

IsoMedIta: A Stable Isotope Database for Medieval Italy

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Abstract

The IsoMedIta database compiles 6304 stable isotope measurements ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}$, $\delta^{34}\text{S}$, $^{87}\text{Sr}/^{86}\text{Sr}$) from archaeological sites in medieval Italy (c. 500–1500 CE). The data is spatiotemporally referenced and includes bioarchaeological and paleo-environmental descriptions, alongside with other archaeological, biological, historical, environmental

and technical metadata. IsoMedIta can be employed to address various historical questions at different spatial and temporal scales. It is also a resource for defining future research agendas and for heritage management.

Keywords

stable isotopes – medieval – Italy – bioarchaeology – database

- Related data set “IsoMedIta: A stable Isotope Database for Medieval Italy” with DOI [www.doi.org/10.48493/tsg9-h779](https://doi.org/10.48493/tsg9-h779) in repository “Pandora”.

1 Introduction

The Middle Ages, spanning from 476 to 1492 CE, played a pivotal role in constructing modern Italian history and culture. This period was characterised by political turmoil, migratory movements, socioeconomic crises, and cultural and religious clashes; nonetheless, it also saw the formation of large trading networks, the implementation of productive activities that transformed the local landscape, and the development of universities and important cultural centres (Abulafia, 1977, 2004; Brown, 2003; Chavarría Arnau, 2011; Houben, 2012; Jarnut, 1982; Loud, 2007; Loud & Metcalfe, 2002; Ostrogorski, 1956; Ward-Perkins, 2006; Wickham, 2006, 2010, 2016). Despite the political fragmentation of the peninsula, the legacy of this epoch has led to the production of a shared Italian heritage comprised of figurative arts, architecture, and traditions. The historiographical and archaeological research that has been conducted on medieval Italy has largely focused on written documents and high-value objects, which tend to reflect the views and wealth of the upper classes (Halsall, 2005; Montanari, 2012). However, anthropological and biomolecular research has provided new insights into the lifeways and activities of the broader illiterate population (Buonincontri et al., 2017; Cocozza et al., 2023; Manzi et al., 1999; Pietrobelli et al., 2020; Riccomi et al., 2021; Rolandsen et al., 2019; Torino et al., 2015). In particular, stable isotope analysis of skeletal and plant remains can be informative on ancient human subsistence practices, farming activities, and past climatic and environmental conditions. (Bogaard et al., 2013; Bonafini et al., 2013; Fiorentino et al., 2015; Hedges et al., 2004; Lahtinen et al., 2021; Lee-Thorp, 2008; Lightfoot & O’Connell, 2016).

The IsoMedIta database (Mantile et al., 2023) has been developed to collect and store the growing number of stable carbon ($\delta^{13}\text{C}$), nitrogen ($\delta^{15}\text{N}$), oxygen ($\delta^{18}\text{O}$), sulphur ($\delta^{34}\text{S}$), and strontium ($^{87}\text{Sr}/^{86}\text{Sr}$) isotopic data becoming

available for medieval Italy. This repository is deposited at MATILDA: a repository for Medieval bioAnThropologIcaL DatABases (www.pandoradata.earth/organization/matilda-a-repository-for-medieval-bioanthropological-databases), and amalgamates archaeological, historical, biological, and sample type data, as well as information on their location and chronology. IsoMedIta can be reused by researchers studying past human and ecological systems, such as archaeologists, historians, anthropologists, palaeoecologists, archaeobotanists, and zooarchaeologists. The database is stored in the Pandora data platform that adheres to FAIR and CARE principles (Russo Carroll et al., 2020, 2021; Wilkinson et al., 2016).

2 Problem

The number of isotopic studies conducted on medieval sites from Italy has been steadily increasing. Advances in isotope ratio mass spectrometry and decrease in analysis costs in the last decades led to a positive trend in the number of publications regarding stable isotope analysis for the Medieval era

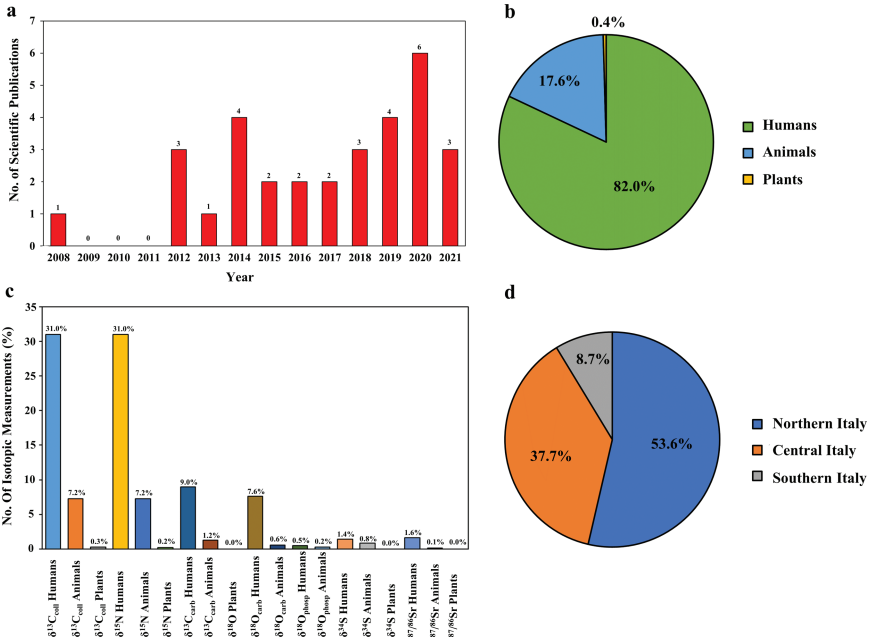


FIGURE 1 IsoMedIta descriptive statistics: a) Number of isotopic studies on medieval Italy per year; b) Proportion of human, animal, and plant isotopic measurements; c) Distribution of isotopic measurements according to type of isotopic proxy; d) Percentages for spatial distribution of isotopic studies

(see Figure 1a). This also follows a shared increasing trend in the application of biomolecular methods to archaeology (Roberts et al., 2018). However, many of these contributions remain inaccessible to the international academic community due to their publication in Italian journals (e.g. Pescucci et al., 2013) or their inclusion in documents that are not easily available (e.g. Marinato, 2017). IsoMedIta was created to tackle this issue by compiling isotopic measurements for medieval Italy, making them available and reusable to a larger audience. Initiatives of this kind have been developed for other regions and time periods (Cocoza et al., 2022; Cocoza & Fernandes, 2021; Etu-Sihvola et al., 2019; Fernandes et al., 2021; Goldstein et al., 2022). IsoMedIta provides new ways to explore historical research questions related to past human lifeways and the assessment of the preservation status of archaeological samples across Italy. The combined data can be used for meta-analysis at broad spatiotemporal scales.

3 Methods

The database was designed with a metadata structure that allows for multiple research lines connected with the study of medieval Italian populations across several historical, archaeological, environmental, and biological variables. IsoMedIta is a partner of the *Compendium Isotoporum Medii Aevii* (CIMA) network (Cocoza et al., 2021, 2022), a collaborative effort for the collection and study of medieval isotopic measurements from Europe and its margins. However, IsoMedIta differs from other partner databases in the network due to its unique data collection criteria and metadata structure.

IsoMedIta centralises bioarchaeological isotopic data from medieval Italian sites that have been published in national and international journals, books, archaeological reports, and academic dissertations. To locate the scientific publications online, search engines and databases such as Google Scholar, Scopus, Researchgate.net, and Academia.edu were used for searches using variations of specific keywords (e.g., 'medieval', 'Italy', and 'isotope', as well as cultural tags like 'Longobard', geographical tags such as 'Tuscany', and chronological tags like 'migration period'). The bibliography of compiled texts was consulted to identify additional publications. In some cases, metadata information was retrieved from related non-isotopic archaeological and historical publications.

4 Data

- **IsoMedIta: A stable Isotope Database for Medieval Italy deposited at Pandora** – DOI:www.doi.org/10.48493/tsg9-h779
- **Temporal coverage:** 500–1500

Currently, IsoMedIta contains 6304 stable isotope measurements from human, animal, and plant samples retrieved from Italian archaeological sites, dated between 500–1500 CE. This dataset reveals important research gaps in Italian medieval isotopic studies, including the scarcity of plant isotopic data (see Figure 1b), the predominance of bulk collagen stable carbon and nitrogen isotopes for dietary studies (see Figure 1c), and the research focus in the vicinity of Rome and northern Italy (see Figure 1d). Regarding the temporal distribution of the data, IsoMedIta illustrates peaks for Early Medieval (c. 500–1000 CE) and Late Medieval (c. 1300–1500 CE) research (see Figure 2).

IsoMedIta is accessible via the Pandora data platform (www.doi.org/10.48493/tsg9-h779). It is part of the MATILDA data community (www.pandoradata.earth/organization/matilda-a-repository-for-medieval-bioanthropological-databases) that collects anthropological and biomolecular datasets for medieval Europe. IsoMedIta is organised into five files. Three files store the isotopic data for human (IsoMedIta Humans 21–12–22), animal (IsoMedIta Animals 21–12–22), and plant (IsoMedIta Plants 21–12–22) samples. The

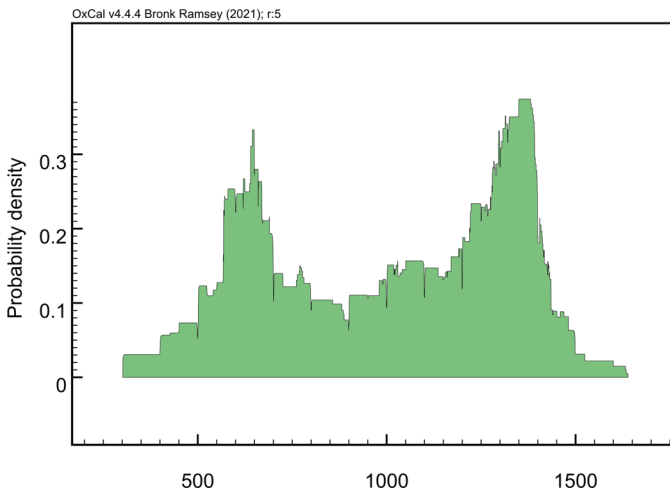


FIGURE 2 Temporal distribution of data collected in IsoMedIta
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(BRONK RAMSEY, 2017).

database structure is then outlined in detail in a metadata file (File Metadata description IsoMedIta 21–12–22). Additionally, IsoMedIta also includes a text file that lists scientific publications used in the compilation (File references IsoMedIta 21–12–22).

Each dataset file is available in both .xlsx (Excel file) and .csv (separate comma separated) formats. The metadata structure of the three files is broadly similar but there are a few differences (e.g., taxonomic descriptions, type of sampled materials). Human, animal, and plant datasets present each a unique integer ID sequence that progressively flags entries ('IsoMedIta ID'). Whenever an entry finds a match in the CIMA database, a specifically designated field reports its corresponding ID ('CIMA Entry ID'). This latter is included to guarantee transparency in the data collection, a quality check of the data and a cross-identification of the isotopic measurements within the CIMA network. Each entry is georeferenced ('Elevation'; 'Latitude'; 'Longitude') and placed within current Italian administrative regions, provinces, cities ('Modern Region'; 'Modern Province'; 'Modern City'), and the archaeological site ('Site Name'). Also included are distance from the current coastline, local geomorphology, and Köppen climate classification ('Distance from Modern Coast (km)'; 'Site Geomorphology'; 'Climate Classification (Köppen)'). Other fields are used to classify the settlement as urban or rural, offer a short description of the type of settlement and identify the category of burial context ('Settlement Type'; 'Site Description'; 'Funerary Context'). Whether the site was fortified (e.g. a castle) is recorded in the field 'Fortified Settlement?'. The presence/absence of grave goods in the burial context is given in the field 'Grave goods'. All entries are temporally referenced using an absolute chronological range expressed in calendar years ('Min. Year'; 'Max. Year') and as categorical fields that offer chronological tags ('General Period(s)'; 'Additional Chronological Tags'). If available, radiocarbon dates are also recorded as BP years ('Radiocarbon ID'; '¹⁴C'; '¹⁴C unc.'). Fields for historical metadata give the ruling political entities, both at the local and broader scales ('Local Power'; 'Central Power'). IsoMedIta is the only database of isotopic data that includes several of the aforementioned data fields.

For measurements carried out on collagen, the dataset also includes fields for collagen yield, carbon, nitrogen, and sulphur elemental concentrations, and the values of atomic C/N, C/S, N/S ratios, when available. These can be used to assess collagen preservation using different criteria (Ambrose, 1990; DeNiro, 1985; Guiry & Szpak, 2021; Nehlich & Richards, 2009; van Klinken, 1999). In the collection, we also included isotopic measurements that did not

fit in the established ranges. These can be easily filtered out by IsoMedIta users whether useful to explore their research question.

Below a brief description of the files composing IsoMedIta.

- The human dataset (IsoMedIta Humans 21–12–22) consists of 5178 isotopic measurements of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}$, $\delta^{34}\text{S}$, $^{87}\text{Sr}/^{86}\text{Sr}$ on human skeletal samples recovered from 64 medieval archaeological sites across Italy (see Figure 3). These measurements, obtained from bone/tooth collagen, bone bioapatite, or tooth enamel are typically used to inform on human diet, nutrition, and spatial mobility (Lee-Thorp, 2008; Lightfoot & O'Connell, 2016).
- The animal dataset (IsoMedIta Animals 21–12–22) consists of 1098 isotopic measurements of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}$, $\delta^{34}\text{S}$, $^{87}\text{Sr}/^{86}\text{Sr}$ from bone and tooth samples collected from 48 Italian medieval sites (see Figure 4). Faunal isotopic measurements of bone/tooth collagen, bone bioapatite, and tooth enamel are typically utilised in archaeology to generate isotopic baselines necessary for human dietary and spatial mobility studies (Lee-Thorp, 2008; Lightfoot & O'Connell, 2016). Animal isotopic measurements also inform on past animal management practices and can be used for paleo-environmental reconstructions (Bogaard et al., 2013; Bonafini et al., 2013; Hedges et al., 2004). Compared to the human dataset, the animal dataset includes additional taxonomic categories. Some fields present in the human dataset (e.g. social status or religion) are not available for the animal dataset.
- The plant dataset (IsoMedIta Plants 21–12–22) includes 28 isotopic measurements of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ (see Figure 5) on samples from only two sites – Castello di Santa Severa (Gismondi et al., 2020) and Portus Romae (O'Connell et al., 2019). The isotopic values of plants vary with farming practices and climatic/environmental conditions (Bogaard et al., 2013; Fiorentino et al., 2015; Hedges et al., 2004) and can inform on these. They are also necessary for an adequate isotopic interpretation of past human diets or spatial mobility. Unfortunately, plant samples are often not preserved in the archaeological record and floatation techniques that could aid in retrieving plant materials are still not widely employed.
- The IsoMedIta metadata file (File Metadata description IsoMedIta 21–12–22) provides a text description of the fields used to describe the human, animal, and plant datasets.
- A text file (File references IsoMedIta 21–12–22) lists the 31 scientific publications from which isotopic data has been retrieved. Citations are formatted using the Harvard referencing style.



FIGURE 3 Spatial distribution of medieval archaeological sites from Italy that included human data compiled in IsoMedIta.



FIGURE 4 Spatial distribution of medieval archaeological sites from Italy that included faunal data for IsoMedIta.

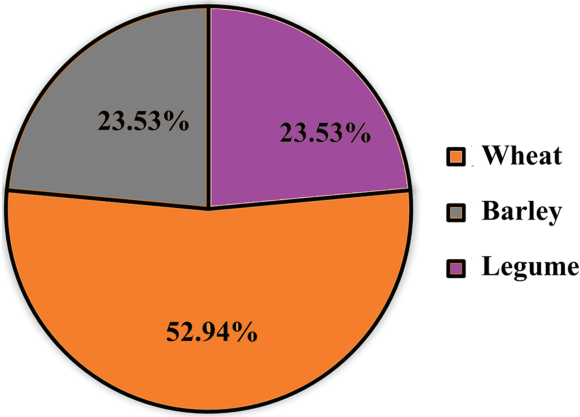


FIGURE 5 Pie chart representing percentages of main Plant categories (wheat, pulses, barley) that are reported in IsoMedIta. No C₄ plants were published for medieval Italy.

5 **Concluding Remarks**

IsoMedIta is a research tool for historians and archaeologists studying medieval Italy. The database can be used for spatiotemporal studies of past human behaviours and productive activities, the reconstruction of past environmental and climatic conditions, and a resource for heritage management. IsoMedIta is an active database and we plan to regularly update it once a year. In line with our collaborative and distributive ethos, we welcome partnerships with research colleagues and with other isotopic databases compiling data for medieval Italy. Data collectors can upload their independent datasets in the MATILDA data community and these will be referenced in IsoMedIta, whenever their data fits with our collection criteria. An example is provided by the “Isotopic dataset for late medieval Capitanata (southern Italy) (www.doi.org/10.48493/woiv-fego)” (Cocozza et al., 2023), referenced in IsoMedIta.

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