**Supplementary Information File 3.**

**ReSources parameter and prior selections**

ReSources is an R application used to implement Bayesian mixing models for isotope-based dietary reconstruction1. It is an upgraded version of the Bayesian software FRUITS2. To improve the precision of dietary estimates, ReSources can also implement prior constraints, based on non-isotopic historical and archaeological dietary evidence (e.g. study of archaeobotanical or zooarchaeological remains, written documents, etc.). The app code is available at GitHub (<https://github.com/Pandora-IsoMemo/resources>) and it can also be run online at https://isomemoapp.com/app/resources. ReSources was used to reconstruct human diets for the late medieval sites of Tertiveri, Montecorvino and San Lorenzo in Carminiano (Apulia, southern Italy).

For dietary modelling we considered seven main food groups which were common in late medieval southern Italy3: C3 plants, C4 cereals, Cattle, Sheep/Goat, Pig, Poultry, and Marine Resources. Freshwater resources were not considered for the model, given that there are no archaeological or historical indications that local freshwater streams could provide for significant amount of foodstuff4. Moreover, freshwater resources typically present 13C-depleted values5 that are not observed in our isotopic results. Estimates of the caloric contributions from these food groups were generated independently for adult population isotopic means (δ13CCollagen, δ15NCollagen, and δ13CCarbonate) for Tertiveri (clusters 1 and 2 separately), San Lorenzo in Carminiano, and Montecorvino.

The food isotopic references for terrestrial fauna relied on available data from Tertiveri and Montecorvino. For other food sources, we relied on previously published values. For marine foods, we relied on isotopic data for Mediterranean fish from the medieval period published by Gismondi *et al.* (2020)6. Reference isotopic values for C3 plants were obtained from the same publication, as these are the geographically closest available measurements for medieval southern Italy. There was no available isotopic data for medieval C4 cereals and we relied on values reported for Bronze Age Greece by Nitsch *et al.* (2017)7. Albeit these belong to a different chronological horizon, Greece presents a temperate Mediterranean climate and a similar environment to southern Italy. δ13C and δ15N values for food remains are listed below in table S3.1.

|  |  |  |
| --- | --- | --- |
|  | δ13C | δ δ15N |
| Charred C3 Plant remains | -22.6±0.9‰ | 4.1±1.6‰ |
| Charred C4 Cereals remains | -10.4±0.3‰ | 6.8±2.7‰ |
| Cattle bone collagen | -20.7±1.2‰ | 6.3±1.6‰ |
| Ovicaprid bone collagen | -21.6±0.9‰ | 5.7±2.0‰ |
| Pig bone/dentine collagen | -21.9±0.9‰ | 7.1±1.4‰ |
| Poultry bone collagen | -21.1±0.7‰ | 9.5±0.9‰ |
| Marine resources bone collagen | -10.7±3.3‰ | 11±1.7‰ |

Tab. S3.1. Isotopic values for food remains employed in Bayesian dietary modelling. These do not include corrections for offsets between edible tissues and food remains (e.g. muscle meat protein or lipids vs. bone collagen collagen). Corrected values are given in table S3.2.

It is necessary to account for potential differences between the isotopic values measured on food remains and the actual edible food component. For this we employed known offsets to calculate the isotopic values of food macronutrients (protein *versus* lipids/carbohydrates) from food remains. The following offset corrections were then applied, with uncertainties for macronutrient isotopic values rounded up to multiples of 0.5‰ (these are based on Fernandes et al. 20155 and include on update by Soncin *et al.* 20218): Plants: Δ13Cprotein-bulk=-2‰, Δ13Ccarbohydrates-bulk=+0.5‰, Δ15Nprotein-bulk=0‰; terrestrial animals: Δ13Cprotein-collagen= -2‰, Δ13Clipids-collagen= -8‰, Δ15Nprotein-collagen=0‰; aquatic animals: Δ13Cprotein-collagen=-1‰, Δ13Clipids-collagen=-7‰, Δ15Nprotein-collagen=+1.5‰). Corrected values for each food source are reported below in table S3.2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | δ13Ccollagen Protein | δ13Ccollagen Lipids/Carbohydrates | δ15N  Protein | δ13Ccarbonate  ‘Bulk’ |
| C3 Plants | -24.6±2‰ | -22.1±2‰ | 4.1±3‰ | -22.5±3‰ |
| C4 Cereals | -12.4±1.5‰ | -9.9±1.5‰ | 6.8±4.0‰ | -10.2±2.5‰ |
| Cattle | -22.7±2.5‰ | -28.7±2.5‰ | 6.3±3‰ | -26.9±3.5‰ |
| Ovicaprid | -23.6±2‰ | -29.6±2‰ | 5.7±3‰ | -27.8±3‰ |
| Pig | -23.9±2‰ | -29.9±2‰ | 7.1±2.5‰ | -28.1±3‰ |
| Poultry | -23.1±2‰ | -29.1±2‰ | 9.5±2‰ | -27.3±3‰ |
| Marine Sources | -11.7±4.5‰ | -17.7±4.5‰ | 12.5±3‰ | -13.8±5.5‰ |

Tab.S3.2. Corrected isotopic food macronutrients values as employed in dietary modelling.

Macronutrient caloric concentration values were reported in Fernandes *et al.* (2015)5 but with doubled uncertainty values: Plants (C4 cereals): protein: 10±5%; Lipids/Carbohydrates 90±5%, terrestrial animals: protein: 30±5%; Lipids/Carbohydrates 70±5%, and marine resources: protein: 65±10%; Lipids/Carbohydrates 35±10%. In the case of C3 plants, we considered the inclusion of pulses and set a higher protein concentration (protein: 15±10%; Lipids/Carbohydrates: 85±10%). The use of human δ13Ccarbonate values for dietary modelling required the inclusion of a fictitious ‘Bulk’ food fraction since that δ13Ccarbonate reflects a dietary carbon mix9. In the case of plant remains the bulk value is measured directly. However, for animal food groups a mass balance calculation was done to estimate the bulk values from the mean concentration values for macronutrients (Table. S3.2) and respective isotopic values (Table. S3.1).

Isotopic offsets between diet and human tissues plus dietary routing mechanisms were included in the Bayesian mixing model. Bone collagen δ15N was assumed to derive entirely from dietary protein with an isotopic offset of 5.5±0.5‰5. For bone collagen δ13C we set an offset of 4.8±0.5‰ towards food values9. Moreover, we considered that the isotopic signal was routed: 74±4% from dietary protein and 26±4% from lipids/carbohydrates9. For bone δ13Ccarbonate, we employed an offset of 10.1±0.5‰ and the signal was considered to derive entirely from the ‘Bulk’ component9.

To improve the resolution of dietary estimates we employed prior constraints1,10 by relying on non-isotopic dietary evidence. Following Ruas (2012)11 and Favia *et al.* (2014)12 we assumed that C3 plants were consumed in larger amounts than C4 plants. We also considered that during the Middle Ages, starches were the staple food for most southern Italian populations3 and therefore we set the following prior information: C3 plants + C4 cereals > 57% of the caloric contribution. This percentage was calculated using as a reference the mean caloric contribution from starches consumed in Mediterranean countries between 1960–1965 (table 14.2 reported in Garnsey & Scheidel 199813). Furthermore, using the same principle, we assumed that combined animal sources were less consumed than starches.

Zooarchaeological studies for our research region12,14–20 show pigs were more consumed than ovicaprids. Cattle bones were overall less represented than the previous taxa and this is likely an indication that meat from this animal was rarely consumed. No indication is given on cow milk and dairy products, but it can be assumed that ovicaprid milk was considered safer21. Poultry is also less represented in the archaeofaunal record and we assumed that their consumption was lower than that of pigs or ovicaprid.

Dietary modelling results are displayed in Fig. 7 in the body of the article. Model inputs used for each population group are available as separate files that can be loaded into the ReSources app:

Tertiveri Cluster 1 and 2: <https://pandoradata.earth/dataset/249a8684-7bee-4508-9a88-ed30391d596a/resource/a87a2de9-77e0-452a-a539-7e36e33cff5f/download/tertiveri-clusters.zip>

Montecorvino and San Lorenzo: <https://pandoradata.earth/dataset/249a8684-7bee-4508-9a88-ed30391d596a/resource/50cf7d52-aca9-406c-9dc8-dad1f4a36b24/download/montecorvino-and-san-lorenzo-model.zip>

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