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Data Article

Contribution to Longobard dietary studies: Stable carbon and nitrogen isotope data from Castel Trosino (6th-8th c. CE, Ascoli Piceno, central Italy)

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ABSTRACT

The arrival of the Longobards in Italy represents one of the most significant periods of the Early Middle Ages. Such arrival had social and political implications, particularly in relation to cultural admixture with local communities. One way to understand this is through the reconstruction of paleodiet via stable isotope analysis. So far, the subsistence strategy of this population in central Italy remains poorly explored. Stable carbon and nitrogen isotope analyses are presented here on a total of 19 human bone collagen samples from the cemetery of Castel Trosino. This isotopic investigation contributes to the dietary reconstruction of Early Medieval populations in Italy, providing a crucial isotopic dataset for an area still poorly explored.

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Specifications Table

Subject	Archaeology
Specific subject area	Palaeodietary reconstruction employing stable carbon and nitrogen isotopes analysis of human bone collagen
Type of data	Table Figure Graph
How data were acquired	Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes of bone collagen were measured using an Elemental Analyzer - Isotope Ratio Mass Spectrometer (EA-IRMS) with a Europa Scientific 20-20 IRMS. Statistical analyses were performed using SPSS software licensed to Sapienza University of Rome.
Data format	Raw Analyzed
Parameters for data collection	Available human remains (n = 19) were sampled (500-1000 mg) for collagen extraction. Six samples were partly covered by consolidant, one specimen was sampled in two different regions (with and without consolidant) to assess possible contaminations. Only collagen that met quality indicators (>0.5% wt) was measured by EA-IRMS, with one in five samples measured in duplicate to check analytical reliability.
Description of data collection	Skulls were sampled and each surface was cleaned by abrasion using a Dremel™ multitool. Samples showing the presence of glue used as consolidant (n = 6) were also pre-treated soaking the bone in distilled water for 24 h following Takahashi et al. [1] before the collagen extraction protocol. 1-1.2 mg of the extracted collagen meeting quality indicators (n = 20) were measured by EA-IRMS. Only one sample (CT1948) was excluded from the following analysis as it did not meet protein quality parameters (C:N ratio out of range).
Data source location	The sampled human skeletal collection is preserved at the Museum of Anthropology "Giuseppe Sergi" (MGS) at Sapienza University of Rome, Italy. The collection comes from the cemetery of Castel Trosino, located 4 km southwest of Ascoli Piceno, in Marche region, Adriatic central Italy.
Data accessibility	The dataset is referenced in IsoArcH (www.isoarch.eu) [2] with the following digital object identifier (DOI): https://doi.org/10.48530/isoarch.2021.007.

Value of the Data

- The skeletal collection from the Early Middle Ages site of Castel Trosino has not received adequate attention in the bioarcheological literature. In this research we offer critical data that contribute to the understanding of the Longobards in Italy.
- This palaeodietary investigation via stable carbon and nitrogen isotope analysis sheds light on the food habits of an Early Medieval community. The results of this investigation contribute to the bioarcheological assessment of early medieval Italian communities following the collapse of the Roman Empire
- The data provided can be used to explore possible changes in food habits during the Middle Ages.

1. Data description

The skeletal collection investigated in this study is housed at the Museum of Anthropology "Giuseppe Sergi" (MGS) at Sapienza University of Rome, Italy. The human remains sampled for stable isotope analysis consist of 19 skulls from the Castel Trosino (CT) cemetery. The funerary area is located in central Italy, in Marche region (Fig. 1). Archaeological information dates the cemetery between the 6th and the 8th centuries CE [3].

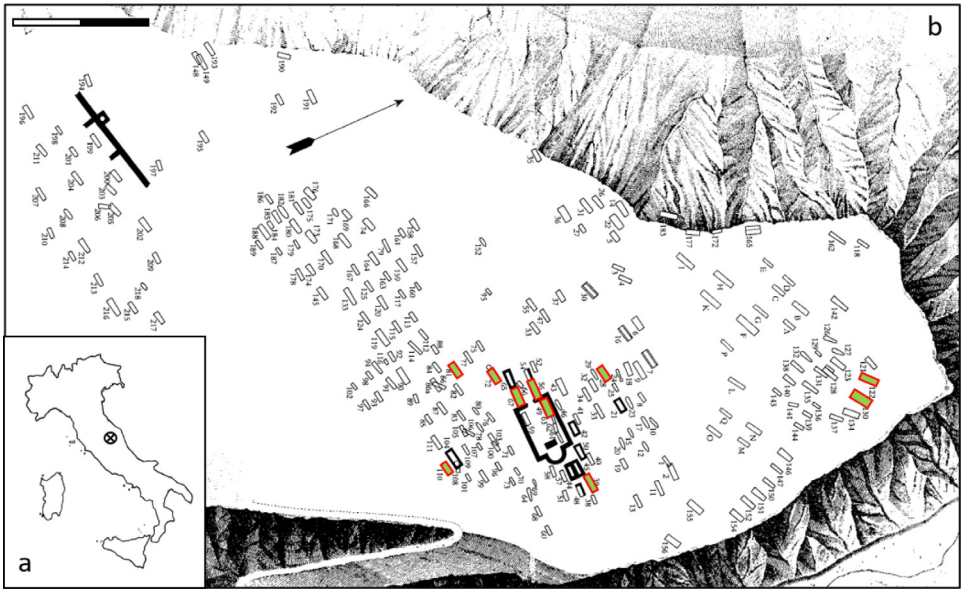

Fig. 1. a) Map of Italy showing the location of Castel Trosino. b) The map of the site with the burial ground. Green-red colored rectangles show the known position of the burials investigated here (modified from Micarelli et al.) [4]. In the map the holy building dedicated to St. Stefano is well recognizable.

Fig. 1 shows a map indicating the position of CT in Italy (a), and the map of the cemetery (b) with the known location of the burials sampled for stable isotope analysis.

Table 1 reports in detail biological and archaeological information for each individual, and the relative stable carbon and nitrogen isotopes values, with collagen quality indicators.

Bioarchaeological information includes sex and age at death and preliminary palaeopathological assessment (following a recent reappraisal by Micarelli et al.) [4].

Table 2 reports descriptive and non-parametric statistics of the stable carbon and nitrogen isotope data summarized by biological and archaeological categories. Mann-Whitney U tests on isotopic distribution according to sex, presence of pathological lesions and funerary evidence (i.e., presence vs. absence of grave goods, position in relation to St. Stefano Church) indicate no significant differences between these groups; one way ANOVA (Kruskal–Wallis) test on age at death categories equally shows no significant differences.

Isotopic data from Castel Trosino are plotted according to biological information such as estimated sex and age at death (Fig. 2), and presence or absence of pathological conditions (Fig. 3).

Fig. 2 shows the distribution of the isotopic ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) according to sex and age at death.

Fig. 3 shows the distribution of $\delta^{13}C$ (a) and $\delta^{15}N$ (b) values according to the presence or absence of pathological lesions observed on the analyzed individuals.

2. Experimental design, materials and methods

The funerary area of CT was excavated during the 19th century. As testified by the richness of cultural artifacts reported with the burials, this cemetery was part of an important community during the Longobard occupation in Italy (6th – 8th c. CE) [3].

The burial ground is located at the top of a hill, which can only be accessed from one side. Following a pattern common among Longobard cemeteries, the burials were arranged in rows

Table 1
Stable carbon and nitrogen isotope data of CT samples with related skeletal and archaeological information. In grey the sample excluded from this study.

Sample Code	Sex	Age at death	Pathological lesions	Grave goods	Place of burial	Bone portion	$\delta^{13}C_{V\text{-}PDB}$ (‰)	$\delta^{15}N_{AIR}$ (‰)	% C	% N	C:N ratio	% collagen
CT 1944*[a]	F	25-35	present	absent	inside	cranium	-19.76	8.87	39.07	14.09	3.2	7.65
CT 1945*	F	20-25	none	present	outside	cranium	-19.71	8,69	39.46	14.60	3.2	3.36
CT 1946*[a]	M	50+	present	absent	inside	cranium	-19.38	7.86	31.32	10.91	3.4	3.84
CT 1947-M	M	25-35	present	absent	outside	mandible	-19.72	8.21	38.03	14.28	3.1	14.83
CT 1947-S*			present	absent	outside	cranium	-19.83	8.13	33.40	12.35	3.2	5.36
CT 1948*	F	adult	none	absent	outside	ethmoid	-21.28	7.95	30.60	7.75	4.6	0.87
CT 1949*	M	35-40	none	absent	outside	cranium	-19.28	10.25	37.90	14.13	3.1	16.59
CT 1950*	F	35-45	present	present	outside	cranium	-19.53	10.20	19.86	6.99	3.3	16.19
CT 1951	M	30-40	none	present	inside	ethmoid	-19.57	9.66	37.16	13.72	3.2	15.70
CT 1952[b]	M	55+	present	present	inside	cranium	-19.36	10.74	43.27	16.16	3.1	12.94
CT 1953[b]	F	50+	present	present	inside	cranium	-19.12	8.77	35.71	13.21	3.2	4.93
CT 1954	M	55+	none	absent	outside	cranium	-18.95	8.55	39.00	13.86	3.3	14.44
CT 1955	F	25-35	present	absent	outside	cranium	-18.80	7.05	15.93	5.44	3.4	10.17
CT 1956	F	50+	present	absent	outside	cranium	-19.43	8.60	39.37	14.69	3.1	4.71
CT 1957	F	55+	none	absent	outside	cranium	-19.73	9.60	28.09	10.02	3.3	4.63
CT 1958	F	25-30	present	absent	outside	cranium	-19.58	8.60	37.91	14.05	3.1	4.98
CT 1959[a]	M	25-35	present	absent	inside	cranium	-19.89	9.20	22.83	8.25	3.2	5.64
CT1960	F	20-30	none	absent	outside	cranium	-18.90	7.67	38.90	14.31	3.2	4.08
CT1961	M	35-50	present	absent	outside	cranium	-19.69	8.32	37.07	13.78	3.1	14.59
CT1962	F	25-35	present	present	outside	cranium	-19.36	8.58	40.35	14,89	3.2	9.42

Abbreviations: F = female; M = male. [a] sample from the multiple burial number 56. [b] sample from the multiple burial number 67 * Consolidated bone, S - skull, and M - mandible.

Table 2
Descriptive and non-parametric statistics of stable carbon and nitrogen data at Castel Trosino. The sample CT 1948 was not included in the statistical analysis, as it did not meet collagen quality control criteria.

			$\delta^{13}C_{V\text{-}PDB}$ (‰)						$\delta^{15}N_{AIR}$ (‰)					
Categories		n	Mean	sd	min	max	range	*P* value	mean	sd	min	max	range	*P* value
Sex	Male	8	-19.5	0.3	-19.9	-18.9	1	0.633	9.1	1	7.9	10.7	2.9	0.696
	Female	10	-19.4	0.3	-19.8	-18.8	1		8.7	0.9	7	10.2	3.1	
Age at Death	Young adult	8	-19.5	0.4	-19.9	-18.8	1.1	0.531	8.3	0.7	7	9.2	2.1	0.169
	Middle adult	4	-19.5	0.2	-19.7	-19.3	0.4		9.6	0.9	8.3	10.2	1.9	
	Old adult	6	-19.3	0.3	-19.7	-18.9	0.8		9	1	7.8	10.7	2.9	
Pathological lesions	Present	12	-19.5	0.3	-19.9	-18.8	1.1	0.553	8.7	1	7	10.7	3.7	0.553
	Absent	6	-19.3	0.4	-19.7	-18.9	0.8		9.1	0.9	7.7	10.2	2.6	
Grave goods	Present	6	-19.4	0.2	-19.7	-19.1	0.6	0.682	9.4	0.9	8.6	10.7	2.2	0.067
	Absent	12	-19.4	0.4	-19.9	-18.8	1.1		8.6	0.9	7	10.2	3.2	
St. Stefano Church burial	Inside	6	-19.5	0.3	-19.9	-19.1	0.8	0.553	9.2	1	7.9	10.7	2.9	0.180
	Outside	12	-19.4	0.3	-19.8	-18.8	1		8.7	0.9	7	10.2	3.2	

Abbreviations: sd = standard deviation, min = minimum value, max = maximum value. Young adult = 20< >34 years old, middle adult = 35< >49 years old, old adult = >50 years old.

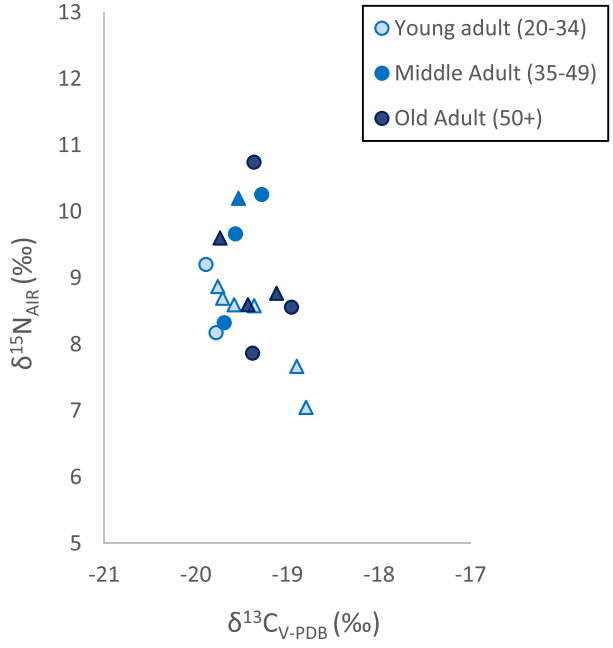

Fig. 2. Distribution of $\delta^{13}C$ and $\delta^{15}N$ values of CT human bone collagen by sex and age at death (circles = males, N = 9; triangles = females, N = 10).

aligned along the N/S axis, with a variable orientation. Although radiocarbon dates are not available for the site, given the richness of the archaeological findings, the funerary area is confidently dated between the end of the 6th to the beginning of the 8th c. CE [3].

Although most of the burials were in a good state of preservation, the complex history of the excavations led to the loss of a considerable amount of information, as well as archaeological and osteological material [5]. Today, out of the 239 burials excavated, only 19 skulls are preserved, housed at the Museum of Anthropology at Sapienza University of Rome. No zooarchaeological material was available from the site.

The first archaeological assessment was performed by Mengarelli [6] at the beginning of the last century. Likewise, Sergi [7] performed a preliminary osteological investigation, estimating the sex of these 19 skulls.

A recent archaeological reassessment of the site frames Castel Trosino as a non-eminent military point in the Longobard strategy [5]. The scarce number of individuals with grave good indicating warrior status, suggest that Castel Trosino was a site of high prestige, with a strategic position. The richness of this site is testified by the grave goods from some of the burials, such as the golden jewelry and buckles, the gold and silver male belt trimmings, and, finally, the gold filaments from CT1952 and CT1953, part of the typical Longobard golden brocade [3,6]. The last phase of the Longobard occupation sees the foundation of the church within the cemetery area. Three underground chamber tombs are undoubtedly connected to the church building: one tomb is inside the holy building and two in front of the façade. All are paved with stone slabs, to preserve the corpses from direct contact with the ground (i.e., individual CT1951 from burial number 49, individuals CT1944, CT 1946 and CT1959 from burial number 56, and individuals CT1952 and CT1953 from burial number 67). This connection between the “privileged” tombs and the church supports the hypothesis that these funerary structures were reserved for the family of the founder, who was likely buried in the tomb inside the church [5].

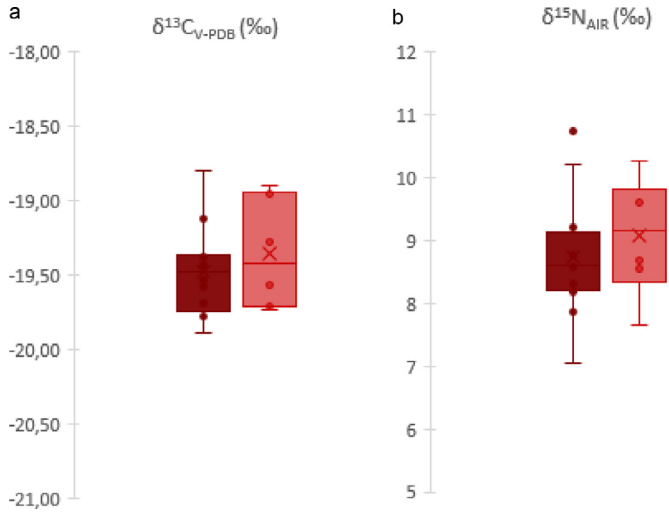

Fig. 3. Distribution of $\delta^{13}C$ (a) and $\delta^{15}N$ (b) values of CT human bone collagen according to the presence (dark red) or absence (light red) of pathological lesions. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

The isotopic analysis at Castel Trosino follows a recent reassessment on the preserved human skeletal remains [4], within a wider project on the bioarchaeology of Early Middle Ages populations in Italy [4].

Despite the small sample, this dataset will contribute to the reconstruction of Longobard dietary habits in Italy, notably improving our understanding of their presence along the Adriatic coast, for which isotopic data are lacking.

Stable carbon and nitrogen isotopes of Longobards from Castel Trosino were measured on 20 samples of human bone collagen. They include 19 cranial remains of which 6 showed the use of glue as a consolidant, which could have affected the isotopic values. Human skeletal material coming from early excavations are in fact frequently contaminated by glue/consolidant, which was made with collagen of animal origin; this can affect stable isotope results as well as radiocarbon dating [1]. We did not test for the presence of exogenous collagen (for example using FTIR) [8], as the presence of the consolidant was undoubtable, but rather decided to remove any exogenous material using tested protocols. Therefore, each consolidated bone's surface was cleaned by mechanical abrasion, and then soaked in distilled water for 24 h before demineralization to remove the glue, based on the protocol developed by Takahashi et al. [1]. To better assess possible contamination, one specimen was sampled twice, namely on a portion of the skull showing traces of glue (CT 1947-S) and on the non-consolidated mandible (CT 1947-M).

Collagen extraction was carried out on a total of 20 samples of cortical bone (0.5 g) following a modified Longin method [9], at the Laboratory of Paleoanthropology and Bioarchaeology, Sapienza University of Rome. Bone samples were demineralized in 0.5M solution of HCl at 4 °C for several weeks. Once demineralized, samples were rinsed to neutrality and gelatinized in pH 3 HCl at 70 °C for 48 h. Samples were then filtered off with 5-8 µm Ezee filters to remove insoluble remnants.

The collagen solution was frozen at -80 °C and then freeze-dried for 48 h. Collagen extracts were then sampled (ca. 1 mg) into tin capsules with one in five samples measured in duplicate (n = 4) to check analytical reliability, and analyzed by Elemental Analysis - Isotope Ratio Mass Spectrometry (EA-IRMS) with a Europa Scientific 20-20 IRMS, at Iso-Analytical Limited (Crewe, UK).

Quality and reliability criteria for collagen preservation follow Van Klinken [10]: collagen yield >0.5 wt%, percentage of C and N, around 35 wt% for carbon and between 11 and 16 wt% for nitrogen, and a C:N ratio with a range of 3.1 - 3.5. The stable isotope data are reported in the δ-notation in parts per thousand (‰) relative to the standard. The international reference standard for carbon is VPDB, while for nitrogen is AIR.

International inter-laboratory standards used at Iso-Analytical were oxalic acid, sucrose (IAEA-CH-6) and ammonium sulphate (IAEA-N-1); while soy protein, L-alanine, tuna protein and ammonium sulphate were used as in-house standards. Analytical error is less than 0.03‰.

Only one in 20 measured samples did not meet reliability criteria (CT 1948) (notably C:N ratio out of range) [10].

Descriptive statistics and non-parametric analysis were assessed using IBM SPSS 25 licensed to Sapienza University of Rome, to investigate possible differences in isotopic ratios related to biological or archaeological data.

Ethics Statement

This study does not involve any modern human or animal subject.

CRediT Author Statement

Sara Bernardini: Data curation, Writing - Original draft preparation, Formal analysis; **Seminew Asrat Mogesie:** Investigation, Formal analysis; **Ileana Micarelli:** Conceptualization, Investigation; **Giorgio Manzi:** Writing – Review & Editing, Funding acquisition; **Mary Anne Tafuri:** Project administration, Supervision, Validation, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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