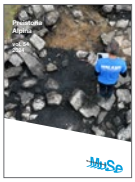

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Article / Articolo

Big Data for the study of lifeways in ancient Italy: the “Inhumation Veneto” and “Samnium” databases

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Key words

- Big Data
- Mountain environments
- Veneto
- Samnium
- Bioarchaeology
- Human-environment interactions

Abstract

Big Data, with accompanying multiregional or pan-continental databases, are a new frontier in bioarchaeology. There are huge benefits in this approach, including the availability of large amounts of scientific data. However, the Big Data approach is not without its challenges, which we contribute to address in this article. We do so by discussing two databases we created: “Inhumation Veneto” and “Samnium”. These are regional databases of archaeological individuals from Italy, spanning over 1,200 years (c.1,200 BC – 25 AD). They include c.2,500 osteological, zooarchaological and archaeological finds associated with c.850 individuals from tombs, as well as scattered human remains. The databases allowed us to reconstruct individual and collective lifeways in late prehistoric and Early Roman Italy. An important focus has been the exploration of human-environment interactions and sociocultural processes between the Alps, the Apennines and nearby plains. In this article, we present both databases and their outcomes. We then outline their utility for addressing constraints and challenges in Big Data, concerning osteology, site selection, chronology and data quality. As regards directions for future research, we discuss issues involving data reuse, ethics, and the obsolescence of information and digital platforms. We conclude by underlining the untapped potential of Italian archaeology for contributing to Big Data, in view of the rich material available.

Parole chiave

- Big data
- Ecosistemi montani
- Veneto
- Sannio
- Bioarcheologia
- Interazioni uomo-ambiente

Riassunto

I Big Data, con i relativi database multiregionali o pan-continentali, sono una nuova frontiera della bioarcheologia. Questo approccio presenta enormi vantaggi, inclusa la disponibilità di grandi quantità di dati scientifici. Tuttavia, l’approccio dei Big Data non è privo di sfide, che contribuiamo ad affrontare in questo articolo discutendo due database da noi creati: “Inhumation Veneto” e “Samnium”. Si tratta di database regionali di individui archeologici provenienti dall’Italia, che coprono un arco di oltre 1.200 anni (circa 1.200 a.C. – 25 d.C.). Includono circa 2.500 resti osteologici, zooarcheologici e archeologici associati a circa 850 individui provenienti da contesti deposizionali come tombe, e resti umani sparsi. Tali database ci hanno permesso di ricostruire i modi di vita individuali e collettivi nell’Italia tardo preistorica e protoromana. Un aspetto importante è stato l’esplorazione dell’interazione uomo-ambiente e dei processi socioculturali tra le Alpi, gli Appennini e le pianure vicine. In questo articolo presentiamo innanzitutto entrambi i database e i risultati derivanti dalla ricerca basata sul loro impiego. Descriviamo quindi la loro utilità per affrontare i vincoli e le sfide dei Big Data, con particolare attenzione per l’osteologia, la selezione dei siti, la cronologia e la qualità dei dati. Per quanto riguarda le direzioni per la ricerca futura, affrontiamo problematiche riguardanti il riutilizzo dei dati, l’etica e l’obsolescenza delle informazioni e delle piattaforme digitali. Concludiamo sottolineando il potenziale inespresso dell’archeologia italiana per contribuire alle iniziative Big Data, vista la ricchezza del materiale disponibile.

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1. Introduction

The study of lifeways in ancient societies is a topic of heightened interest in bioarchaeology, with growing reliance on multiregional or pan-continental databases. Recent examples of this trend include the databases “Amalthea” in Cocozza & Fernandez (2022), “Isotòpia” in Formichella et al. (2024), “Maia” in Farese et al. (2023), and “IsoMad” in Hixon et al. (2024). At the same time, there has been increasing attention to bioarchaeological datasets from Italy (e.g. Capuzzo et al. 2024; Cavazzutti et al. 2019a, 2019b; Laffranchi et al. 2019; Riccomi et al. 2024). Big Data, therefore, have emerged as a new frontier in (bio)archaeological research (Green 2023). There are significant benefits in this approach, including the availability of large amounts of data deriving from archaeology and cognate disciplines, such as isotope analysis, osteology, taphonomy, and ancient DNA (aDNA).

However, the Big Data approach faces challenges of its own, which we contribute to address in this article. We do so by means of two case studies deriving from our work on Big Data and past lifeways. We, therefore, present “Inhumation Veneto” and “Samnium”, two databases for the study of social dynamics and human-environment interactions in late prehistoric and Early Roman Italy. The databases focus on the regions of Veneto in Northeast Italy and Samnium in Central Apennine Italy, c. 1.200 BC – 25 AD (Fig. 1, Fig. 2, Fig. 3). Overall, they gather c.850 human individuals, with accompanying information on the biological, taphonomic and pathological profiles of the deceased. The databases also include information on the material culture and any faunal materials associated with the human remains. In addition, they gather information on chronology, geography and scholarly literature.

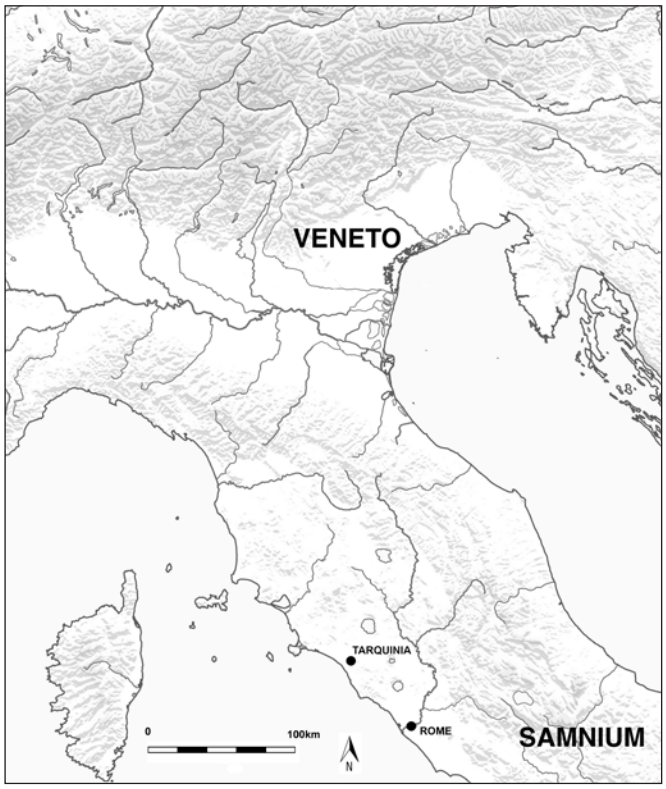

Fig. 1 – *Map of Italy with the main regions discussed in this article (by E. Perego and R. Scopacasa; base map courtesy of the Ancient World Mapping Center). /* ***Fig. 1 –*** *Mappa dell’Italia con le principali regioni trattate in questo articolo (di E. Perego e R. Scopacasa; mappa originale per gentile concessione dell’Ancient World Mapping Center).*

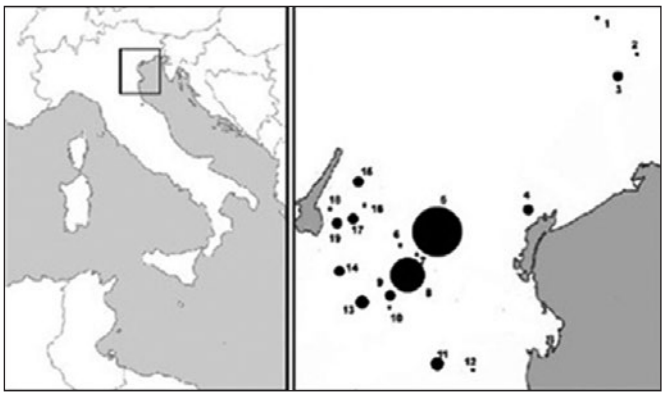

Fig. 2 – *Geographical distribution of the sampled sites in “Inhumation Veneto”, listed below with the approximate number of individuals in each: 1. Montereale (n=1); 2. Concordia (n=3); 3. Oderzo (n=11); 4. Altino (n=8); 5. Padua (n=110); 6. Lozzo (n=3); 7. Ponte della Torre (n=1); 8. Este (n=57); 9. Montagnana (n=10); 10. Vallarana (n=1); 11. Frattesina (n=14); 12. Villamarzana (n=3); 13. Gazzo (n=17); 14. Oppeano (n=7); 15. Santorso (n=9); 16. Montebello (n=4); 17. Colognola (n=9); 18. Rivoli (n=2); 19. Archi di Castelrotto (n=8). The dimensions of the dots reflect the sample size (elaboration by E. Perego after Perego 2012a with bibliography) ./* ***Fig. 2 –*** *Distribuzione geografica dei siti campionati in “Inumazione Veneto”, di seguito elencati con il numero approssimativo di individui per ciascuno: 1. Montereale (n=1); 2. Concordia (n=3); 3. Oderzo (n=11); 4. Altino (n=8); 5. Padova (n=110); 6. Lozzo (n=3); 7. Ponte della Torre (n=1); 8. Este (n=57); 9. Montagnana (n=10); 10. Vallarana (n=1); 11. Frattesina (n=14); 12. Villamarzana (n=3); 13. Gazzo (n=17); 14. Oppeano (n=7); 15. Santorso (n=9); 16. Montebello (n=4); 17. Colognola (n=9); 18. Rivoli (n=2); 19. Archi di Castelrotto (n=8). Le dimensioni dei punti riflettono la dimensione del campione (elaborazione di E. Perego da Perego 2012a con bibliografia estesa).*

“Inhumation Veneto” and “Samnium” allowed us to reconstruct individual and collective ways of life at the interface of human-environment interactions and sociocultural processes (e.g. Perego 2012a, 2012b, 2014a, 2014b, 2016, 2020; Perego & Scopacasa 2016, 2018, 2019, 2024a, 2024b; Perego et al. 2015, 2020a, 2020b; Scopacasa 2009, 2010, 2014, 2015, 2016, 2024, forthcoming). An important focus has been the exploration of ancient mountain lifeways in a comparative perspective between the Alps, the Apennines and nearby plains; additional collaborative work drawing on data from “Inhumation Veneto” compared funerary practices and social dynamics in Veneto and Trentino-Alto Adige, with a focus on the Alpine range (Saracino et al. 2017, 2021; Zanoni et al. 2018).

In this article, we first present both databases and their outcomes to date. We then outline their utility for addressing constraints and challenges in Big Data, specifically concerning osteology, site selection, chronology and data quality. As regards directions for future research, we also discuss issues involving data reuse, ethics, and the obsolescence of information and digital platforms. We conclude by underlining the untapped potential of Italian archaeology for contributing to Big Data initiatives, in view of the richness of the material available from Italy.

“Inhumation Veneto” and “Samnium” could be made available to the scholarly community, for promoting future collaborative work on the areas under study. This is pending further evaluation of the evidence sampled in the databases, including permission to divulge unpublished data. Both databases contribute to our new Big Data initiative: MARGA—the MARGinality in Archaeology database (Perego & Scopacasa 2024a) and to further collaborative work within the framework of the EUREKA project.[1] Ultimately, our research contributes to the Big Data movement, while addressing limitations in evidence and methods.

[1] https://linktr.ee/MARGAproject

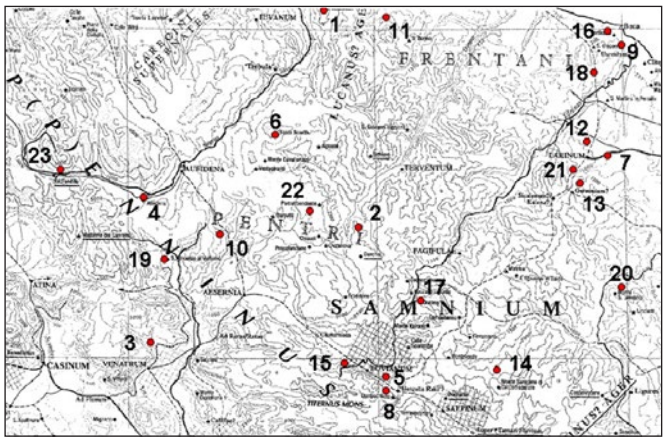

Fig. 3 – *Geographical distribution of the sampled sites in "Samnium" listed below with the approximate number of individuals in each: 1. Atessa (n=4); 2. Bagnoli del Trigno (n=1); 3. Camerelle (n=62); 4. Campo Consolino (n=134); 5. Campone (n=37?); 6. Capracotta (n=4); 7. Carpineto (n=30); 8. Cerro Copponi (n=2); 9. Difesa Grande (n=43); 10. Forli del Sannio (n=1); 11. Gissi (n=6); 12. Monte Arcano (n=28); 13. Montorio nei Frentani (n=n/a); 14. Morgia della Chiusa (n=23); 15. Noce di Massaro (n=6); 16. Porticone (n=141); 17. Pozzo Nuovo (n=1); 18. S. Margherita (n=9); 19. San Vincenzo al Volturno (n=13); 20. Santo Venditti (n=34?); 21. Stazione (n=5); 22. Troccola (n=3); 23. Val Fondillo (n=154) (elaboration by R. Scopacasa after Scopacasa 2009 with bibliography). /* ***Fig. 3 –*** *Distribuzione geografica del campione in "Samnium" di seguito elencati con il numero approssimativo di individui per ciascuno: 1. Atessa (n=4); 2. Bagnoli del Trigno (n=1); 3. Camerelle (n=62); 4. Campo Consolino (n=134); 5. Campone (n=37?); 6. Capracotta (n=4); 7. Carpineto (n=30); 8. Cerro Copponi (n=2); 9. Difesa Grande (n=43); 10. Forli del Sannio (n=1); 11. Gissi (n=6); 12. Monte Arcano (n=28); 13. Montorio nei Frentani (n=n/a); 14. Morgia della Chiusa (n=23); 15. Noce di Massaro (n=6); 16. Porticone (n=141); 17. Pozzo Nuovo (n=1); 18. S. Margherita (n=9); 19. San Vincenzo al Volturno (n=13); 20. Santo Venditti (n=34?); 21. Stazione (n=5); 22. Troccola (n=3); 23. Val Fondillo (n=154) (elaborazione di R. Scopacasa da Scopacasa 2009, con bibliografia estesa).*

2. Methods

2.1 Data collection

We carried out data collection for "Inhumation Veneto" and "Samnium" in the late 2000s and early 2010s for our doctoral research (Perego 2012a and Scopacasa 2009, respectively). Data collection was primarily based on research publications, such as journal articles, book chapters, exhibition catalogues and academic dissertations. These were mainly in English and Italian. Grey literature such as excavation reports and *schede museali* (museum archival data) was also consulted. In addition, we conducted visits to relevant institutions in the Italian regions of Veneto, Molise and Abruzzo, which included museums, *Soprintendenze* and universities.

We initially carried out data collection separately for our individual doctoral research. These datasets were later joined and expanded in the context of our collaborative work and later projects such as CoPOWER (2017-2019, Principal Investigator Elisa Perego) and EUREKA. This work resulted in our new database MARGA (Perego & Scopacasa 2024a), which has been integrating data from both novel publications and science-based methodologies in the field, such as isotope analysis, that are increasingly being applied to samples from ancient Italy (e.g. Capasso et al. 2023; Cavazzuti et al. 2019a). The two original databases remain a valuable source for the data they contain (some of which are not necessarily transferable to MARGA) and for developing comparative approaches to marginality and inhumation in diverse environments of late prehistoric and Early Roman Italy. "Inhumation Veneto" and "Samnium" can also be used as case studies to address strengths and constraints in Big Data, as we do in this article.

2.2 Geographical remit

"Inhumation Veneto" and "Samnium" comprise 42 sites in Veneto and Central Apennine Italy, largely dating to the late 2nd and 1st millennia BC. In late prehistory to the Early Roman period, these regions varied in terms of climate, environment, sociopolitical structures, and funerary practices. Samnium and Veneto are characterized by intricate topographical and hydrologic systems: Veneto is marked by lacustrine and riverine configurations between the Po plain, the Adriatic Sea and the Alps (Capuis 1993). Samnium is a region of interlocking mountain chains and upland valleys sided by the Campanian plain to the west (Tagliamonte 1996). These geographical diversities allowed us to explore ancient ways of life in different ecosystems between mountains and plains.

2.3 Scope

"Inhumation Veneto" was assembled for Perego's doctoral research on "Venetic" personhood together with additional databases, here collectively labelled as "Cremation Veneto", which stored and analysed data concerning c.2000 cremation graves and accompanying material culture from Veneto, c.1,200 BC – 25 AD.[2] In-depth discussion of "Cremation Veneto" falls beyond the scope of this article, which focuses on inhumations. The overall dataset in Perego 2012a afforded a comparison between inhumations and cremations, by looking at different chronological phases and Venetic subregions. "Inhumation Veneto" was specifically built to investigate marginality and personhood in connection with the adoption of inhumation. A minority rite in late prehistoric Veneto, inhumation had usually been considered an anomalous funerary practice, and a probable marker of stigma, low status, foreign origin, punishment and/or enslavement, as opposed to wealthier cremations in the region (e.g. Capuis 1993, p. 83; Gamba & Tuzzato 2008; Michelini & Ruta Serafini 2005; Pascucci 1984; Saracino 2009). These hypotheses, however, often relied on small samples and case studies. "Inhumation Veneto", therefore, provided a systematic evaluation of the evidence available at the time of its construction. Four aspects of sociocultural practice were considered: i) gender and age, in light of correspondences between burial practices and osteological data; ii) the spatial disposition of inhumations and its significance for the expression of social relations; iii) the link between post-mortem treatments and the construction of personhood for inhumations; and iv) whether and to what extent inhumation could be linked to the expression of social marginality.

"Samnium" was meant to aid the study of collective identity formation among the communities of Central Apennine Italy described as Samnites in ancient sources. The Samnites are generally portrayed in Greco-Roman accounts as mountain societies with a distinctive pastoral raiding lifestyle, who resisted the Roman conquest of the 4th and 3rd centuries BC (e.g. Scopacasa 2015; Tagliamonte 1996). A key aim of "Samnium" was to assess systematically the cohesiveness of sociocultural practices in the areas where Samnite communities were supposed to have concentrated, both according to ancient authors and modern literature

[2] Statistical Package for the Social Sciences 17 – SPSS – was used to this aim. Several SPSS databases were produced, according to the study's logistics and scope (here, collectively, "Cremation Veneto"). The adoption of different databases aimed at a flexible and easy manipulation of data that differed significantly in their quality and degree of documentation. Our re-evaluation of these databases while preparing this paper afforded reflection on technological obsolescence (see below).

(Bispham 2007; Dench 1995; Salmon 1967). Funerary data represented the vast majority of the archaeological evidence available and/or published at the time of Samnium’s construction. The database was therefore designed to gather such data, to support the systematic study of patterns in funerary practices as proxies for identity formation. This was done in view of individual sites through time as well as by comparing different sites in the study area. Four spheres of sociocultural practice were in mind: i) gender, in view of correlations between surviving grave furnishings and osteological data; ii) the spatial arrangements of tombs and their significance for the expression of social relations; iii) the signalling of tombs in the landscape and its implications for social memory; and iv) funerary expressions of socioeconomic differentiation.

2.4 Database structure

“Inhumation Veneto” is a relational database built in Microsoft Access. Access was chosen because of its ability to store large amounts of both textual and numerical information, in view of the study’s aims, logistics and type of material available. The database was originally called “Inhumation” (Perego 2012a) and is here named “Inhumation Veneto”, to underline its geographical remit in relation to “Samnium”. “Inhumation Veneto” has three tables. The primary table, called TOMB, provides a path to two secondary tables, INDIVIDUAL and GRAVE GOODS, which store more detailed information about the human remains and any associated finds. The database has a “one to many” relationship that allows one record in the main table to have more than one record in each secondary table. Tables 1-3 detail the entries of each table. Figure 4 shows the visual elaboration of a tomb in the database as it appears in PDF format (*scheda*).[3]

Tomb 2

Locality	ContextName	TombNumber	Chronology	Start	End
Este	Ricovero	12/1984	IIID1	525	500/450

Context	TombType	Individual(s)	GraveGoodsPresence	AnimalRemains	Horse
cemetery	pit grave	1	no	no	no

Evidence	Publication	Bibliography
excellent	excellent	Michelini and Sainati 1998, 150-4

Remarks: pit excavated in pyre debris; west side of the cassetta; buried at the same time of the main deposition

Individuals

Record No. 1
Age: foetus
Condition: good
Remarks: eight months in utero; anatomical connection

Grave goods

Fig. 4 – *Visual elaboration from “Inhumation Veneto” of a tomb sampled for the database (after Perego 2012a). /* ***Fig. 4 –*** *Elaborazione in forma di scheda di una tomba in “Inumazione Veneto” (da Perego 2012a).*

The evidence in “Samnium” is catalogued in a Microsoft Excel spreadsheet database, with the available and/or published information from the sampled funerary sites. The basic units catalogued are the surviving grave goods contextually associated with the individual tombs. Each individual grave good corresponds to a row in the spreadsheet. Each row is then divided into fields (columns), which refer to different features and/or dimensions of the tomb. These fields/columns are presented below (tables 4-6), standardised in view of the framework of “Inhumation Veneto” and MARGA, for consistency.

Tab. 1 – *Entries for main Access table TOMB in Perego 2012a. /* ***Tab. 1 –*** *Voci per la tabella Access principale TOMBA in Perego 2012a.*

FIELD	DESCRIPTION
locality	name of site (e.g. Este)
context name	name of cemetery or other context of burial (e.g. Benvenuti)
tomb number	tomb number [ID]
context	whether the burial was found in a cemetery, settlement or ritual area
tomb type	tomb structure (e.g. pit)
chronology	approximate chronology of the grave according to the Peroni/Bondini framework (e.g. IIIC)
start	post quem of the grave (e.g. 750)
end	ante quem of the grave (e.g. 700)
individual(s)	number of individuals
grave goods	whether the tomb contained grave-goods (e.g. yes)
evidence	quality of the evidence (e.g. excellent= the grave was very well preserved when discovered)
publication	quality of the publication (e.g. poor, i.e. only scanty information is available about the tomb)
remarks	additional information on the burial
bibliography	
animal remains	presence of animal remains in the tomb (e.g. yes)
horse	presence of complete horse skeletons, or large portions of a horse skeleton, in the tomb (e.g. yes)

Tab. 2 – *Entries for secondary Access table INDIVIDUAL in Perego 2012a. /* ***Tab. 2 –*** *Voci per la tabella Access secondaria INDIVIDUO in Perego 2012a.*

FIELD	DESCRIPTION
sex	biological sex as determined through the osteological analysis
age	approximate age at death as determined through the osteological analysis (e.g. child)
min	minimum age at death (e.g. 21)
max	maximum age at death (e.g. 40)
condition	condition of skeleton at the time of discovery (e.g. incomplete)
position	body position (e.g. prone)
orientation	body orientation (i.e. head-feet orientation: e.g. N-S= north-south)
right arm	position of right arm
left arm	position of left arm
right leg	position of right leg
left leg	position of left leg
shroud	possible presence of a shroud
remarks	additional information on the burial
disease	evidence of paleopathology

[3] In MARGA (Perego & Scopacasa 2024a), which is currently an Access database, we updated the names of the primary table TOMB to TOMB-DEPOSITION, and of the secondary table GRAVE GOODS to GRAVE GOODS-OBJECT. This was done to avoid *a priori* narrowing down the interpretive scope of the remains: for example, human remains deposited with no funerary scope in mind should not be necessarily categorized as “tombs”; while objects found with the human remains are not necessarily “grave goods”. MARGA also features a third secondary table called ISOTOPES, where we are storing isotope data that were not available at the time of the original databases (Capasso et al. 2023; Cavazzuti et al. 2019a; CoPOWER). Further tables could be added to MARGA if new data, such as ancient DNA (aDNA) and radiocarbon data, are produced in our regions of interest.

Tab. 3 – *Entries for secondary Access table GRAVE GOODS in Perego 2012a. /* ***Tab. 3 –*** *Voci per la tabella Access secondaria CORREDO in Perego 2012a.*

FIELD	DESCRIPTION
typology	typology (e.g. fibula)
height	
length	
diameter	
material	material (e.g. bronze)
position	position of object in respect to the body
remarks	additional information on the object

Tab. 4 – *Entries for main Excel table TOMB in "Samnium" (after Scopacasa 2009). /* ***Tab. 4 –*** *Voci per la tabella Excel principale TOMBA in "Samnium" (da Scopacasa 2009).*

FIELD	DESCRIPTION
locality	name of site (e.g. Alfedena-Campo Consolino)
tomb number	tomb number [ID]
tomb date	post quem/ante quem range
tomb type/shape	e.g. pit/cist; circular/rectangular
tomb measurements	width, length, depth
tomb lining/fill	e.g. earth-rubble fill; limestone slab/ terracotta tile lining
tomb cover	e.g. limestone slab cover/ terracotta tile cover
burial type	no. of individuals, rite (inhumation vs. cremation), position of body if inhumation (e.g. supine)
animal remains	presence of animal remains in the tomb (e.g. yes)

Tab. 5 – *Entries for secondary Excel table INDIVIDUAL in "Samnium" (after Scopacasa 2009). /* ***Tab. 5 –*** *Voci per la tabella Excel secondaria INDIVIDUO in "Samnium" (da Scopacasa 2009).*

FIELD	DESCRIPTION
sex	biological sex as determined through the osteological analysis
age	approximate age at death as determined through the osteological analysis, with varying degrees of precision (e.g. 17-25 years/"child")
condition	condition of skeleton at the time of discovery (e.g. incomplete/absent)
orientation	body orientation (i.e. head-feet orientation: e.g. N-S= north-south)

Tab. 6 – *Entries for secondary Excel table GRAVE GOODS in "Samnium" (after Scopacasa 2009). /* ***Tab. 6 –*** *Voci per la tabella Excel secondaria CORREDO in "Samnium" (da Scopacasa 2009).*

FIELD	DESCRIPTION
typology	objects were assigned to five main 'artefact classes': vessels (subdivided according to function); personal ornaments/jewellery, weapons/armour; banqueting paraphernalia (other than vessels); 'other items'.
height	
length	
diameter	
decorative features	
quantity	
material	material (e.g. bronze)
position	position of object in respect to the body
remarks	additional information on the object

3. Results

Both "Inhumation Veneto" and "Samnium" afforded broad-ranging, quantitative and qualitative analyses of cultural attitudes to death and burial in complex paleoenvironments, which included Alpine and Apennine mountain ecosystems.

"Inhumation Veneto" included a minimum of 280 individuals from 19 sites (Fig. 2). Depositions were mostly single supine inhumations without accompanying monumental structures. Most individuals seem to have been deposited in simple pits or perishable and now-disappeared structures, such as wooden coffins, "shrouds" (*sudari*), or possibly leather bags (e.g. Gamba & Voltolini 2018; Perego et al. 2020a, 2020b). Individuals in positions other than supine were recovered (e.g. crouched, prone), with such positions apparently indicating specific social identities (e.g. younger age) or more entrenched forms of social exclusion in some cases (Fig. 5). Individuals of different ages and sexes were present, as was the case in "Samnium". Scattered, unburnt human remains were also occasionally reported in Veneto. Such remains could correspond to the remnants of poorly preserved inhumation burials, or ritual deposits composed of incomplete individuals, sometimes placed outside the formal burial ground (Gamba & Tuzzato 2008; Gamba & Voltolini 2018; Michelini 2005; Michelini & Ruta Serafini 2005, 2013; Perego 2016). The exact number of individuals in "Inhumation Veneto", therefore, might be slightly higher than the recorded minimum number of individuals (MNI) of 280. Contextual and statistical analysis from "Inhumation Veneto", as compared to data in "Cremation Veneto", shed new light on the social meaning of inhumation in Veneto, with inhumation potentially embodying forms of social exclusion and diminished personhood. However, inhumation was heterogeneous in nature; there were diverse practices linked to this rite, which could be used to express apparent forms of ritual violence and extreme erasure of personhood (Perego 2012a, 2012b, 2014a, 2014b, 2016, 2020; Perego et al. 2015, 2020a, 2020b; Saracino et al. 2014, 2017, 2021; Zanoni et al. 2018).

In "Samnium", the sample comprised c.530 tombs from 23 sites (Fig. 3). Most tombs were documented as individual supine inhumations (Fig. 6), with around a dozen cremations. The inhumations were mostly described as deposited in simple pits or stone-lined coffins; as in Veneto, these inhumations were not placed in architecturally prominent structures such as stone tumuli and chamber tombs. Analyses of the data in "Samnium" pointed to a high degree of variability in sociocultural practices in Central Apennine Italy in the period under study. This suggested a culturally dynamic and heterogeneous scenario, compatible with the development of multiple and overlapping corporate identities. Such identities coexisted and/or competed with regional-level, federal-type allegiances such as the one described in ancient accounts as the "Samnite league" (Scopacasa 2009, 2010, 2014, 2015, 2016, 2024, forthcoming).

Taken together, our analyses shed new light on lifeways in two different socio-ecosystems of Italy, c.1200 BC – 25 AD. The complex geomorphological landscapes of both areas were linked to different cultural trends at the subregional level. For example, inhumation, at the time of "Inhumation Veneto"'s construction, seemed not to be attested in the more mountainous north of Veneto in the 1st millennium BC before the Roman encroachment. In contrast, inhumation appears to be more common at the main centre of Padua in the plain, even in respect to other sites such as the

Fig. 5 – *Adult inhumation deposition from the settlement of Oppeano La Montara, Veneto (after Perego 2016, courtesy of Soprintendenza archeologia belle arti e paesaggio per le province di Verona, Rovigo e Vicenza [SABAP – Vr]). /* ***Fig. 5 –*** *Inumazione di adulto dall’insediamento di Oppeano La Montara, Veneto (da Perego 2016, per gentile concessione della Soprintendenza archeologia belle arti e paesaggio per le province di Verona, Rovigo e Vicenza [SABAP – Vr]).*

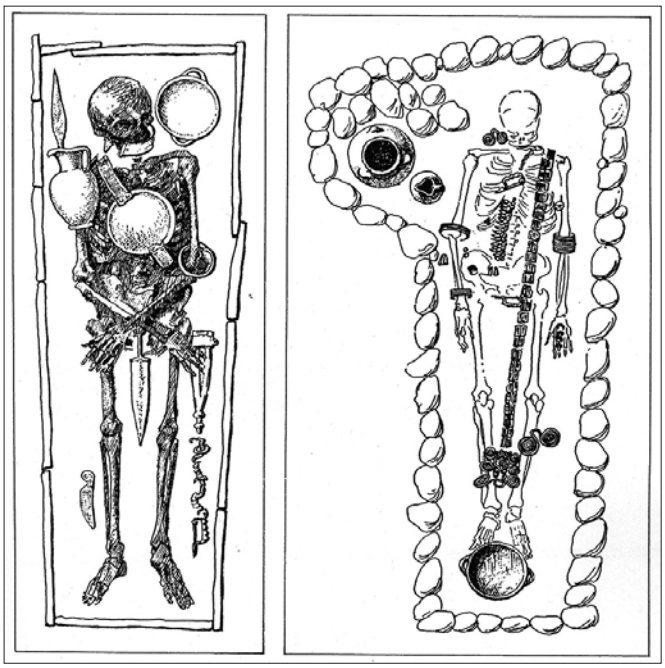

Fig. 6 – *Adult inhumation depositions from the cemetery of Alfedena, Chieti (Samnium) (from Mariani 1901; courtesy of Soprintendenza archeologia, belle arti e paesaggio dell’Abruzzo [SABAP-Abr]). /* ***Fig. 6 –*** *Inumazione di adulti dalla necropoli di Alfedena, Chieti (Samnium) (da Mariani 1901; per gentile concessione della Soprintendenza archeologia, belle arti e paesaggio dell’Abruzzo [SABAP-Abr]).*

nearby Este, where the rite was still used but far more rarely than cremation. The reasons for such geographical discrepancies remain partially obscure; however, the evidence available suggests localized sociocultural practices and attitudes toward people in life and death, with variation between different Veneto subregions and “protourban” centres (Perego 2012a; Fig. 2). A similar scenario is discernible in the Central Apennine mountains, where diverse cultural manifestations can be identified as regards burial customs: for example, cremation was unattested in the more mountainous areas, but was present in lower-lying valleys towards the Adriatic (Di Niro 1991b). In Veneto, inhumation was, overall, a minority rite that expressed a heterogeneous range of identities, and seems to have occasionally embodied extreme forms of social exclusion in areas such as the Veronese and central Veneto. The percentage of inhumation tombs attested at different sites at the time of “Inhumation Veneto”’s preparation was variable, ranging between 0 in certain areas and 20-25% at certain burial sites in Padua (e.g. Gamba & Voltolini 2018; Michelini & Ruta Serafini 2005; Perego 2012a, Table A1.9.1; Ruta Serafini 1990). Given that a significant percentage of cremation tombs contained multiple individuals (e.g. Bianchin Citton & Calzavara Capuis 2006; Bianchin Citton et al. 1998), while inhumation tombs generally contained only one individual, the real incidence of cremated individuals in the overall sample might be even higher, although not fully elucidated (Perego 2012a). This was especially an issue when cremation graves – while identified in the field – remained to be analysed osteologically to determine the MNI they contained. Cremation, at any rate, was the commonest visible rite in Veneto in the period under study. While across the region, both very simple cremations and inhumations are attested, the most conspicuous and wealthiest graves were generally cremations, which also tended to receive more “prominence” spatially (e.g. in the middle of mounds for the richer ones). This suggests that cremation was used to underline, on average, the most prominent social statuses, as well as higher degrees of social inclusion. There were, however, some regional and diachronic variations affecting these patterns (Perego 2012a, 2014a, 2016; Perego & Scopacasa 2019, 2024b; Perego et al. 2020a, 2020b).

A diverse range of funerary identities can be noted among the inhumations in 1st-millennium BC Samnium, where, unlike Veneto, inhumation seems to have been the dominant funerary rite. Yet, in comparison with neighbouring Tyrrhenian regions such as Etruria, Latium and Campania (Cuozzo 2003, 2016; Rajala 2016; Riva 2010), where inhumation is also attested, one distinctive feature of the known funerary record of 1st-millennium BC Samnium is the apparent absence of monumentality and/or overly ostentatious tombs (Capini & Di Niro 1991; Faustoferri 2003; Tagliamonte 1996). An important point, therefore, is that inhumation seems to have shared some similar sociocultural implications in Veneto and Samnium, for example in terms of levels of energy expenditure (e.g. the cost of pyre wood), which motivated our work on MARGA. One key issue in this regard is how to use data from the original databases to investigate whether inhumation in the two regions could have embodied marginalized identities and in what ways.

Our subsequent, collaborative analysis drawing from both the original databases as well as data in more recent publications (e.g. Gamba & Voltolini 2018) cast new light on social dynamics and human-environment interactions in the two sampled regions. For example, we identified increasing inequality in the context of growing environmental and hydrological instability (flooding) in Veneto in the first half of the 1st millennium BC (Perego & Scopacasa 2019, 2024b; Perego et al. 2020a, 2020b). This could manifest with an increase of anomalous depositions, such as prone inhumations, at various Venetic sites, and/or with a more hierarchical arrangement of burial places, such as at the Este Ricovero cemetery. We also shed new light on the burial treatment of sub-adults in phases of accelerated sociopolitical change in both Veneto and Samnium, with heterogeneous expressions of personhood and social inclusion. We showed the acquisition of personhood in these regions to have been incremental, namely an individual’s degree of social inclusion, as shown in the funerary sphere, became, on average, more pronounced as they aged, for example by means of more conspicuous grave assemblages and rites. However, personhood acquisition was informed by other aspects of the individual’s identity, such as social affiliation and status: sometimes young children could be presented in death as having a higher degree of social inclusion than adults bearing markers of marginalization (Perego 2020; Perego & Scopacasa 2018; Perego et al. 2020b; on child depositions from other regions of Italy see e.g. Nizzo 2011; Tabolli 2018a, 2018b; Zanoni 2016).

The merger of “Inhumation Veneto” and “Samnium” also laid the foundation for MARGA, a more recent project and accompa-

nying database we have been developing for the study of marginality in the ancient Mediterranean and nearby inland areas. To date, MARGA gathers osteological, archaeological, taphonomic, and isotope data ($\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$ and $^{87}Sr/^{86}Sr$). This comes with contextual information on chronology, epigraphy, zooarchaeology, geography, palaeobotany and scholarly literature. We discuss MARGA further in upcoming publications (e.g. Perego & Scopacasa 2024a). We are currently working towards making MARGA open access for the scholarly community. In addition, we prepared an Excel database which includes data from both "Inhumation Veneto" and "Samnium", along with a sample of around 100 newly-published inhumations from Veneto, in the context of the EUREKA project, for making such data open access.

4. Constraints and limitations

In view of developments at the intersection of Big Data and bioarchaeology, in this section of the article we reflect on constraints and limitations regarding our original databases. These reflections can contribute to other Big Data projects that encounter similar challenges. This is particularly salient in Italian archaeology, where a considerable amount of older material faces issues regarding the preservation of archaeological and biological evidence, as well as sampling, analysis and storing.

4.1 Osteological evidence

The osteological data stored in both "Inhumation Veneto" and "Samnium" derived from analyses carried out by bioarchaeologists working on the original materials. As can be the case with database builders, we did not analyse the specimens ourselves, including any zooarchaeological data. Osteological data on inhumations excavated at the dawn of Venetic archaeology, such as in the 1800s and early 1900s, are particularly scanty and subject to many methodological limitations. Basic distinctions between, for example, "adult" and "child" are sometimes, however, available (e.g. Soranzo 1885; also Perego 2012a with bibliography).

The human depositions in "Samnium" and "Inhumation Veneto" subjected to osteological analysis from the 1970s to the 2000s were examined on the basis of criteria and procedures standard at the time. These were laid out by the *Istituto Italiano di Antropologia*, the *Journal of Human Evolution* and other specialist literature (e.g. Bondioli et al. 1986; Bowden et al. 2006; Buikstra & Ubelaker 1994; Di Niro & Petrone 1993; Drusini et al. 1988, 1998, 2001, 2006; Onisto 2004; Paine et al. 2007; Parise Badoni & Ruggieri Giove 1981; Perego 2012a with further bibliography). For the identification of biological sex, analysis relied on diagnostic traits such as in the pelvis and skull, as well as sheer bone size, to situate individuals within a spectrum ranging from "male" to "female" (e.g. "probably male"). These measurements based on sexual dimorphism were, however, affected by a degree of subjectivity, with particular regard to less diagnostic traits, such as bone robusticity.

Osteometric measurements were impossible for sub-adults and badly preserved and/or incomplete adult remains. Preservation was affected by variables such as i) diagenesis (the factors which affect the preservation of archaeological remains in the ground); ii) the excavation and documentation methods used in the field; iii) activities in the areas of interest, which might have damaged and sometimes obliterated the archaeological layers; iv) the adoption of cremation as a funerary rite, especially in Veneto. We note, however, that the degree and extent of exposure to fire appear to have varied across osteological samples, resulting in diverging levels of bone and tooth preservation (e.g. Drusini et al. 1988, 1998, 2001, 2006).

In terms of age, the individuals were classified into categories which were standard at the time of analysis, in view of their bone development and presentation. For sub-adults, age determination was mainly based on dental eruption and the development of long bones. Age estimations in archaeological samples, however, were already noted to be subject to limitations. Age assessments within the adulthood category remained especially contingent. For example, Table 7 shows the age categories and associated terminology used in "Inhumation Veneto". These categories are essential to make sense of osteological data in that database, but reflect then-current standards and constraints (e.g. Onisto 2004). They also attest endeavours by the database builder (Perego) to identify and catalogue information obtained from original datasets that varied considerably in terms of the preservation of human remains and the accuracy of the analyses. For instance, the category "14-60+" was adopted for individuals identified as non-children in the original publications. Similar issues also affect "Samnium".

Tab. 7 – *Age categories in Perego 2012a /* ***Tab. 7 –*** *Categorie di età in Perego 2012a.*

AGE GROUP	DEFINITION
Up to 8 months *in utero*	Foetus
Death up to 15 days before full term, at birth, up to 15 days after birth	Perinatal infant, stillborn
Approximately from birth to 1 year	Infant, neonate
From 1 to 13/14	Child
From birth to 13/14	Child (when osteological analysis failed to distinguish between child and neonate)
From 14 to 20	Juvenile, adolescent, young
From 21 to 40	Adult
From 41 to 60	Mature
From 60	Senile, elderly, old
From 14 to 60+	'Adult' (when no precise osteological results are available but the deceased was not immature)

The complexity of age-at-death and sex determinations in bioarchaeology has recently been put into sharper focus, which is reflected in our more recent initiative MARGA. For instance, there is growing attention to the multitude of factors, besides chronological age (the time elapsed from birth to death), that affect the human body and might impact on age determinations in osteological samples: degenerative changes to bones and teeth, for example, are increasingly recognized to be affected by genetics, workloads, diet and pathology (e.g. Bas et al. 2023; Mant & Holland 2019).

Thus, our work on MARGA also involves reassessing the age and sex estimates from the original publications. This is being done, for example, by means of novel analyses such as in CoPOWER, or by reconsidering how and which osteological data we should store in view of their estimated accuracy (Perego & Scopacasa 2024a). For example, an age category such as "41-60 years", which is used in "Inhumation Veneto" based on existing literature, has a degree of arbitrariness and should be contextualized in view of developments in bioarchaeology. We take a similar approach to data drawn from paleopathology, a discipline which has undergone significant developments in recent years (e.g. Anastasiadou et al. 2024; Bas et al. 2023; De Luca et al. 2023; Grauer 2023; Laffranchi et al. 2019; Mant & Holland 2019). We note that there are new techniques being increasingly adopted for sex and/or age determinations, including amelogenin peptide analyses and aDNA. These can be used to infer sex even in sub-adults, and in adults where osteometric measurements did not suffice (e.g. Bas et al. 2023; Cintas-Peña et al. 2023; Rebay et al. 2022).

4.2 Site selection

The area studied for "Inhumation Veneto" was roughly coincident with the present-day region of Veneto. The study focused on

a heterogeneous but apparently discreet cultural complex that has been attributed to a population or "ethnic group" broadly coinciding with the "Veneti" of ancient literary sources (Capuis 1993). Local epigraphic material carries evidence of a partially deciphered language written in the so-called "Venetic" alphabet, which displays subregional variation and attests the name *Venetkens* (Gamba et al. 2013; Marinetti 2004, 2023). The distribution of Venetic inscriptions across the region, in conjunction with relevant material culture, contributed to guiding site selection. Consequently, sites that are now located within the boundaries of Veneto, but were presumably occupied by "non-Venetic" communities in the study period, were excluded from sampling in "Inhumation Veneto". In particular, archaeological, epigraphic and historical evidence indicates that various areas of Veneto were home to non-Venetic groups through time, for example in the second half of the 1st millennium BC. Such groups have been broadly identified in scholarship as "Celtic", "Greek", "Etruscan" and "Raethic" (Bondini 2005a, p. 313; Gamba et al. 2013; Laffranchi et al. 2019). Among these people, inhumation appears to have carried a different social meaning than within the so-called Venetic complex. This is indicated, for example, by inhumation apparently being a standard funerary rite for some such groups, rather than a marker of marginality or social diversity. In view of this, "Inhumation Veneto" included only certain samples from Veneto in the timeframe under study. While such selectivity was necessary for the original research, it introduced biases in data collection, leading to the exclusion of some depositions found in the region. We underline that the concept of "ethnicity" can be seen in itself as a social construction: its application – even if in broader terms – to a region as diverse as late prehistoric and 1st millennium BC Veneto is not exempt from pitfalls (Perego 2011, 2014b).[4]

The sites included in "Samnium" were selected in view of their location in the areas of Central Apennine Italy where Samnite communities are reported to have concentrated in the late 1st millennium BC. The definition of these areas followed ancient Greco-Roman narratives, as well as the prevailing consensus in modern scholarship at the time of "Samnium"'s construction (Capini & Di Niro 1991; La Regina 1981; Salmon 1967; Tagliamonte 1996). The areas in question corresponded broadly to the modern provinces of Campobasso and Isernia (Molise) and Chieti (Abruzzo). Archaeological investigations in the late 19th and 20th centuries tended to focus on these areas in searching for distinctively Samnite material cultures. Epigraphic attestations of the Oscan *safin(im)*, probably the local version of the Latin ethnic *Samnites*, were also considered diagnostic in the search for a Samnite presence (Dench 1995; La Regina 1981). "Samnium"'s research aim was to explore systematically the development and transformation of collective identities in these geographical areas in the mid-late 1st millennium BC. While this approach was consistent with the study's aims and logistics, one drawback was the exclusion of large, richly documented funerary sites such as Fossa and Campovalano: these were geographically close to sites selected for "Samnium", but fell outside the limits of the study area. The quality of the evidence was also a factor in site selection, as we explain below.

4.3 Quality of data

The quality of data in "Inhumation Veneto" is highly variable. Looting, for example, was a serious problem, especially for contexts from the late 1st millennium BC (Bondini 2006, 2008). The scope of "Inhumation Veneto", however, was to find ways to make use of even poorly preserved evidence. This justified the sampling of depositions with very different levels of preservation and, in the end, impacted on how the database itself was constructed. Another problem was the loss of information, with many tombs being excavated before the introduction of modern archaeological techniques. The quality of the available publications was sometimes uneven. Complete lists of all finds in a given tomb were not always available, as was also the case in "Samnium". Inhumations in Veneto were also, often, poorly documented until recently, as their lack or scarcity of visible grave goods made them less attractive to earlier expeditions than wealthy cremations, which were considered paramount at the time (e.g. Alfonsi 1911, 1922; Callegari 1930; Soranzo 1885). In addition, in the case of both "Inhumation Veneto" and "Samnium", large amounts of excavated but unpublished evidence remained inaccessible. Access to some unpublished data was granted by relevant institutions, but with limitations as regards the possibility to release such data. Some of this material is currently in course of publication by local research groups and is of interest to MARGA.

More specifically, three main phases can be identified as regards the excavation history of Venetic tombs, which correlate with data quality and therefore shaped the way in which "Inhumation Veneto" was constructed (Perego 2012a). A first phase comprises materials excavated between the late 19th century and the early 20th. At the time, the discovery of wealthy cremations in the main Venetic centre of Este attracted significant attention in Italy and internationally, and laid the groundwork for both standard chronologies of Venetic materials and later re-analyses of such finds (Alfonsi 1911, 1922; Balista & Ruta Serafini 1998; Callegari 1930; Capuis 1993; Chieco Bianchi & Calzavara Capuis 1985, 2006; Prosdocimi 1882; Soranzo 1885). The level of the Este excavations was often excellent for contemporaneous standards, although data have been lost, including about stratigraphy. Most of the material excavated outside Este, however, was poorly documented (Nascimbene 1999; Salzani 2008). A second phase involves materials excavated between the first half of the 20th century and the 1960s. Interest in Venetic archaeology by the international community decreased, together with the number of field interventions. Excavations in this second phase are sometimes less accurate than earlier campaigns. Most of the material remained either unpublished or had been reanalysed second-hand by the time of assembling "Inhumation Veneto" and "Cremation Veneto" (e.g. Bianchin Citton 1982; Gregnanin 2002-3; Perego 2012a with bibliography). A third phase concerns materials recovered from the 1970-1980s onwards. Starting with excavations of sites such as the Piovego cemetery, Padua, and a new sector of the Ricovero cemetery, Este, the quality of excavations in Veneto improved significantly, with the introduction of routine osteological analysis, micro-stratigraphic techniques, and the excavation of tombs in the lab (Balista & Ruta Serafini 1991, 1992; Bianchin Citton et al. 1998; Leonardi 1990). Attention to the inhumations also increased, leading to better documentation. More recently, growing interest in techniques such as isotope analysis has consolidated (Capasso et al. 2023; Cavazzuti et al. 2019a; CoPOWER). Some such data are contributing to MARGA, as we detail in upcoming publications (e.g. Perego & Scopacasa 2024a).

The quality of data in "Samnium" is also affected by the context in which the sampled sites were excavated. One overarching issue concerns the relatively fragmentary nature of the data: practically all the tombs in "Samnium" were excavated in the 1970-1990s by the local archaeological *Soprintendenze* of Molise and Abruzzo, often in the context of rescue archaeology (e.g. Capini & Di Niro 1991; De Benedittis 2005; Di Niro 1981, 1989, 1991a, 1991b; Faustoferri 2003; *Sannio* 1980). Consequently, many excavated areas likely represent limited sectors of what are probably bigger sites (e.g. Di Niro 1991b). This problem also applies to sites in Veneto. The scarcity of microstratigraphic and osteological data at the time of "Samnium"'s construction is an additional constraint: only a portion of the c.530 sampled tombs had been analysed osteologically (e.g. Bondioli et al. 1986; Bowden et al. 2006; Di Niro & Petrone 1993;

[4] Ongoing research in the study area based on isotope analysis, iconography and epigraphy is also suggesting the presence of non-local individuals in areas pertaining to the Venetic complex (Capasso et al. 2023; Marinetti 2023; Saccoccio 2023), thereby further complicating the matter.

Paine et al. 2007; Parise Badoni & Ruggieri Giove 1981). The issue of tomb looting, however, is not noted as paramount, because the sampled tombs were mostly recorded as undisturbed prior to excavation (e.g. Capini & Di Niro 1991; Faustoferri 2003).

The availability, quality and reliability of archaeological evidence were additional selection criteria in "Samnium". This led to the exclusion of a few known sites in the study area whose material was either devoid of archaeological context or had not been systematically excavated, dated and published (e.g. De Benedittis 2005; Scopacasa 2009 with bibliography). Also excluded were sites excavated in the late 19th and early 20th centuries, such as most of the Alfedena necropolis (Mariani 1901), with the exception of the Campo Consolino sector of Alfedena (Bondioli et al. 1986; Parise Badoni & Ruggieri Giove 1981).

4.4 Chronology

Chronology in the original databases generally relies on relative dating based on diagnostic objects and stratigraphic associations. In both "Samnium" and "Inhumation Veneto", the object-based sequences available when the databases were assembled remain to be systematically confronted with the latest radiocarbon calibration curves and other absolute dating methods (Becerra-Valdivia & Higham 2023).

Dating in "Inhumation Veneto" mostly draws on a local chronological sequence, the so-called Peroni-Bondini framework; this has been developed by multiple scholars over several decades and intersects with other frameworks such as the Fogolari-Frey chronology (e.g. Bianchin Citton & Calzavara Capuis 1985, 2006; Bianchin Citton et al. 1998; Bondini 2005b, 2006, 2008, 2010; Peroni 1981). The framework adopted in "Inhumation Veneto" is therefore a relative chronology grounded in artefact dating and stratigraphy, linked to some degree to absolute chronological sequences from outside Veneto, in view of diagnostic objects such as imports. Many inhumations could not be dated with precision, as they lacked surviving grave goods. Stratigraphy and spatial relations with cremations could provide a date range for these inhumations in some cases (Perego 2012a).

The dating of the tombs catalogued in "Samnium" was done on the basis of object typologies, mainly diagnostic pottery. The typological sequences used referred primarily to neighbouring regions of Italy, namely Campania and Puglia: De Juliis (1977) for proto-Daunian and Daunian ware; Albore Livadie (1979) for Campanian *bucchero*; and Sparkes & Talcott (1970) and Morel (1981), for Campanian and Attic black gloss pottery, respectively. These sequences are valid for the study area, as it yielded these pottery types. However, Gnathian ware, which significantly helps to narrow down the dating context for the period between the late 4th and 3rd centuries BC, has been very rarely recovered in Samnium (Lloyd 1995).

Although the artefact-oriented dating is helpful for estimating the earliest possible date of a tomb, or *terminus post quem*, it is less useful for pinpointing the latest possible date, or *terminus ante quem*. This is because artefacts can circulate for long before being deposited. Heirlooms are an obvious example, and their potential presence in tombs makes dating uncertain. In Veneto, the presence of tombs with multiple depositions from different chronological phases is another example of this kind of issue (Bianchin Citton & Calzavara Capuis 1985, 2006; Bianchin Citton et al. 1998). Unclear stratigraphy or unsystematic recording of layers upon excavation are also a problem.

To counterbalance issues such as these, a flexible chronology was used for the material in "Samnium". The periods in this chronology were longer, usually a little over a century. This made it possible to include both precisely and imprecisely dated tombs in the same broad period. The dated tombs were, therefore, assigned to three main periods, roughly corresponding to: i) the 6th century BC; ii) late 6th – late 5th centuries BC; and iii) the late-5th – early 3rd centuries BC. This allowed the detection of diachronic trends in funerary practice, which was a key research objective of "Samnium". Chronologies based on *post* and *ante quem* dating were used in "Inhumation Veneto", too, thereby affording the use of broader chronologies in addition to, or together with, the more refined Peroni-Bondini framework (e.g. Fig. 4).[5]

5. Directions for future research

5.1 Reuse

Sharing of the original databases with other scholars would allow novel research to be carried out in the study areas. A further option would be to make the databases available open access, such as those contained in the IsoArcH initiative (https://isoarch.eu/). We note, however, that the release of our databases in open-access format might involve ethical and practical issues that remain to be fully addressed, as discussed below and in upcoming publications (e.g. Perego & Scopacasa 2024a). Given the need to address such factors, the open-access release of the databases is under consideration, also in view of collaborations with Big Data initiatives which we are currently undertaking such as EUREKA. A constraint to address involves further evaluation of the evidence in the databases, including permission to divulge unpublished or embargoed data. Our work on MARGA and in EUREKA aims to remedy some such issues.

5.2 Ethics

We aim to build a framework for the ethical reuse of data catalogued in "Inhumation Veneto" and "Samnium".[6] We outline potential debates on issues such as:

1) the presence in the databases of information, especially regarding osteology, produced through excavations in early phases of Italian archaeology – when now-established international ethical standards and procedures involving human remains were not yet in place; such discussions are coming to the fore in international bioarchaeology, including the conditions under which the use of such data can be considered appropriate (e.g. Stantis et al. 2024 with extensive bibliography);[7]
2) the storage in the databases, with permission, of unpublished data that nonetheless need to be released first through ongoing initiatives in the study areas, in view of any extant scientific agreements;
3) the presence in the databases of information generated by early-career researchers and/or students, some of whom might have left the field, are employed in precarious positions, and/or remain to publish their work in journals or as monographs (e.g. data from doctoral theses which were made available to us, or produced by us). Whenever we employ data already published or released as open-access dissertations or theses, we aim to cite the initial source when appropriate, as a way to give full credit to data producers.

Our own use of "Inhumation Veneto" and "Samnium" is sustained by a thorough understanding of the broader contexts from which their data derive. This affords a more careful treatment of the information than would otherwise be possible were such knowl-

[5] In MARGA, we employ a *post/ante quem* chronological framework that accommodates the different dating sequences and ranges from "Inhumation Veneto" and "Samnium": e.g. 800 BC (MAX YEAR), 750 BC (MIN YEAR). We remain committed to adding calibrated dates in the database as they become available.

[6] The same applies to "Cremation Veneto" and MARGA.

[7] This debate is especially focused on the use of osteological data from indigenous communities in the USA (Stantis et al. 2024).

edge absent. For example, we are fully aware of potential margins of error regarding the age categorizations of the sampled human remains, including in view of in-depth knowledge of the original publications from which the data derive. The same issue pertains to the sampling of data, e.g. in view of “ethnicity”, as detailed above. A query of the databases without such previous knowledge could risk overlooking limitations in evidence and methods.

5.3 Obsolescence

We highlight the risk of technological and informational obsolescence, and loss of bioarchaeological data, in Big Data initiatives. This applies to an extent to “Inhumation Veneto” and “Samnium”: these databases were produced over a decade ago, and could not be made available open access immediately after their construction, as they contain unpublished data. The full datasets in “Inhumation Veneto” and “Samnium” are available to us in hard copy and PDF format, thereby preventing the loss of data. However, lack/loss of access to the original databases in Microsoft Access and Excel would prevent querying the latter with new research questions. Our more recent projects such as MARGA and our participation in EUREKA attempt to remedy such issues in the sampled areas, for example by updating the dataset with new information and by using up-to-date platforms.

We highlight, however, that issues of obsolescence are paramount in the current Big Data approach in bioarchaeology. This is especially with regard to data collected in excavations and projects from decades ago, in early phases of the digital revolution, when then-novel forms of data processing, formatting and storage were emerging. Some such projects may remain to be updated to current digital formats. We note the following potential threats to bioarchaeology in particular: i) loss of data through lack of access to original sources; ii) the sustainability of digital platforms; iii) database builders leaving the discipline without divulging their material; and iv) databases falling behind innovative IT resources and platforms, for lack of funding and/or personnel. We highlight that the support of IT specialists and programmers would be crucial towards the proper curation of databases, in the current context of accelerated technological advancements. There is the risk, however, that such resources are not available to all projects that require them.

5.4 Big Data in Italian Archaeology

We underline the untapped potential of Italian archaeology for contributing to Big Data initiatives. The sheer amount and richness of the (bio)archaeological record of the Italian peninsula make it an ideal source of information on ancient lifeways and identities (e.g. Acconcia 2015, 2021; Laffranchi et al. 2019; Nizzo 2011; Pasini et al. 2019; Perego & Scopacasa 2016; Tabolli 2018a, 2018b; Zanoni 2011, 2016), including through Big Data (Farese et al. 2023). We highlight a growing interest in this regard in the discipline, including in the regions of Veneto and Samnium (e.g. Cavazzuti et al. 2019a, 2019b; Faustoferri 2016; Riccomi et al. 2024; Sparacello et al. 2015). We acknowledge that there are issues concerning access to, and (re)use of (bio)archaeological data from the peninsula, as well as their storing and dissemination. We have noted some such issues above (e.g. ethics, obsolescence, loss of labour and expertise, lack of access to funding and IT specialists). In this regard, we hope that our work can offer a contribution to Big Data forays into Italian archaeological datasets. We highlight that there are a number of initiatives which have been applying state-of-the-art technology to document bioarchaeological finds from Italy, such as, but not limited to, the case of the Piovego cemetery in Veneto (e.g. Bezzi 2005; Capasso et al. 2023; Gallo 2023) as well as Frattesina and the Terramare (e.g. Cavazzuti 2019a, 2019b).[8]

6. Conclusion

Databases are a key tool for the collection, preservation and dissemination of bioarchaeological data. Big Data approaches drawing on repositories of bioarchaeological information are a new frontier in archaeology and cognate disciplines. We, therefore, presented “Inhumation Veneto” and “Samnium”, two databases we built for the study of social dynamics and human-environment interactions in ancient Italy, c.1,200 BC – 25 AD. The databases comprise c.850 archaeological individuals and c.2,500 associated specimens, such as objects and faunal remains, which we sampled from the regions of Veneto and Samnium, in Northeast and Central Apennine Italy, respectively. Both databases contribute to MARGA, a project and accompanying database we have been developing for the study of social marginality in the ancient Mediterranean and inland nearby areas. Our work on MARGA and its subsidiary databases contributes to the Big Data initiative in bioarchaeology, evolutionary biology and cognate disciplines, while addressing limitations in evidence and methods.

“Inhumation Veneto” and “Samnium” have been instrumental to the study of collective and individual lifeways in two different ecosystems of ancient Italy at the crossroads between plains and mountains. They allowed us to explore burial practices, ritual, paleopathology and ecology in the study areas. Here we provided an outline of the databases and their outcomes. We also identified research constraints and gaps to be addressed. These include concerns about osteological data, as well as data quality, sampling and chronology. As regards future research, we also underlined issues which can affect similar Big Data initiatives, namely: the obsolescence of IT systems and of the information collected; access to embargoed and unpublished data; and ethics around data dissemination and reuse. In view of this, “Inhumation Veneto” and “Samnium” could be made available open access, pending further evaluation of the unpublished or embargoed data they contain. Overall, we are keen to make our datasets available for collaborative work through research agreements. We hope that our endeavour will contribute to highlight the untapped potential of Italian archaeology in Big Data.

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Author contribution

E.P. and R.S. contributed to the article equally. E.P. is solely responsible for work on “Inhumation Veneto”, including conceptualization, data acquisition, data curation, database implementation and analysis. R.S. is solely responsible for work on “Samni-

[8] We are unable to cite here all of the various ongoing initiatives in this regard, but we want to raise attention to this important trend in Italian bioarchaeology.

um", including conceptualization, data acquisition, data curation, database implementation and analysis. E.P. and R.S. are equally and solely responsible for MARGA, including conceptualization, data acquisition, data curation, database implementation and analysis.

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