geschlecht und Alter zum Zeitpunkt ihres Todes. Wochen = fetales Alter; Monate und Jahre = postnatales Alter.*

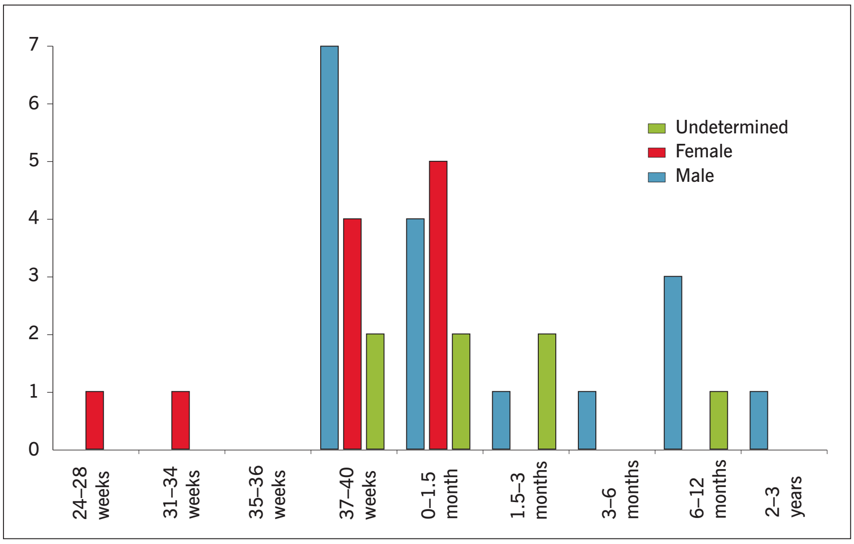

Fig. 15 Histogram of age and sex of the child burials from Alto de la Cruz. Weeks = fetal age; months and years = postnatal age.

Abb. 15 *Histogramm von Alter und Geschlecht der Kinderbestattungen in Alto de la Cruz. Wochen = fetales Alter; Monate und Jahre = postnatales Alter.*

are higher on PC2 (Olalde et al. 2019). In contrast to the Bronze Age individuals from northern Spain, the Iron Age Navarra individuals tend to occupy higher PC2 values indicative of more steppe-related ancestry compared to the Bronze Age individuals. This is also seen in qpAdm modelling of the Iron Age Navarra individuals, who cannot be modelled as being genetically indistinguishable from the preceding Middle and Late Bronze Age individuals from northern Spain ($p < 2.4E-03$), but instead are better modelled as a two-way mixture of 89.1 % (82.5–95.7 % two standard errors) Middle and Late Bronze Age northern Spanish-like ancestry admixed with 10.9 % (4.3–17.5 % two standard errors) French Bell Beaker-like ancestry ($p = 4.3E-02$).

In terms of genetic variation along PC1, the new Iron Age children from Navarra tend to occupy lower values than the previously published Iron Age individuals from northern Spain (Welch Two Sample t-test $p < 1.3e-03$, Wilcoxon rank sum test with continuity correction $p < 5.3e-05$; Fig. 16). In the context of post-Bronze Age Spain, PC1 is correlated with Mediterranean ancestry (Olalde et al. 2019; Villalba-Mouco et al. 2021), suggesting that the published Iron Age individuals ($n = 8$) were more influenced by Mediterranean gene flow compared to the new intramurally buried Iron Age children from Navarra. This is supported by the f_4-statistic of the form f_4(Mbuti, test; Iron Age_Navarra, Iron Age_published), which is significantly positive for Near Eastern test populations such as Turkey_SoutheastByzantine ($Z > 4$) and Iran_GanjDareh ($Z > 5$). We note that geography does not explain this shift, as the new Iron Age Navarra children are geographically closer to the Mediterranean coast than the published Iron Age samples from northern Spain. One interpretation is that the Iron Age children from Navarra may have belonged to groups that resisted gene flow from communities with higher Mediterranean ancestry, perhaps suggesting some level of relative isola-

LabID	Archaeological label	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
ERE001	Eretas Indiv. 1	mm	59.2	56.6	65.1	65.1	37 w	M	Twin of ERE002
		Fazekas/Kósa 1978 (w)	37	36	37	37			
		Balthazard/Dervieux 1921 (cm)	46.48	44.79	44.456	44.456			
ERE002	Eretas Indiv. 2	mm	50.2	50.5	53.9	50.5	32 w	M	Twin of ERE001
		Fazekas/Kósa 1978 (w)	32	32	31	31			
		Balthazard/Dervieux 1921 (cm)	40.63	40.82	38.18	36.28			
ERE003	Eretas Indiv. 3	mm		63.6		71.6		M	
		Fazekas/Kósa 1978 (w)		39		39			
		Balthazard/Dervieux 1921 (cm)		49.34		48.09			
ERE004	Eretas Indiv. 4	mm	40.6				26 w	M	Down's syndrome
		Fazekas/Kósa 1978 (w)	26						
		Balthazard/Dervieux 1921 (cm)	34.39						
ERE005	Eretas Indiv. 5	mm	41.2				0/1 m	UD	
		Fazekas/Kósa 1978 (w)	26						
		Balthazard/Dervieux 1921 (cm)	34.78						
ERE006	Eretas Indiv. 6	mm			79.7	76	> 40 w	F	
		Fazekas/Kósa 1978 (w)			> 40	> 40			
		Balthazard/Dervieux 1921 (cm)			52.63	50.56			

Tab. 3 Infant individuals from Las Eretas. Genetic sex, age (gestational weeks) and size obtained (cm) from the length of humeri and femurs (mm) for intramural child burials from Las Eretas. HU: humerus, FE: femur, TI: tibia; R: right, L: left; M: male, F: female; UD: undetermined; w: weeks (gestational age); m: months (postnatal age); y: years (postnatal age).

Tab. 3 *Säuglingsindividuen aus Las Eretas. Genetisches Geschlecht, Alter (Schwangerschaftswochen) und Größe (cm), ermittelt aus der Länge der Ober- und Unterschenkelknochen (mm) für intramurale Kinderbestattungen aus Las Eretas. HU: Humerus, FE: Femur, TI: tibia; R: rechts, L: links; M: männlich, F: weiblich; UD: nicht bestimmt; w: Wochen (Gestationsalter); m: Monate (postnatales Alter); y: Jahre (postnatales Alter).*

tion from coastal south-eastern areas. Another possibility is that the Iron Age children from Navarra predate the published Iron Age individuals and this Mediterranean influence.

Kinship analysis

In order to identify close biological relatedness in Iron Age Navarra, we used READ (Relationship Estimation from Ancient DNA; Kuhn et al. 2018; cf. Günther in this volume) along with calculating rates of pseudo-haploid genotype mismatch in all pairwise comparisons of both published and newly reported individuals (Tab. 7; Fig. 17). We identified nine cases of biologically closely related pairs of individuals, ranging from 0th- to 2nd-degree related.

We identified two cases (BGO001–BGO002 and ERE001–ERE002) of identical twins. In addition to having a high rate of identical genotypes on the autosomes (Fig. 17), they also share the same mitochondrial and Y-chromosome hapw-

Age	Male	Female	Undetermined	Total
26 w	ERE004	ERE005		2
32 w	ERE002			1
37/39 w	ERE001 ERE003			2
≥ 40 w			ERE006	1
Total	4	1	1	6

Tab. 4 Sex and age distribution of intramural child burials at Las Eretas; w: weeks (gestational age).

Tab. 4 *Geschlechts- und Altersverteilung der Kindergräber in Las Eretas; w: Wochen (Gestationsalter).*

LabID	Reference	HUR	HUL	FER	FEL	Age	Sex	Observations
BGO001	Individual 1	mm				0/6 m	M	Clavicle left 47 mm (Black/Scheuer 1999). Twin of BGO002
BGO002	Individual 2	mm	69.6			0/1 m	M	Twin of BGO001
		Fazekas/Kósa 1978 (w)	> 40					
		Balthazard/Dervieux 1921 (cm)	53.24					

Tab. 5 Infant individuals from El Castejón (Bargota). Measurements of the preserved remains that were recovered. HU: humerus, FE: femur, TI: tibia; R: right, L: left; M: male, F: female; UD: undetermined; w: weeks (gestational age); m: months (postnatal age); y: years (postnatal age).

Tab. 5 *Säuglingsindividuen aus El Castejón (Bargota). Maße der erhaltenen Überreste, die geborgen wurden. HU: Humerus, FE: Femur, TI: tibia; R: rechts, L: links; M: männlich, F: weiblich; UD: nicht bestimmt; w: Wochen (Gestationsalter); m: Monate (postnatales Alter); y: Jahre (postnatales Alter).*

Individual ID	Site	Period	C^{14} Date	Shotgun Endogenous DNA Post (%)	5' C-to-T damage 1^{st} base	Number of SNPs on »1240K«	Genetic Sex	Mitochondrial Haplogroup	Y-chrom Haplogroup
BGO001	Castejón de Bargota	Iron Age	790–567 cal BC	59.31	0.285	559.108	Male	J1c1	R1b–151
BGO002		Iron Age	779–546 cal BC	60.73	0.287	508.624	Male	J1c1	R1b–P310
CRU001	Alto de la Cruz	Iron Age	—	18.12	0.356	619.206	Male	H1e1a	R1b–P312
CRU002		Iron Age	—	25.12	0.383	205.154	Female	H17	—
CRU003		Iron Age	—	59.75	0.334	498.150	Male	HI	R1b U51
CRU004		Iron Age	771–544 cal BC	24.88	0.353	195.426	Female	H4a1	—
CRU005		Iron Age	—	56.03	0.341	449.823	Male	T2b	R1b–2272
CRU006		Iron Age	—	36.39	0.332	226.316	Male	J1c3g	R1b–2266
CRU007		Iron Age	726–407 cal BC	26.83	0.369	192.208	Female	J2a1a1	—
CRU008		Iron Age	—	53.89	0.31	426.467	Female	T2e	—
CRU009		Iron Age	—	7.6	0.331	491.909	Male	H1ak1	R1b–P312
CRU010		Iron Age	—	41.65	0.308	338.699	Male	H1ae2	R1b–P312
CRU011		Iron Age	—	10.08	0.338	231.190	Male	J1c1	R1b–2272
CRU012		Iron Age	800–593 cal BC	22.7	0.342	160.253	Male	K1a3	I2a1
CRU013		Iron Age	—	55.08	0.329	443.640	Female	H1ae2	—
CRU014		Iron Age	—	13.96	0.292	477.865	Female	H1ae2	—
CRU015		Iron Age	—	44.13	0.344	282.166	Male	H1ah	R1b–U51
CRU016		Iron Age	—	22.86	0.358	163.053	Male	T1a1	R1b–U51
CRU017		Iron Age	—	25.91	0.345	187.803	Female	T1a1	—
CRU018		Iron Age	—	53.04	0.294	390.581	Male	H1t	R1b–P310
CRU019		Medieval	992–1032 cal ACE	20.12	0.22	690.655	Female	U5b1	—
CRU020		Iron Age	—	51.23	0.326	475.669	Female	H3y	—
CRU021		Iron Age	—	7.85	0.344	392.560	Male	K1a4a1	R1b–2195
CRU022		Iron Age	—	47.23	0.303	310.099	Female	T2a1a	—
CRU023		Iron Age	774–544 cal BC	26.67	0.342	203.563	Female	T2a1a	—
CRU024		Iron Age	779–549 cal BC	38.71	0.32	294.884	Female	J2a1a1	—
CRU025		Iron Age	—	36.11	0.294	270.491	Female	K1a4a1	—
CRU026		Iron Age	—	12.16	0.351	571.749	Male	J1c1	R1b–2295
CRU027		Iron Age	—	0.49	0.418	43.447	Male	J1c1	R1b–2195
CRU028		Iron Age	—	30.4	0.342	300.276	Male	H4a1	R1b–P310
CRU029		Iron Age	—	41.97	0.332	272.017	Male	J1c1b	R1b–M269

Individual ID	Site	Period	C14 Date	Shotgun Endogenous DNA Post (%)	5' C-to-T damage 1st base	Number of SNPs on »1240K«	Genetic Sex	Mitochondrial Haplogroup	Y-chrom Haplogroup
ERE001	Las Eretas	Iron Age	758–479 cal BC	34.31	0.372	282.642	Male	T1a1	R1b–M269
ERE002		Iron Age	—	37.55	0.355	308.220	Male	T1a1	R1b–U51
ERE003		Iron Age	—	11.13	0.403	6.516	Male	U2e1	Unknown
ERE004		Iron Age	801–764 cal BC	22.14	0.388	198.307	Male	J1c2	R1bP312
ERE005		Iron Age	775–549 cal BC	32.58	0.388	178.682	Female	J1c2	—
ERE006		Iron Age	—	1.56	0.484	134	Unknown	Unknown	Unknown

Tab. 6 General overview of ancient Navarra individuals studied from a genetic perspective.

Tab. 6 *Allgemeiner Überblick über prähistorische Individuen aus Navarra, die unter genetischen Gesichtspunkten untersucht wurden.*

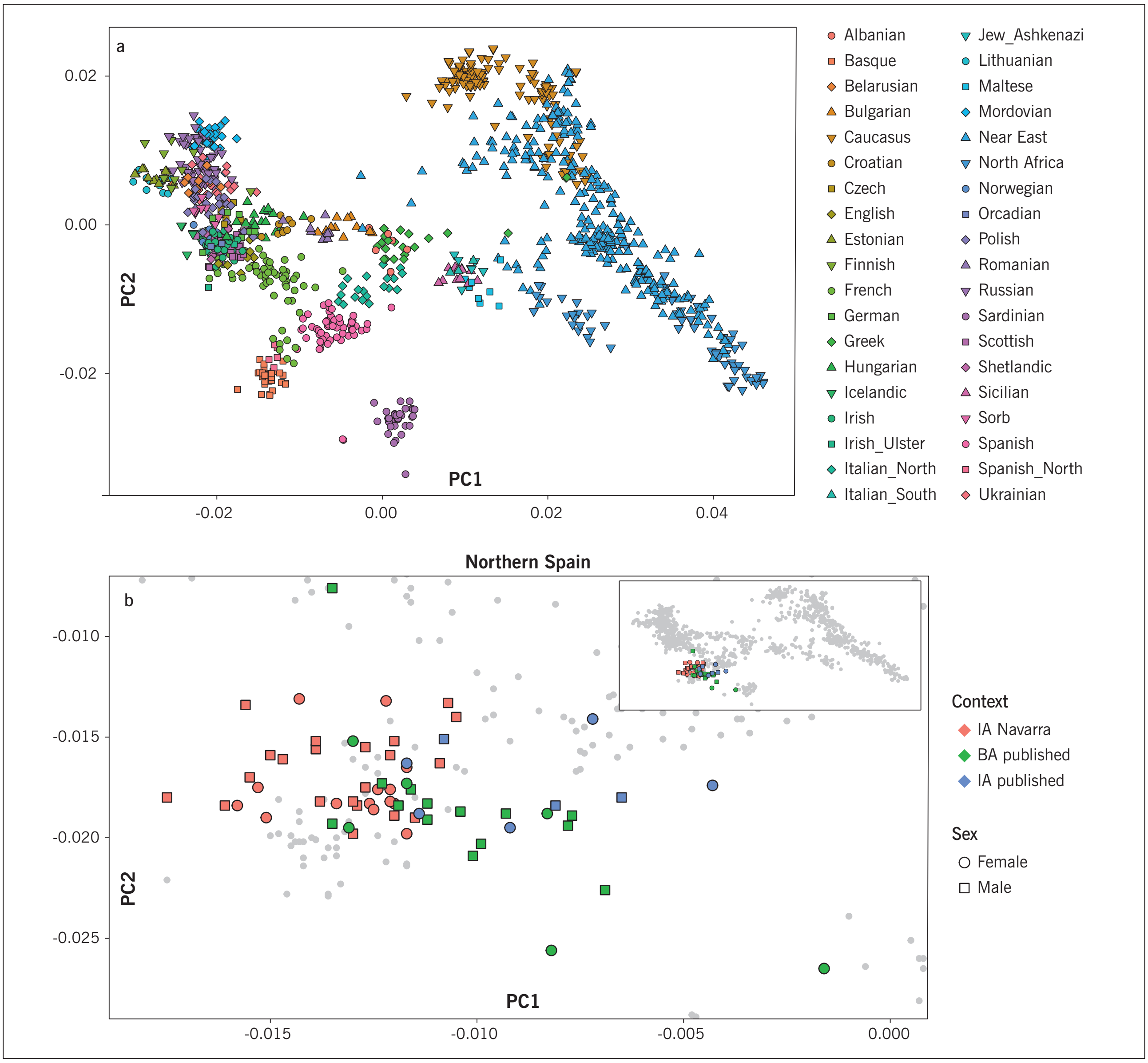

Fig. 16a–b a) Principal component analysis (PCA) of contemporary West Eurasian genetic variability, with b) projections of diverse prehistoric individuals: intramural buried children in Iron Age Navarra (red, n = 34), Bronze Age (green, n = 20) and Iron Age (blue, n = 8) individuals from northern Spain presented in this study (previously published data). Enlarged image (see small graphic above right).

Abb. 16a–b *a) Hauptkomponentenanalyse (PCA) der heutigen westeurasischen genetischen Variabilität, mit b) Projektionen diverser prähistorischer Individuen: in dieser Studie vorgestellte intramural begrabene Kinder im eisenzeitlichen Navarra (rot, n = 34), bronzezeitliche (grün, n = 20) und eisenzeitliche (blau, n = 8) Individuen aus Nordspanien (bereits veröffentlichte Daten). Vergrößerte Darstellung (siehe kleine Grafik oben rechts).*

Pairindividuals	Relationship	Z upper	Z lower	Mitochondrial Haplogroups	Y Haplogroups
BGOOO1–BG0002	Identical Twins/ Same Individual	29.68	NA	J1C1-J1C1	R1b-LI51-R1b-P310
EREOO1–ERE002	Identical Twins/ Same Individual	22.78	NA	T1a1-Tlal	R1b-M269-R1b-L151
CRU022–CRU023	First Degree	5.2	-10.5	T2a1a-T2a1a	NA-NA
CRU026–CRU027	First Degree	3.80	-7.95	J1Cl-J1C1	Rlb-Z295-R1b-Z195
CRU010–CRU014	Second Degree	7.19	-7.83	H1ae2-H1ae2	R1b-P312-NA
CRUOO8–CRU015	Second Degree	7.49	-6.10	T2e-H1ah	NA-R1b-L151
CRU027–CRU029	Scoond Degree	1.55	-3.49	J1c1-J1c1b	R1b-Z195-R1b-M269
ERE004–EREOO5	Second Degree	6.77	-1.661	J1c2-J1c2	R1b-P312-NA
CRU026–CRU029	Unrelated	NA	-0.18	J1cl-J1c1b	R1b-Z295-R1b-M269

Tab. 7 Output from READ (columns 1–4) quantifying the degree of genetic relationships for pairs of relatives. Z-scores smaller than 3 and larger than 3 indicate uncertain assignments. Mitochondrial and Y-chromosomal haplogroups (columns 5–6) match in cases where matches based on autosomal relatedness are expected. Note that due to different and uneven Y-chromosomal coverage between relatives, the resulting Y haplogroup assignments might be slightly different, but all pairs of male relatives are consistent with carrying the same lineage.

Tab. 7 *Ergebnis von READ (Spalten 1–4), die den Grad der genetischen Verwandtschaft von Verwandtenpaaren quantifiziert. Z-Scores kleiner als 3 und größer als -3 zeigen unsichere Zuordnungen an. Mitochondriale und Y-chromosomale Haplogruppen (Spalten 5–6) stimmen in den Fällen überein, in denen Übereinstimmungen auf der Grundlage der autosomalen Verwandtschaft zu erwarten sind. Zu beachten ist, dass aufgrund der unterschiedlichen und ungleichmäßigen Y-Chromosomenabdeckung zwischen den Verwandten die resultierenden Y-Haplogruppenzuordnungen leicht unterschiedlich sein können, aber alle Paare männlicher Verwandter stimmen mit der gleichen Abstammung überein.*

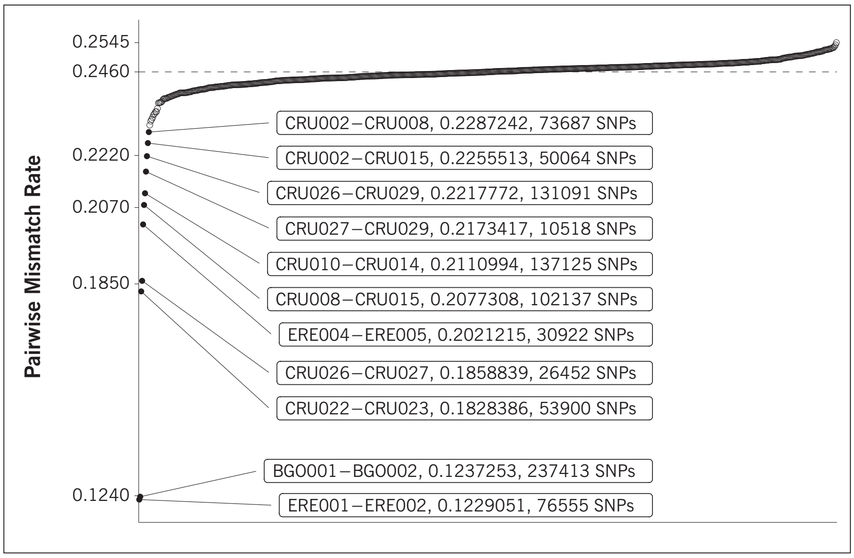

Fig. 17 The distribution of autosomal pairwise genotype mismatch rates in in studied individuals from Iron Age northern Spain. Lower mismatch rates indicate closer biological relatedness. The median mismatch value (0.246) is indicated by the dashed line, and the number of overlapping SNPs is shown for selected pairwise relationships.

Abb. 17 *Die Verteilung der autosomalen paarweisen Genotyp-Mismatch-Raten in hier untersuchten Individuen aus dem eisenzeitlichen Nord-Spanien. Niedrigere Mismatch-Raten weisen auf eine engere biologische Verwandtschaft hin. Der mediane Mismatch-Wert (0,246) ist durch die gestrichelte Linie gekennzeichnet, und die Anzahl der überlappenden SNPs ist für ausgewählte paarweise Beziehungen dargestellt.*

logroups (cf. Tab. 6). Adding further confidence to the assignment of identical twins (as opposed to potentially sampling different elements from the same individual twice) is the fact that in both cases the same skeletal element from both individuals was sampled (i.e., the left petrous bone), which rules out any possibility of a sample mix-up. It is noteworthy that the two individuals originating from another possible double burial (CRU020–CRU021) were not related in a first or second degree, implying that not all multiple Iron Age infant burials need to be seen as twins, siblings or half-siblings. However, this conclusion needs to be taken with caution, as no information on the context of both skeletons, found in 1949, has been published.

We also identified two cases of first-degree relatives (CRU022–CRU023 and CRU026–CRU027). *IcMLkin* (Maximum Likelihood Estimation of Relatedness; Lipatov et al. 2015) did not yield enough overlapping SNPs between the pairs of relatives to distinguish between parent-offspring or siblings, but the fact that all four individuals are newborns implies they must be siblings (too young to be parent-offspring). The assignment to siblings is also consistent with both pairs sharing mitochondrial and Y-chromosome haplogroups (cf. Tab. 7).

Five cases of second-degree relatives (ERE004–ERE005, CRU008–CRU015, CRU010–CRU014, CRU027–CRU029, CRU026–CRU029) were also found. The CRU026–CRU029 relationship is ambiguously placed between the 2nd and 3rd degree by *READ* (cf. Tab. 7), however given that CRU026 and CRU027 are brothers, CRU029 must be equally related to both. The CRU027–CRU029 relationship is assigned to the 2nd degree, making it more likely that CRU026–CRU029 are also 2nd-degree related.

All identified pairs of relatives were interred at the same site, and pairs show overlapping dates where both individuals were ^{14}C-dated (BGO001–BGO002, ERE004–ERE005).

Runs of Homozygosity

Runs of homozygosity (ROH) in genomes inform on patterns of consanguinity and effective sizes of the population from which individuals are sampled. We analysed ROH of various haplotype lengths using HapROH (Ringbauer et al. 2021).

Most of the new children from Navarra show patterns of ROH indicative of low levels of consanguinity in their recent family history (lacking ROH > 20 cM), as well as having come from communities with effective population sizes of several thousand (lacking ROH > 8 cM; Fig. 18). However, patterns typical of consanguineous mating behaviour can be seen in at least three individuals. ERE004, CRU022, and CRU023 harbour long stretches of ROH (≥ 33 cM) totalling ≥ 62 cM in length, suggesting that they are the offspring of parents who were related to one another in approximately 3rd degree (possibly 1st cousins). CRU022 and CRU023 are siblings with the same parents, making a similar ROH pattern in both of them an expected result.

Sex bias

The archaeogenetic study of Iron Age intramural burials from Navarra allows us, for the first time, to test if perinatal children were preferentially selected according to their biological sex. Our results reveal 22 of 36 children were male, indicating a ratio of 1.57:1 towards male interments, which is not significantly different from 1:1 (p = 0.24, binomial test).

Cases of trisomy as a possible approach to past demography

The individuals studied here were also subject to a recent screening project involving 9855 ancient samples with genetic data for chromosomal trisomies (Rohrlach et al. in preparation). Notably, the individuals included in this study revealed 4 cases of trisomies. In particular, individuals CRU001, CRU024, ERE004 were identified as having three copies of chromosome 21 (Down's syndrome), while CRU013 had three copies of chromosome 18 (Edward's syndrome). Only three other cases of trisomy 21 were identified among the 9855 screened samples. While a more detailed assessment of these conditions in light of anthropological information is beyond the scope of this paper, we discuss in the following some implications of these findings for demographic interpretations.

To investigate whether the number of observed cases of trisomy 18 and 21 was higher than might be expected by chance, we simulated cases for Alto de la Cruz and Las Eretas in the following way. We accounted for both variability of case numbers due to the randomness of developing a trisomy, and for the uncertainty of the simulation parameters themselves. Moreover, this simulation allowed us to test paleodemographic models that have been proposed by archaeology and anthropology, and which have been in use for a long time (Hassan 1981).

For each simulation at each site, we required a (cumulative) population size, denoted, which represents the total

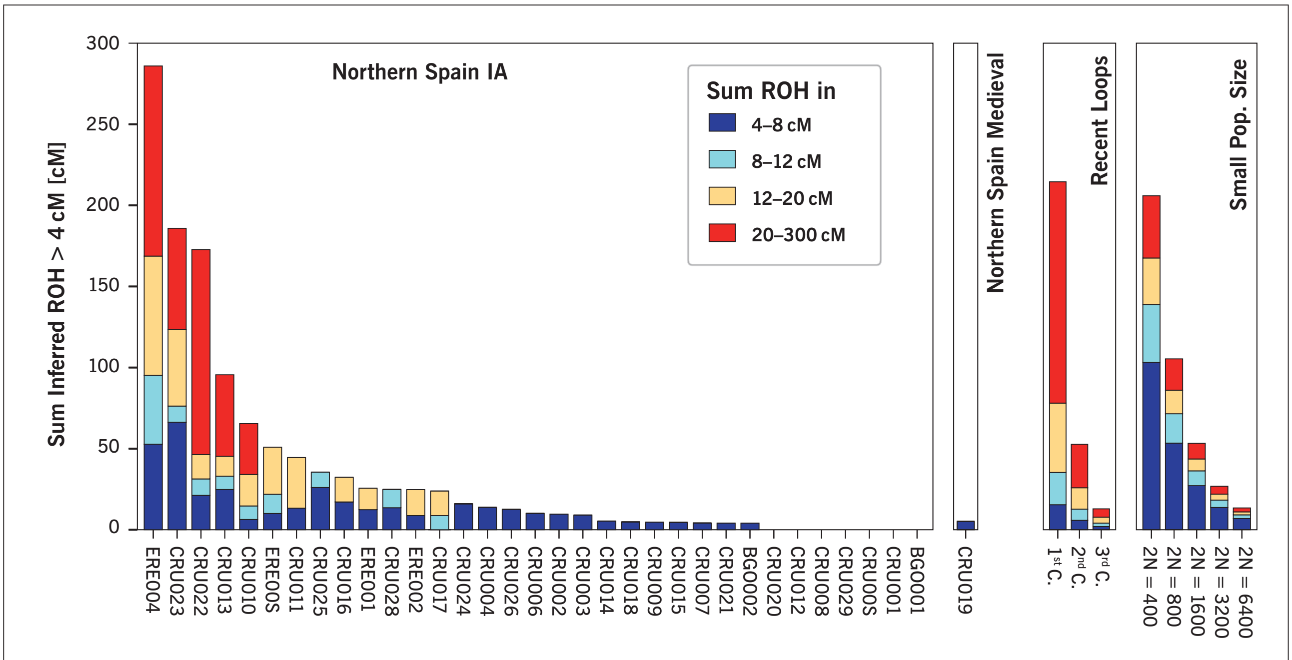

Fig. 18 Runs of Homozygosity (ROH) in the Iron Age Navarra individuals. Most of the individuals have low levels of ROH indicative of effective population sizes of several thousands. A few individuals also show evidence of consanguineous mating behaviour, indicative of being offspring from first-cousin unions.

Abb. 18 *Umfang homozygoter Genom-Abschnitte (Runs of Homozygosity, ROH) in den eisenzeitlichen Individuen aus Navarra. Die meisten Individuen weisen niedrige ROH-Werte auf, was auf eine effektive Populationsgröße von mehreren Tausend hinweist. Einige wenige Individuen zeigen auch Anzeichen sexueller Verbindungen zwischen Blutsverwandten, die darauf hindeuten, dass sie die Nachkommen von Cousin/Cousine-Paaren ersten Grades sind.*

number of individuals born at the site and can be found via the well-known paleodemographic formula proposed by G. Acsádi and J. Nemeskéri (1970):

$$D = \frac{PT}{e^0}\,.$$

Where P is the population size of individuals living at any point in time in the settlement, T is the time span of the settlement in years, and e^0 is the mean life expectancy in years. First, we used four methods for estimating the initial population size P[14] from the settlement area *(A)*. A random integer $K = 1,2,3,4$ was chosen, and then the associated population size estimator was used to account for the uncertainty in the literature in estimating P (Tab. 8).

Based on the ^{14}C dates produced at each site, we estimated the site usage period using the Normal distributions $N(400,25/3)$ and $N(250,25/3)$ for Alto de la Cruz and Las Eretas, respectively, from which T was sampled. The standard deviations are set such that 99.9 % of the weight falls inside of 50 years around 400 BC and 250 BC, respectively. Finally, the mean life expectancy obtained using 26 anthropological studies of 3rd–1st millennium BC cemeteries[15] is $e^0 = 24{,}86$ years, with a standard deviation of 4.04 years. However, as infant deficits can be expected in several case studies, a corrected life expectancy of 22.90 ± 1.37 years is obtained when the formula proposed by C. Masset/J. Bocquet (1977) is used, and hence we sampled $e^0 \sim N(22.9,1.37)$.

Once we have sampled P, T, e^0, and actually used the rounded value of D, we simulated a number of cases of trisomy 18 and 21 using the binomial distributions:

$$X^{18} \sim Bin(D, p^{18})$$

and

$$X^{21} \sim Bin(D, p^{21}),$$

k	P	Study
1	A , where C ~ N(250,50/3)	Renfrew 1972
2	146√A	Kramer 1978
3	DA , where D ~ N(180,60/3)	Schreiber/Kintigh 1996
4	−441.37 + 149.89 xlog (Ax10⁴)	Curet 1998

Tab. 8 The estimators for the census population size per average lifespan used with equal probability in the simulation study.

Tab. 8 *Die Schätzwerte für die Größe der Bevölkerung in der Erhebung pro durchschnittlicher Lebensspanne werden mit gleicher Wahrscheinlichkeit in der Simulationsstudie verwendet.*

$p^{18} = 1/3226$ and $p^{21} = 1/1282$ (Mai et al. 2013).

We generated five million simulations according to the above description. We report the mean and standard deviation of the simulated number of cases, and 95 % empirical confidence intervals for all sampled simulation parameters, as well as for the simulated number of cases of each trisomy (Tab. 9).

By considering the remaining area to be excavated, and the proportion of samples that have yielded aDNA, we corrected the observed number of cases of each trisomy at each site. After a careful examination of all the published archaeological information[16], it appears that c. 45 individuals were identified during the excavations of Alto de la Cruz carried out between 1947–1988, of which 29 have now been genetically screened. Then, air photographs and the published site plans were used to determine the area excavated over the years. This allows us to conclude that 0.23 ha of this 0.75 ha-large site or 0.7 ha-large settled area, if we exclude the fortification wall, have been explored. Las Eretas has a well delimited, more or less oval, 0.5 ha large surface area, of which 0.075 ha have been thoroughly excavated. The resulting correction factor for the unex-

Site (% excavated)	Ha	P	T	D	$\bar{t}_{18}$ Mean (upper 95 % CI)	t_{18} Observed	$\hat{t}_{18}$ Observed corrected	$\bar{t}_{21}$ Mean (upper 95 % CI)	t_{21} Observed	$\hat{t}_{21}$ Observed corrected
Alto de la Cruz (32.5 %)	0.75	126–197	383–417	2040–3738	0.827 [0,3]	1	4.72	2.08 [0–5]	2	9.43
Las Eretas (15 %)	0.5	49–80	233–267	520–934	0.227 [0,1]	0	0	0.57 [0,2]	1	16.67

Tab. 9 Results comparing expected numbers of cases of trisomy 18 and 21, based on simulations of settlement sizes, to (corrected) observed numbers of cases. Ha is the settlement area in hectares, P is the census population size per average lifespan, T is the time of use for a settlement, and D is the cumulative census population size over the site's use. Ha, P, T and D are reported with 95 % confidence intervals for simulation parameters, $\hat{t}$ and $\bar{t}$ represent the observed, corrected and empirical sample mean number of cases of trisomies 18 and 21.

Tab. 9 *Ergebnisse des Vergleichs der erwarteten Fallzahlen von Trisomie 18 und 21, basierend auf Simulationen der Siedlungsgrößen, mit den (korrigierten) beobachteten Fallzahlen. Ha ist die Siedlungsfläche in Hektar, P ist die Volkszählungsbevölkerungsgröße pro durchschnittlicher Lebensspanne, T ist die Nutzungsdauer einer Siedlung und D ist die kumulative Volkszählungsbevölkerungsgröße über die Nutzungsdauer des Standorts. Ha, P, T und D werden mit 95 % Konfidenzintervallen für Simulationsparameter angegeben,* $\hat{t}$ *und* $\bar{t}$ *stehen für die beobachtete, korrigierte und empirische mittlere Anzahl von Fällen der Trisomien 18 und 21.*

14 Renfrew 1972; Kramer 1978; Schreiber/Kintigh 1996; Curet 1998.

15 Kunter 1990, Tab. 30; Alesan et al. 1999; Nicklisch 2017, Tab. 1.6; Aytek 2020; Lukasik 2020.

16 Taracena/Gil 1951; Gil 1953; Maluquer de Motes 1954; Maluquer de Motes 1958; Maluquer de Motes et al. 1990.

plored area in both settlements is 78.8 % and 85 % at Alto de la Cruz and Las Eretas, respectively (cf. Tab. 9).

The results based on the frequencies of trisomy shown in Tab. 9 suggest that in both settlements the cases of trisomy are over-represented in relation to the estimated population. As the recent screening of 9855 genomes (Rohrlach et al. in preparation) does not suggest that trisomy frequencies were significantly different in the past than in the present, this over-representation implies that these children where preferentially buried intramurally in these sites. Though not quantifiable in the same way, the same situation seems to be observed in relation to twins. These over-representations imply that the population from which these children originated was notably larger than $\boldsymbol{D}$ (and $\boldsymbol{P}$). The only explanation for such an excess in population is the participation of a much larger community in the intramural burials practice. Given the spatial limits of the living space in both fortified settlements, such a population must have come from a larger territory surrounding the settlements.

Child burials and household organisation

The ritual placement of the genetically related children inside buildings provides further insight into the social organisation of these Early Iron Age communities. Unfortunately, spatial information is only available for the recent excavations of Alto de la Cruz and Las Eretas. Few of the archaeological labels of the anthropological remains recovered between 1948 and 1957 provide sufficient information to relate them, at least tentatively, to some of the individuals mentioned in the excavation reports (Taracena/Gil 1951; Gil 1953; Maluquer de Motes 1958).

While the stratigraphic sequence of Las Eretas only consists of a single occupation phase, Alto de la Cruz was a multiperiod site occupied from the Final Bronze Age until the end of the Early Iron Age. During the latter period, the settlement went through four major building phases interrupted by generalised destructions and burning down of the houses. Such sequences typically pose two questions in archaeology with historical and social implications: 1) How much time elapsed between the phases of occupation?; and 2) Was the settlement rebuilt by the same community or did a population replacement take place? The genetic study of Alto de la Cruz sheds light on both issues thanks to a second-degree relation between children from two successive and stratigraphically overlapping buildings. While CRU029 was buried under building H88/21 of phase IIIb, CRU027 (and probably CRU026) is associated with the more recent building H87/8, belonging to the subsequent phase IIa (Maluquer de Motes et al. 1990). Although an »uncle-nephew« relationship seems as likely as a half-sibling relationship, it can be concluded that the same kin group was present in both settlements and, more specifically, in two buildings constructed at practically the same spot, a pattern which in archaeology is often understood as an architectural expression of property rights. The time elapsed between both burials and, consequently, the destruction of settlement IIIb and construction of IIa could only have lasted a few decades or even years. Regardless of what caused the burning down of the older settlement, this did not imply a hiatus in the occupation of the site, nor a (large) population replacement.

The biological relationships between the infants also allow us to delve into the size and organisation of the social group connected to the buildings. Two of the three perinatal burials of the older building H88/21 have been analysed in this study and a first and second relation can be excluded. In the successive building H87/8 DNA from all five children could be sequenced. In this case, a set of brothers (CRU026–CRU027), a set of sisters (CRU022–CRU023), as well as a female infant with no 1st or 2nd degree relation with the other children can be identified (Fig. 19).

A similar situation is observed in one of the square buildings of Las Eretas (Fig. 20). Only two of the four interments were related to the 2nd degree (ERE004–ERE005), while the other two were unrelated at a 1st or 2nd degree level. Although, the causes for the variable number of burials in houses remains unresolved, it appears that some of them were used as funerary spaces and, expectedly, occupied by more than one adult couple and maybe even with as many as three. While further analysis of the biological relatedness is required to identify more distant links, the present results do not support the identification of individual dwellings with nuclear families, as conventional archaeological models would assume. Rather, the Early Iron Age square buildings seem to have been built and used by extended groups formed by several couples and their offspring. Such a model would also explain the so far puzzling presence of two or more fireplaces and kilns in some of the buildings, which are usually related to basic subsistence units formed by a couple of adults and their close relatives.

Equally revealing is the burial of children with trisomy 18 or 21. CRU001 and CRU013 probably belonged to the youngest occupation phase (settlement I), but cannot be located in the excavation reports. Instead CRU024 was found in building 86/19 of settlement IIIb, which corresponds to the beginning of the Iron Age. This perinatal girl with Down's syndrome died at a very premature age (c. 27 weeks) and was buried with comparatively rich grave goods, formed by three bronze rings and one *Glycymeris glycymeris* shell (probably brought from the Mediterranean Sea). Moreover, the child seems to have been buried with three complete sheep/goats in the central part of this large, rectangular building, in which no other children were found. This special burial and the discovery of a large, decorated fireplace, which is unique at Alto de la Cruz, has led archaeologists to interpret this building as a possible ritual space.

The third case of Down's syndrome (ERE004) was found in Las Eretas in a burial under a large stone block that had been intentionally placed in the south-western corner of a large rectangular building (Fig. 21). The skeleton was recognised as very immature and gracile in the initial anthropological study (Armendáriz/de Miguel 2006). This might be due to the young age of the child or a case of delayed intrauterine growth restriction (IUGR).

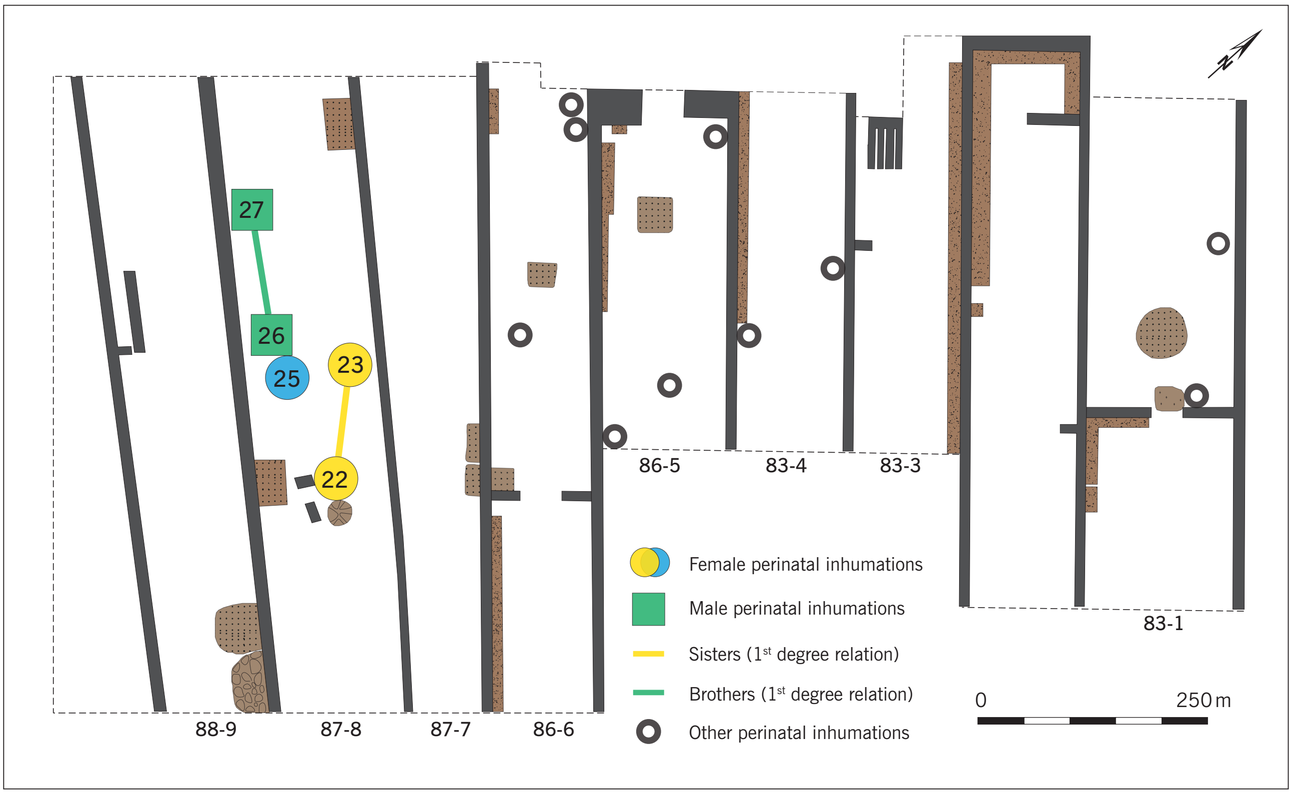

Fig. 19 Buildings at Alto de la Cruz settlement of the PIIa and 1st degree relationships between perinatal inhumations identified in the buildings.

Abb. 19 *Gebäude der Siedlung Alto de la Cruz des PIIa und Verwandtschaftsbeziehungen 1. Grades zwischen den in den Gebäuden identifizierten perinatalen Bestattungen.*

Conclusions

The intramural inhumation burials from Iron Age Navarra provide an important opportunity to study aspects of human behaviour and ritual practices at the local level, as well as aspects of population dynamics from the Bronze to the Iron Age in northern Spain more broadly. This burial practice seems to have emerged at the end of the Bronze Age in the north-eastern and eastern sector of the Iberian Peninsula among communities which are identified by archaeology with the local Urnfield Culture (cf. Fig. 1). The burial practice became widespread during the Iron Age and endured well into Roman times, although it always remained restricted to a small part of the communities. Cremation burials outside the settlements were the regular funerary practice. The genetic data provide, for the first time, some indications why certain children, usually under one year of age, were placed under the living floors inside settlements and houses.

In the first place, no clear selection in terms of sex is observed. Despite more male than female intramural child inhumations being recovered, the ratio did not deviate statistically significantly from 1:1. However, an exceptionally high number of twins (4/35) and cases of chromosomal trisomies (4/35) were genetically identified. These high case numbers suggest that only children with unusual traits, or that were born under special circumstances, remained in the settlement domain instead of being cremated when they died at young age. The discrepancies that were observed between dental and post-cranial growth in some individuals, and the pathological signs observed in others, would support the idea that intramural child burials were limited to cases of recognisable and exceptional diseases, birth conditions or physical traits, in contrast to the more common causes of infant mortality, which would leave no visible sign on the children, such as due to infectious diseases.

The combination of genetic and archaeological information also provides new insights into the social organisation of the typical Early Iron Age houses and settlements of the region. The presence of infants who were not closely related to one another (1st–2nd degree) in at least two of the houses at Alto de la Cruz, and one at Las Eretas, suggests that these buildings may have been used by extended families or by multiple, biologically-unrelated kin groups. This cohabitation would also explain the discovery of two or more fireplaces or ovens (or both) in many houses.

Additionally, the population size required to observe the high incidence of trisomies and identical twins found at the studied sites must have been much larger than what would be anticipated by demographic models for the sites, based on settlement size. In fact, we estimated that a population size of about five times larger than what could be modelled would be required to explain the increased number of chromosomal trisomies. As 625–1000 inhabitants would be an excessive population size for a pre-urban settlement of 0.75 ha (such as Alto de la Cruz), both socio-archaeological categories (*community* and *settlement*) do not seem to have been equivalent in the Early Iron Age of Navarra. It is more likely that the community engaged in these settlements, including aspects such as the intramural burials, settled

Fig. 20 Buildings and infant burials of Las Eretas. Besides the twins ERE001 and ERE002, only inhumations ERE005 and ERE006 revealed a 2nd degree relationship.

Abb. 20 *Gebäude und Säuglingsbestattungen von Las Eretas. Neben den Zwillingen ERE001 und ERE002 zeigten nur die Bestattungen ERE005 und ERE006 eine Verwandtschaft zweiten Grades.*

beyond the fortified area. The sharing of buildings by biologically unrelated groups, otherwise residing in a wider area, suggests a complex economic and political use of the fortified *tell* space, which challenges the usual household-based models envisaged by archaeology. The existence of dispersed dwellings, nearby villages, or in extramural quarters should be identified in the future through geophysical and archaeological surveys.

Finally, population genetic analyses revealed a relatively homogeneous group of individuals, with an increase of approximately 10 % of steppe-related ancestry, relative to the preceding Middle and Late Bronze Age individuals in northern Spain. Compared to published Iron Age individuals from northern/eastern Spain, the newly analysed individuals from Las Eretas, Alto de la Cruz, and El Castejón yielded less evidence of Mediterranean-related ancestry. This, in conjunction with elevated runs of homozygosity in these newly studied individuals may suggest some degree of isolation from individuals carrying Mediterranean-related ancestry. It would also be consistent with migration bringing more steppe-related ancestry into the region. Deeper sampling of this time period is necessary to test these hypotheses more carefully.

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The raw sequencing data will be publicly available upon further publication of genetic results.

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Source of figures

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2 M. Ángel García
3 after Maluquer de Motes et al. 2009, 14
4 after Maluquer de Motes 1958, Lám. 2
5 J. Armedáriz after Maluquer de Motes 1954, Pl. 1
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10 J. Armendáriz
11 Armendáriz/de Miguel 2006, 11 Fig. 3
12 a after Armendáriz/de Miguel 2006, 18 Foto 7; b J. L. Larrión, Gobierno de Navarra
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14 a after Castiella et al. 2009, Fig. 4; b after Castiella et al. 2009 Fig. 5,4; c J. L. Larrión, Gobierno de Navarra
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19 M. Peres based on Maluquer de Motes et al. 1990, 247 Pl. 38
20 M. Peres based on Armendáriz/de Miguel 2006, Fig. 3

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