**Supplementary Information File 2.**

**S2. Description of the Archaeological Sites and Osteological Analysis**

**S2.1 Tertiveri**

The bishopric of Tertiveri was fortified in the early eleventh century as part of a hilltop defensive system set between Campania and Apulia. The ongoing archaeological excavation of the site involving the Deutsches Historisches Institut (DHI) in Rome and led by the Universität Trier in cooperation with the Soprintendenza Archeologia, Belle Arti e Paesaggio per le Province di Barletta-Andria-Trani e Foggia and other European institutions, has unearthed two churches, traces of a settlement, fortifications, and a residential tower1–5. The bishopric was in decline by mid thirteenth century, and in 1296 the site was given by the king of Naples Charles II to ‘Abd al-‘Azīz, a Muslim knight from the nearby city of Lucera6. An adult and an infant Islamic individual according to the burial rite, were found in the cemetery, respectively TC8 and TC217. In 1300 Tertiveri was given to a Christian knight.

*S2.1.1 Osteological analysis of the human skeletons from Tertiveri*

In total, 113 human skeletons from Tertiveri were included in this study. Osteological material was sampled with the permission and collaboration of the Soprintendenza Archeologia, Belle Arti e Paesaggio per le Province di Barletta-Andria-Trani e Foggia and this is currently stored at the Soprintendenza in Foggia. The majority of the human dataset was recovered from four burial shafts (features 105, 112, 142, 143) parallel to the external walls of the Cathedral church (Samples TC1-21, 61-77, 79-84, 113)8. These burials likely include high-status individuals, among which the so-called ‘Bishop’ (TC74). Neonates, small infants and children are underrepresented in these burial shafts, therefore they were presumably buried in the nearby ‘ordinary’ cemetery (e.g. TC78). Also 26 samples from this ‘ordinary’ cemetery were recovered during fieldwork activities, before the archaeological excavations began, on the NE of the Tertiveri Cathedral (Samples TC86-112). At a second church, 40 mostly incomplete burials were sampled (Samples TC22-60, 85)9. Radiocarbon analysis was carried out on skeletons from funeral shaft 105. These date the burials from the eleventh to the thirteenth centuries7. The burials contained commingled remains and their 14C analysis showed cases of secondary deposition of earlier burials7. Congenic pathological features observed in some of the skeletons suggest some relatedness among commingled individuals7,10. Within the feature 105, the skeleton of a senile adult (c. 70-80 years old, TC74) was found together with the remains of a pastoral shaft and therefore supposed to belong to a bishop7,11.

Prior to sampling for isotopic analysis, skeletal remains were analysed anthropologically and documented (see below). The bone surface preservation of the remains was overall good12 and samples taken for isotopic analyses had a high collagen content13 (also see Supplementery Information File 1). However, materials recovered from the ‘ordinary’ cemetery during fieldwork activities were heavily fragmented due to recent ploughing and, for most individuals, collagen was not preserved. For conservation purposes, only fragmented bones were taken for isotopic analysis. For this reason, sampled bone material was sometimes barely sufficient for collagen extraction, hence bioapatite stable carbon and oxygen isotope analysis was not carried out for all individuals.

Ribs were preferred for sampling, however, due to the presence of commingled skeletons, these could not be sampled systematically. Whenever ribs were unavailable or not clearly associated with an individual, long bones or skull fragments were sampled. In alternative, whichever bone fragment available and clearly associated to an individual was sampled.

All human remains were studied using well established anthropological methods. A preliminary report of the results of anthropological and palaeopathological analysis was published7. This included a case study on a defect of the neural arch10 and a case of leprosy.

Biological sex in adult individuals was assessed through the observation of pelvis and cranium14–16. Whenever standard methods could not be employed due to limited skeletal completeness and/or preservation, metrical sex determination was used. In this case, femur circumference17, and talus and calcaneus18 were measured. Furthermore, robusticity was recorded, and sometimes also used for sex assessment.

Age at death in non-adults was mainly assessed using tooth development charts19,20 and long bone length21,22. For foetuses, Kósa (1978)23 was followed. Also the epiphyseal and apophyseal closure of the postcranial bones was observed15. In adults, age at death was determined through closure of the cranial sutures, the relief of the pubic symphysis, and the spongiosa structure of the humeral and femoral heads14–16. Furthermore, whenever these could not be used, age at death was determined through morphological changes of the sternal rib end24, palatal suture closure25 and facies auricularis26. The definition of measurements of cranial and postcranial bones (e.g. for height estimation) followed Bräuer (1988)27  [and Martin (1928)](https://www.zotero.org/google-docs/?XqB54J)28. Whenever possible, body heights were also calculated according to Pearson (1898)29. These Pearson’s formulas are best adapted for height estimations in ancient and medieval skeletons30, and the mathematical and anatomical estimates do not differ significantly from each other31. Epigenetic features, and pathological alterations of the cranial area (including teeth), and the postcranial skeleton were also recorded. These will be reported in a forthcoming publication. Biological sex and age at death distribution for each burial ground in Tertiveri is recorded below in Table S2.1.1, S2.1.2, and S2.1.3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age Class | M | F | M=F | Total |
| 0-1y |  |  | 0.65 | 0.65 |
| -5y |  |  | 1.85 | 1.85 |
| -10y |  |  | 1.5 | 1.5 |
| -20y |  |  | 0.1 | 0.1 |
| -30y | 8.3 | 2 | 3.5 | 13.8 |
| -40y | 5.5 | 1 | 4.5 | 11 |
| -50y | 0.7 | 1 | 1 | 2.7 |
| -60y | 1.2 |  |  | 1.2 |
| >60y | 1.3 |  |  | 1.3 |
| 21+ |  | 1 | 6.9 | 7.9 |
| 40+ | 1 |  | 2 | 3 |
| Total | 18 | 5 | 22 | 45 |

Tab. S.2.1.1. Sex and age distribution (n) of the sampled individuals in in the Privileged Burial

Shafts (N=45).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age Class | M | F | M=F | Total |
| 0-1y |  |  | 2.5 | 2.5 |
| -5y |  |  | 3.45 | 3.45 |
| -10y |  |  | 1.05 | 1.05 |
| -20y | 1 | 0.5 | 1 | 2.5 |
| -30y | 6.5 | 5.5 | 1.5 | 13.5 |
| -40y | 6 | 4 | 0.5 | 10.5 |
| -50y | 2.5 |  |  | 2.5 |
| -60y | 1 | 1 |  | 2 |
| >60y | 1 |  |  | 1 |
| 21+ | 1 |  |  | 1 |
| 40+ |  |  |  |  |
| Total | 19 | 12 | 9 | 40 |

Tab. S2.1.2. Sex and age distribution of the sampled individuals in in the Second Church

Cemetery (N=40).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age Class | M | F | M=F | Total |
| 0-1y |  |  | 1.7 | 1.7 |
| -5y |  |  | 3.8 | 3.8 |
| -10y |  |  | 3.1 | 3.1 |
| -20y | 0.7 |  | 3.4 | 4.1 |
| -30y | 0.3 |  | 2 | 2.3 |
| -40y |  | 0.5 | 2 | 2.5 |
| -50y |  | 0.5 | 1 | 1.5 |
| -60y |  |  | 1 | 1 |
| >60y |  |  |  |  |
| 21+ | 1 | 1 | 6 | 8 |
| 40+ |  |  |  |  |
| Total | 2 | 2 | 24 | 28 |

Tab. S2.1.3. Sex and age distribution of the sampled individuals in in the Cathedral Ordinary

Cemetery (N=28).

In the burial shafts, some animal remains were recovered and five of them were sampled for isotope analysis: Two cattle (TCCA1-2), one ovicaprid (TCSG1), one pig (TCPI1), and one tortoise bone (TCTO1).

**S2.2 Montecorvino and San Lorenzo in Carminiano**

The late medieval site of Montecorvino was founded as part of the same defensive network that included Tertiveri. The archaeological excavation of the site is still ongoing under the leadership of the Università di Foggia in collaboration with the local Soprintendenza office. Previous campaigns focused on the local Cathedral, segments of the settlement, and on fortified architectures32–36. Only sporadic traces from the Byzantine period (early eleventh century) are attested whereas most archaeological remains date to the Norman period. Norman-Swabian Montecorvino observed a structural defensive restyling transforming the fortification into a two-tower system (motte and bailey). In addition, the development of a coeval urban centre is also attested. The site presented traces of different productive and crafting activities (e.g. evidence of pottery and lime kilns) and silos, indicating an economy based on cereal production. The decline of the settlement started in the fifteenth century.

San Lorenzo in Carminiano was a late medieval rural settlement located in the Tavoliere plain. The archaeological site has only been partly investigated through archaeological surveys and an excavation led by the Università di Foggia in collaboration with the Soprintendenza office37–39. Sporadic traces of an earlier Roman and Late Antiquity occupation have been observed, but the main structure of the settlement appears to date to the late-eleventh century. Most of the local economy appears grounded on crafting activities, animal husbandry - in particular pigs - and on cereal production. A demographic increase is observed in the thirteenth century, as evidenced by the creation of a suburban area. From the fourteenth century onwards there was a progressive decline of the settlement until its abandonment. The main church of San Lorenzo in Carminiano has only been partially excavated.

*S2.2.1 Preliminary assessment of osteological data from Montecorvino and San Lorenzo*

The skeletal assemblage from Montecorvino consists of 17 human individuals and 15 faunal specimens.Osteological material was sampled with the permission and collaboration of the Soprintendenza Archeologia, Belle Arti e Paesaggio per le Province di Barletta-Andria-Trani e Foggia and its study is curated by the University of Foggia (Laboratorio di Archeologia, Dipartimento di Studi Umanistici). Human skeletons were recovered during the excavation of the Cathedral in Montecorvino, but one individual from this assemblage was instead buried in the castle area (i.e. MO17) and dates somewhere between the mid-eleventh to the mid-thirteenth centuries. Graves contained single and multiple individuals and were located along the lateral walls of the building, both externally and internally. Those placed inside the building (e.g. T.1) are assumed to contain wealthier individuals. Some of the individuals from Montecorvino were radiocarbon dated and preliminary results suggest they date from the eleventh to the sixteenth centuries, with the majority dating to the Norman, Staufen, and Angevin periods.

From San Lorenzo only four human individuals could be analysed plus one deer specimen. The latter was sampled for isotopic analysis since there is historical evidence of a royal hunting ground nearby the site39 which may have carried out deer management. Human remains were recovered from three graves discovered on the external frontal part of the only church excavated on the site. These graves have been radiocarbon dated to the Norman or Staufen periods (1053-1266).

Completeness12, preservation of the human skeletons12, and collagen preservation was overall good according to established parameters13 (see also Supplementary Information File 1). Analysed individuals presented overall high level of completeness (above 75%). For Montecorvino and San Lorenzo, it was possible to sample rib bones from all individuals for isotopic analysis. Sex identification focused on the two skeletal regions that represent the most reliable sexual dimorphism, i.e. cranium and pelvis. An assessment was carried out through both morphological14 and metric40 analysis. Age at death was determined via cranial sutures41,42, pubic symphysis morphology43–46 and facies auricularis47. Demographic and palaeopathological analyses are currently undergoing as a larger assemblage was excavated only recently. Faunal specimens were identified following Schmid’s (1972)48 methods.

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